Lake Biwa

Experience and Lessons Learned Brief

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1. Introduction

This brief outlines the major management issues for Lake Biwa, the largest freshwater lake in Japan. The lake and its watershed communities have enjoyed a common history for thousands of years, fostering a unique lake culture in the surrounding area. The birth of the lake can be traced back to some four million years ago. As one of few ancient lakes in the world, it embraces a rich ecosystem, with fifty-seven endemic species being recorded. At the same time, it is a principal water resource in Japan, supplying drinking water for 14 million people in its watershed and downstream areas. Additionally, its catchment area is highly industrialized and urbanized, being inhabited by approximately 1.3 million people, with the population still increasing at one of the highest growth rates in Japan. The lake also attracts people with its scenic beauty; every year some 30 million tourists visit the lake.

A key characteristic of the lake in terms of lake management is the fact that its watershed coincides almost perfectly with the boundaries of Shiga Prefecture. Thus, the history of the lake's management is one of environmental administration by the prefectural government, which has taken an integrated and holistic approach toward the management and conservation of Lake Biwa.

The history of the lake's management is also one of conflicts over water utilization and flood control between Shiga Prefecture and the central government or the downstream mega-cities, including Kyoto, Osaka and Kobe. The Lake Biwa Comprehensive Development Project (LBCDP), the largest

Figure 1. Lake Biwa and Yodo River Basin.

water resources development project in Japan, was launched to resolve the conflicts, as well as serve as a tool for local economic and water resources development. The framework of the LBCDP made it possible to utilize the large quantity of funds from the central and downstream local governments, which are needed to implement not only water resources development but also conservation works for the lake and its watershed. With LBCDP, deterioration of Lake Biwa water quality has been prevented to some degree. However, as discussed further below, a negative legacy from the project came into prominence during this same period, even though it was neglected at that time.

Nevertheless, the environmental administration, particularly of the water environment of Shiga Prefecture, for which the conservation of Lake Biwa is a top-priority, has always led, rather than followed, the relevant activities of the central government. Further, the environmental consciousness of the citizens of Shiga Prefecture for the lake gave birth to the Soap Movement, the most successful citizens' movement in Japan, enabling the prefectural government to enact the Eutrophication Control Ordinance, the very first act for eutrophication control in Japan.

Lessons learned from the history of lake management and pollution issues and countermeasures for Lake Biwa should be highly informative and helpful for many lakes facing the same types of issues.

2. Background

2.1 Biophysical Features

Lake Biwa is the largest lake in Japan, with a surface area of 670 km^2. Located in the uppermost reaches of the Yodo River Basin in central Honshu Island, it occupies one sixth of the jurisdictional area of Shiga Prefecture lying upstream of Osaka and Kyoto Prefectures (Figure 1). The lake consists of a minor basin in the south (South Basin) and a major basin in the north (North Basin), the latter being 11 times greater in surface area than the former. The South Basin has an average depth of only 4 m, while the North Basin has an average depth of 43 m. The lake has a volume of 27.5 km^3 and a shoreline length of 235 km. The water retention time is around 5.5 years, with 15 years needed for a complete flushing of the lake. The watershed (3,848 km^2), including the lake itself, is almost identical to the jurisdictional area of Shiga Prefecture. It covers 90% of the prefectural land, and consist of forest-covered hills and mountains (50.6%), rice paddy fields and other farmlands (14.7%), urban and industrial areas (18%), and the lake itself (16.7%). Over the past decades, the urban and industrial areas have been expanding, especially in the southeastern part of the watershed. The population in the catchment area has been increasing at the second highest growth rate in Japan, being approximately 1.3 million inhabitants at the present time. While more than 400 tributaries flow into the lake, only one natural watercourse, the Seta River, flows out of Lake Biwa. The Seta River is joined by the Kizu and the Katsura Rivers to become the Yodo River, which flows into Osaka Bay and eventually to the Pacific Ocean.

The annual precipitation and average temperature in the catchment area are about 1,700 mm and 14°C, respectively. Because it never freezes, the lake is classified as a semi-tropical lake. Thermocline formation is observed from May to November in the North Basin, but not in the South Basin. Lake Biwa is a typical monomictic lake.

The lake was formed about four million years ago, therefore being one of the oldest lakes in the world geologically. It was originally located some distance south and moved gradually to its present place about 430,000 years ago. The long history of isolation from the other regional water bodies is suggested by the lake's biota, which is fairly rich for an island lake. More than 1,000 animal and plant species, including 57 endemic species, have been recorded in the lake. Among the endemic species, 12 are fishes and 38 are benthos including many mollusk species.

Lake Biwa is an invaluable freshwater resource in terms of fishery and water supply. Its scenic beauty and recreational amenities also attract large numbers of tourists. The national park area encompassing Lake Biwa is also one of the most visited recreational sites in Japan. The navigational use of the lake, limited today mostly to pleasure boat tours, was quite important until the 1950s, both for passenger and commercial transportation. In addition, for the native Shiga residents, Lake Biwa has been the source of spiritual and even religious inspirations. Shiga is called "Lake Country." The social and cultural settings of the watershed communities have naturally been affected greatly by the history of their interaction with the lake, having evolved over thousands of years. Lake Biwa's water, together with water from the Kizu and Katsura Rivers, is used for municipal, industrial and agricultural purposes in Kyoto, Osaka and other downstream areas of the lake. The average amounts of water used for municipal, industrial and agricultural purposes are 6.6 million, 1.2 million, and 23.6 million m^3/day, respectively. The water for municipal use is distributed to 8 cities, 28 townships and 1 village in Shiga, Kyoto, Osaka and Hyogo Prefectures, with the combined population served being about 14 million.

The industrial water demand, which is less than 20% of municipal demand, has been declining over time, due to a decrease in the number of water-intense industries in the region, as well as to improved water-use efficiency over the past few decades. The agricultural water use takes place mostly in Shiga and Osaka Prefectures, about two thirds being in the former and one third in the latter.

2.2 Political and Socio-economic Features on Development and Conservation

Shiga Prefecture, which contains 98% of the entire Lake Biwa and its catchment area, was economically underdeveloped until approximately the mid-1970s. The strong desire of

the watershed communities for economic and regional development of the lake watershed was partially fulfilled by the Kinki Region Improvement Law (KRIL) of 1963, in which the lake watershed was designated as a development zone within the framework of the national development plan for the Kinki Region (the centrally located prefectures of Shiga, Kyoto, Nara, Wakayama, Osaka and Hyogo). Once designated as a development zone, the regional authority was required to lay out specific plans for appropriate population size, labor force requirements, categories of industry to be promoted, land use and the required infrastructure systems, and to mobilize the appropriate financial resources.

The enactment of a Special Law for Lake Biwa Comprehensive Development (LLBCD) of 1972 was implemented within the framework of KRIL, within which a comprehensive set of projects for water resource development, flood control and regional infrastructure development. It was called the Lake Biwa Comprehensive Development Project (LBCDP: 1972-1997).

The type and scale of development taking place in and around a lake's watershed invariably affects the quantity of water to be withdrawn out of the lake. Water resource development policy, therefore, is generally closely intertwined with regional economic development policy. In the case of Lake Biwa, the demand for water in the downstream region of Lake Biwa, called the Keihanshin (Kyoto, Osaka and Kobe) area, was projected in the mid-1960s to dramatically increase in the following decades.

However, LBCDP did not readily deliver its goals. Instead, there was a major conflict between the central government, which wanted to implement a large-scale development project, and the prefectural government, which wanted to minimize the destruction of nature by the project. After several years of scientific debate and difficult political negotiation, Shiga Prefecture was successful, to some extent, in turning back the original large-scale development plan proposed by the central government. Shiga Prefecture, central government and downstream governments eventually came to agreement in regard to the enactment of LLBCD mentioned above to realize a major national project, LBCDP.

For the Keihanshin Region, the development of water resources from Lake Biwa constituted part of a comprehensive water resource development for the whole of Yodo River, whose water resource management is dictated by the River Law of 1964 (revised in 1997), and the Water Resource Development Law of 1961.

The development and conservation needs arising within a watershed community usually evolve over time. Generally, the needs often shift from those directed toward development, followed by those directed toward control of environmental degradation and, eventually, by those directed toward conservation and restoration of natural resource values. In the end, the pursuit of a comprehensive, coherent and consistent legal framework for lake management may ideally become a major concern for the community. The legislative scheme devised in each phase of lake management reflects the administrative response towards fulfillment of such needs in each community. As the phase evolves, however, the resource management conflicts can become more severe, and the development of legal schemes of compromise in resource use and conservation become more and more problematic. After the completion of LBCDP, for example, the pursuit of an appropriate legislative framework for comprehensive conservation, or the enactment of a special Law for Lake Biwa Comprehensive Conservation (LBCCP), became a major interest for Shiga Prefecture. Such a legislative framework, however, was not realized because, for the national and downstream local governments, the investment requirements for the conservation components (such as construction of a comprehensive sewerage system around the lake) had already been included and implemented as part of LBCDP.

3. Biophysical Environment

3.1 Past and Current Conditions

The water quality of Lake Biwa deteriorated significantly during the high economic growth era of the 1960s, due mainly to rapid population growth, inadequate wastewater treatment, and the abuse of agro-chemicals in the catchment area. A wide variety of countermeasures, including the strengthening of industrial effluent standards, prohibition of the use of phosphate-containing synthetic detergents, and construction of sewerage systems have been conducted since then to prevent further deterioration of lake water quality. With those efforts, success in avoiding its further degradation has been achieved (Figure 2); however, no indication of improved lake water quality has yet been noted. More details are provided in Section 3.2.

In the meantime, significant changes have been induced by human activities to the littoral and catchment area over the past decades. There previously were 29 km² of lagoons

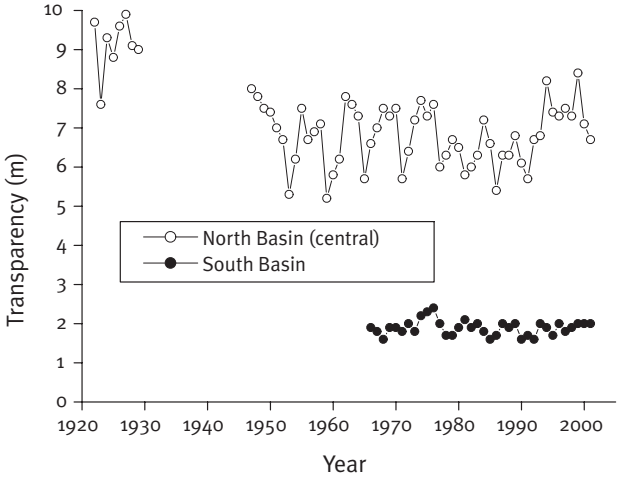


Figure 2. Water Transparency in Lake Biwa (Source: Adapted from Shiga Prefecture Environmental White Papers).

scattered around the lake. These lagoons provided breeding and spawning sites for native fish, and acted as buffer zones to reduce land-based nutrient loadings to the lake. However, most were reclaimed to form new paddy fields before and after World War II (WWII), with only 4 km^2 remaining today. Natural lakeshore areas have been gradually disappearing because of the development of the lakeshore. The area of reed belts also has decreased, being less than one half of the area existing in the 1950s. Most of the rivers flowing into the lake were straightened and concreted for flood control purposes. Meanwhile, urbanization due to rapid population growth has continued in the catchment area, resulting in a decrease in the green areas.

Through farmland improvement projects, the irrigation system for agriculture has totally changed. Irrigation ditches were completely separated from drainage ditches, with a vertical interval being installed between the paddy fields and drainage ditches to improve drain capacity. As a result, the use of water in a cascade style, as practices in past times, can no longer be seen, and fish cannot swim up to paddy fields for breeding. About 44% of the entire farmland in Shiga Prefecture is irrigated today with water pumped from the lake. The drainage water from the farmlands flows through drainage ditches directly into the lake.

The area of forests in the catchment area has been decreasing due to rapid urbanization in Shiga Prefecture since the 1960s. More importantly, a large area of pinewoods, which were previously used intensively as secondary forests providing fuel woods and green manures for people, have been gradually shifting to deciduous forests. As a result, the forests are no longer used as much since WWII.

Fish catches in Lake Biwa have been declining dramatically, today being almost one third of the catch in the late-1960s. Most of the native fish breed in the littoral area or lagoons around the lake. Due to road construction along the lakeshore, reclamation of lagoons, and changes in the irrigation system for paddy fields in the catchment area, however, many endemic cyprinid fishes have lost their breeding and nursery sites. Another hazard for the fish is the intentional lowering of the lake water level in June, which coincides with their primary spawning season. As a result, their eggs would dry up, even if they succeeded spawning. Furthermore, if their eggs could hatch, the juvenile fish would be killed by invasive species (e.g., large-mouth bass and bluegill) or by toxic herbicides or insecticides being spread on, and flowing out of paddy fields in the lake catchment area.

Another major concern today is the potentially adverse effects of global warming on the lake. According to climate change model predictions, the quantity of snow falling in Japan is projected to decrease significantly over the coming decades. Presumably because of global warming, in fact, the quantity of snow accumulation has been declining in the Shiga Prefecture over the past decades. The water in the snowmelt is cold and contains high levels of dissolved oxygen. As it enters Lake Biwa, its high density (relative to warmer lake water) means that it flows to the bottom of the lake, thereby adding a large volume of oxygen to the lowest water layers. Due to the lower snowmelt runoff in recent years, however, the oxygen supply associated with the snowmelt water is decreasing, resulting in the development of an anoxic (oxygen-depleted) zone in the deep water layer of the North Basin in the summer. This lack of dissolved oxygen may exacerbate the further deterioration of the lake's water quality.

3.2 History of Lake Degradation

The history of environmental issues, particularly of water quality degradation in Lake Biwa, can be categorized into four phases.

The first phase was characterized as fisheries damage caused by agro-chemicals. After WW II, a large area of lagoons around the lake was converted to new farmlands, for the purpose of eliminating poverty and alleviating food shortages. At the same time, significant quantities of agro-chemicals were applied to increase crop yields and alleviate farm production problems, resulting in serious soil and water pollution in Shiga Prefecture. The most serious issue was the massive death of fish by PCP, a commonly used herbicide at that time. The loss of the lake fishery in 1962 was estimated to be valued at 400 million yen. To cope with this issue, the prefectural government set a guideline for the use of agro-chemicals for the first time in Japan, directing farmers to use them appropriately, and particularly not to use some of them within a 6 km area around the lakeshore. A few years later, the Agricultural Chemicals Regulation Law was revised, with the use of persistent and hazardous agro-chemicals, including PCP, BHC, and DDT, being completely prohibited in Japan.

The second phase was in the era of environmental pollution in the 1970s. During the high economic growth era in the 1960s, many pollution issues, such as Minamata disease, Itai-Itai disease (cadmium poisoning), Niigata Minamata disease, and Yokkaichi asthma, were rapidly spreading nationwide, even as the standard of living in Japan went up dramatically. Shiga Prefecture was no exception; heavy metal pollution by antimony and fishery pollution by PCBs occurred in 1968 and 1972, respectively. To address these problems, the prefectural government enacted the Pollution Control Ordinance in 1969, laying down stricter effluent standards for industrial wastewater. The national Water Pollution Control Law also went into effect in 1971.

Although the environmental issues in Phase 1 and 2 were serious, they were nevertheless very local in impact, with the damages being confined mainly to the fishery. However, the characteristics of the environmental issues changed entirely in Phase 3, which began with the outbreak of "freshwater red tide" in 1977. The phenomenal economic growth in Japan in the 1960s, which caused severe environmental stresses across the country, also began to affect the water quality of this lake as a whole behind the scenes. As early as 1959, the outbreak of

Closterium aciculare caused clogging of sand filters in a water purification plant in Kyoto for the first time. Eutrophication became more severe, with the trophic state of the North Basin changing from oligotrophic to mesotrophic and the South Basin from mesotrophic to eutrophic. The lake's biota began to exhibit correspondingly drastic negative changes. The blooms of the bluegreen alga *Oscillatoria* resulted in taste and odor problems in drinking water for the first time in 1969. There also have been frequent occurrences of "freshwater red tide" from the bloom of the flagellate alga, *Uroglena Americana*, the first outbreak of which took place at the west side of the North Basin in 27 May 1977 (Figure 3).

The population in Shiga Prefecture was shocked by this incident, which made people realize that eutrophication of the lake was escalating. From then on, the environmental awareness of the Shiga Prefecture population rose considerably. For example, the Soap Movement (See more details in Section 4.4), which was initiated by women's consumer groups in the 1970s, was backed by strong public support that eventually spread out throughout the prefecture. This citizens' movement pressured the prefectural government to enact the Eutrophication Control Ordinance in 1979. This ordinance set stricter effluent standards on phosphorus and, for the first time in Japan, prohibited the use of phosphate-containing synthetic detergents.

This ordinance helped improve the quality of the lake water in the early-1980s. Nevertheless, the rate of improvement faded quickly in the latter part of the 1980s, and the lake water has exhibited signs of water quality deterioration ever since. Today much focus is placed on how to control non-point sources of nutrients in the catchment area. The outbreak of bluegreen algae *Anabaena* and *Microcystis* occurred for the first time in the South Basin in 1994, the most severe drought year on record. All these phenomena have recurred almost every summer since their initial appearances.

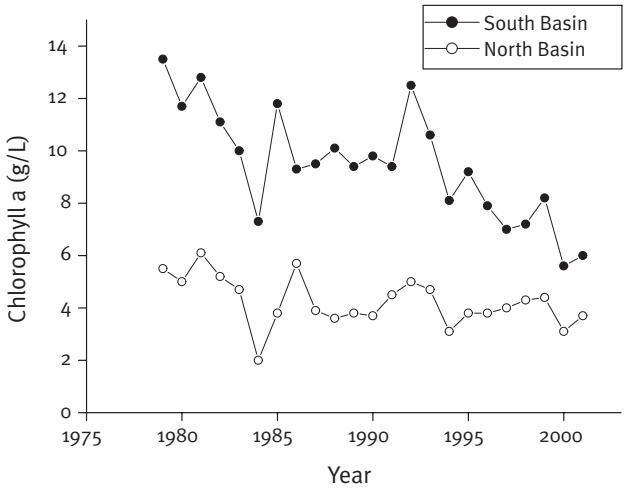


Figure 3. Chlorophyll-*a* Concentration in Lake Biwa (Source: Adapted from Shiga Prefecture Environmental White Papers).

Environmental issues involving Lake Biwa are now in Phase 4, which focuses on the degradation of the lake and the lakeshore ecosystems. Environmental policy in Japan has traditionally focused on the achievement and compliance of environmental standards for water quality, thereby not typically considering ecosystems and landscapes, for which no standards have yet been set. Consequently degradation in the lake and its littoral ecosystems, including disappearance of natural lakeshore, has become a serious issue for Lake Biwa today. Recognizing this deficiency, in 2000 the prefectural government developed the Lake Biwa Comprehensive Conservation Plan, called "Mother Lake 21 Plan," literally directed to the comprehensive conservation of the lake and its watershed. The plan sets up three major goals for 2050: the water quality to be restored to the level of the late 1950s; the basin inhabitants to live together in harmony with the forests and make full use of the natural water cycle; and a variety of unique creatures living in a rich natural ecosystem. Within the framework of this plan, the establishment of citizens' watershed organization in each major river flowing into the lake also has been promoted for these years.

Meanwhile, the disturbance of the lake ecosystem, as exemplified by a decrease in native and endemic fish because of invasive fish species, is becoming more apparent. In addition, with improved accessibility to the lakeshore, more tourists visit and make use of the shoreline for recreational purposes. As a result, littering with garbage, fish lines, and lures has become a serious issue. Other environmentally-related issues are noise pollution from personal watercraft, water pollution by gas emissions from pleasure boats, and beach impacts of recreational vehicles. To protect the living environment along the lakeshore, and the ecosystems in the lake and its littoral area, the prefectural government enacted the Ordinance for Appropriate Leisure Use of Lake Biwa in 2002. The ordinance designates regulatory zonings for pleasure boats, prohibits the use of personal watercraft with 2-cycle engines, and forbids the release of invasive fish once they are caught.

3.3 Lake and Drainage Basin Resource Conflicts

As implied in Section 2.2, the history of Lake Biwa and Yodo River water management was one of a conflict of interests and their resolution, in terms of flood control and water utilization between the Keihanshin Area downstream, particularly the Greater Osaka Region, and Shiga Prefecture upstream. Early in the history of Lake Biwa management, the communities in the immediate surroundings of Lake Biwa experienced severe flooding of their agricultural fields. The practical solution at that time was to increase the discharge capacity of the outflowing Seta River by dredging, which might, however, also increase the risk of flooding in the downstream Osaka area. The national government finally agreed, after the severe flooding of 1896 (in which the water level rose 3.76 m, keeping some of the watershed communities in water for up to 220 days), to a major dredging of the Seta River at the outlet of the lake, in combination with the construction of Seta Weir, the only artificial water-flow control facility of the lake outflow. The

weir, constructed in 1905 and renovated in 1961, controls the lake level and water discharge rate to Yodo River.

In regard to water resources development, the first significant human intervention took the form of the construction of a canal linking the lake with Kyoto City, initiated in 1874 and completed in 1885. The city, whose development had been hampered by a lack of water at that time, was able to regain its economic strength. Nearly a century later, another major human intervention for water resources development was introduced in the form of the previously-noted LBCDP, when the phenomenal economic growth in Japan after WWII prompted a sharp increase in water demands in the late 1960s in the downstream Yodo River and Osaka Bay area. The industrial use of groundwater in the region also was becoming severely constrained due to competition between industrial establishments, as well as land subsidence caused by the overuse of the water. Domestic water supply needs also began to increase in the Yodo River area after suburban cities joined Osaka in requiring access to Yodo River water, leading to the inception of large-scale water resource development (LBCDP).

The Lake Biwa Comprehensive Development Project (LBCDP) was a major national project (Figure 4), with its primary object being provision of additional supply of Lake Biwa water to the downstream region. The specific goals of the project were: (1) to construct levees[1] around the lake, with various flow control structures to enable the release of an additional 40 m^3/sec of lake water through the Yodo River; (2) to improve the flood control capability of rivers by channelization, and by installation of flow control gates along the Lake Biwa coastline, as well as along the Yodo River itself; and (3) to improve the water irrigation pipelines and sewerage systems around the lake. The financial support for these massive development projects came from the national government, the downstream prefectural and municipal governments, as well as Shiga Prefecture. The LBCDP cost 1.9 trillion yen, becoming the largest project ever implemented for water resources development in Japan. The project laid sound foundations for flood control and water utilization, and industrial and urban infrastructures, boosting the economy of Shiga. As a result, the average income of the Shiga Prefecture population is the third highest in Japan, behind only the Tokyo and Aichi Prefectures. There are many factories associated with high-tech industries around the lake, in which, for example, 60% of the desalinization membrane in the world are produced.

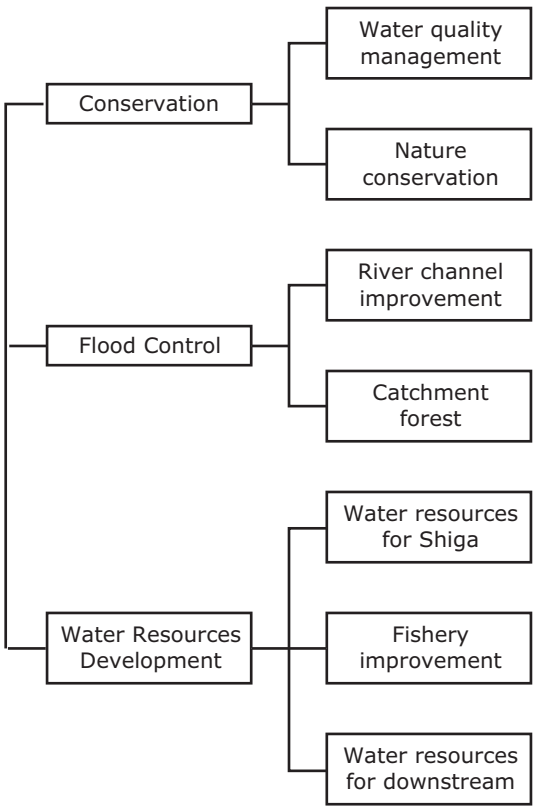


Figure 4. Basic Framework of the LBCDP.

It should be also noted that the largest portion of the project expense (26.6%), was used for the development of sewerage systems[2] in the catchment area, which was very effective in reducing nutrient loading from domestic sources to the lake.

The LBCDP, however, also triggered massive destruction of the lakeshore and littoral ecosystems as a result, and possibly degradation in the lake water quality, becoming a major conflict over the development versus the conservation of Lake Biwa. In 1976, demanding the right to enjoy clear water (a kind of environmental right), more than 1,000 citizens, mostly residents of Osaka, initiated a lawsuit against the central and Shiga Prefectural governments to stop the project. Although the plaintiffs lost the case after 13 years of civil lawsuit, the fundamental argumentation in this case came to fruition with the enactment in 1992 by the Shiga Prefectural Government of the Reed Belt Conservation Ordinance, the first act in Japan advocating the importance of an ecosystem, and the Basic Environment Ordinance in 1996. In line with the trend of the times, the concern of the watershed inhabitants has been shifting from comprehensive development to comprehensive conservation of Lake Biwa.

4. Management Environment

4.1 Lake Management Programs and Processes

4.1.1 Flood Control and Water Level Control

The water level of Lake Biwa, being controlled by the Seta Weir, may rise up to 1.4 m above the Biwa-ko Surface Level (BSL) to prevent downstream flooding in the case of torrential rains, whereas it may decline down to 1.5 m below BSL to meet downstream water demand in the case of drought. To cope with such water level fluctuations, embankments surrounding the lake were constructed to protect the lakeshore areas, and drainage facilities were installed to prevent those areas from inundation within the framework of LBCDP, in which many mudslide and flood control dams also were constructed upstream of the watershed and courses of many rivers downstream were changed and improved for flood control.

The flood control measures made within LBCDP have been successful to some degree, with flood damages in the lake watershed and downstream areas declining significantly. However, adverse effects of water level control on the lake and its littoral ecosystems have since become prominent, even though they were not as apparent at the beginning of LBCDP implementation. To this end, and involving a wide range of stakeholders, a process to review the rule of water level control at Seta Weir was begun a few years ago.

4.1.2 Agriculture

Pumping facilities to lift the lake water also were established widely over the prefecture within the LBCDP framework. Prior to these facilities, Shiga Prefecture population relied exclusively on rivers and groundwater for irrigation. Of a total of 600 km^2 of farmland in Shiga, 90% is paddy fields[3]. For many years, people in most parts of Shiga Prefecture suffered from water shortage for rice cultivation. Thus, many, sluice gates and reservoirs were constructed, developing a very water-conserving irrigation system, in which water discharged from upstream paddy fields was used in downstream field in a cascade manner. Such irrigation watercourses connected paddy fields, creeks, and lagoons, thereby also establishing water corridors for aquatic lives. The corridors acted as regulating pondages, and created unique and irreplaceable semi-artificial ecosystems around the lake.

However, today farmers in Shiga Prefecture can use as much water as they want and, when necessary, with the pumping facilities. They have no incentive to save water. In addition, because of the complete separation of irrigation and drainage ditches with farmland improvement projects, all the drainage water from paddy fields runs through drainage ditches directly into the lake. Further, aquatic creatures can no longer migrate within the water corridors. Thus, the unique aquatic ecosystems are on the verge of disappearing.

4.1.3 Forestry

Most of the forests in Shiga Prefecture are secondary forests, consisting of two types which have been utilized sustainably, but in different ways. Forests on the slopes of the mountains in the watershed which border the lake's basin were formerly used for commercial fuel, mainly charcoal, production. Those fuel forests, dominated by oak and other deciduous trees, have been cut periodically at 20-30 year intervals and, thereafter, left for natural regeneration by sprouting from cut stumps. On the other hand, forests covering low hills located near villages were used by farmers to harvest undergrowth plants and litter as manures for paddy fields, as well as to obtain fuel wood, resulting in the dominance of pine trees that can tolerate severely exploited poor soils. However, such functions of both forest types became no longer necessary after WWII with the advent of oil fuel and chemical fertilizers. As a result, pine woods, which once surrounded farming villages, have been rapidly disappearing. The rate of disappearance has been accelerated by the outbreak of pine-wilt disease, and by changing to deciduous forests more or less resembling fuel forests. Although considerable area of former fuel forests have been turned into conifer plantations, they are not well maintained today, since forestry in Japan as a whole has been declining and the numbers of forest workers decreasing. A plan for the future of forestry in Shiga Prefecture is still being sought. Ironically, however, ecological services provided by the forests in the catchment area have been enhanced.

4.1.4 Fishery

Fishing is not a major industry in Shiga Prefecture. Thus, there is no serious water pollution associated with aquacultures in the lake. However, fishery in Lake Biwa has fostered a unique food culture in the prefecture, including small Ayu fish boiled in sweetened soy sauce and "Funa-Zushi", a ferment food made of indigenous cyprinid fish named "Nigorobuna" *(Carassius auratus grandoculis)*. In addition, among other diverse piscatologies, "Eri", a unique and traditional fixed-trap netting in the lake, provides a scenic beauty shape off the shores. The lake fishery plays a central role in the Japanese freshwater fishery. Shiga Prefecture also ships a large quantity of juvenile Ayu fish *(Plecoglossus altivelis altivelis)*, the most popular freshwater fish in Japan, to the other prefectures, although the shipment today is not as much as it used to be. Cultivation of freshwater pearls also was once-booming in the lake.

The LBCDP cast a shadow over the lake fisheries. Within the project, fishermen were paid a high level of compensation, separate from one for individual lakeshore development, for the lowering of the lake water level associated with the project. With this compensation, expensive, high-tech fishing boats and gears became available for fishermen, thereby aggravating over-fishing of the lake to some extent.

Fishermen in Shiga Prefecture recently are trying to shift from a fishery of catching to one of cultivating. Stocking the lake with artificially hatched and raised native fish has been attempted. However, because of the loss of breeding and spawning sites for native fish together with adverse effects of invasive fish, fish catches in Shiga Prefecture have been declining significantly. Thus, the lake fishery faces serious problems today.

4.1.5 Nature Conservation

Lake Biwa and its surrounding areas were designated in 1950 as the first quasi-national park in Japan. Together with four other nature reserves, protected areas occupy 37% of the lake catchment area. Some 30 million tourists come to Shiga Prefecture each year to enjoy its nature and picturesque beauties. The lake is also an important wintering site for migratory birds, including ducks, and thus became a designated wetland of the Ramsar Convention in 1993. On the other hand, agricultural damage by wild life, including boars, deer, and monkeys, and fisheries damage by cormorant have become serious issues. In addition, abuse of the lake and lakeshore by excessive numbers of visitors is causing another serious issue, as previously discussed in Section 3.2.

4.2 Reduction of Lake Stresses

The regulatory program for industrial discharge control began to take effect first in Japan in the early 1970s. Preceding this movement of the central government, the Shiga Prefectural Government enacted the Pollution Control Ordinance in 1969 to regulate industrial wastewaters.

In 1970, environmental standards for water quality were established, based upon the Basic Law for Environmental Pollution Control of 1967. They consist of standards for the protection of human health and for the conservation of living conditions; the former were applied to all waterbodies, and the latter were further classified into six types by taking into consideration the kind of waterbody, either rivers, lakes or seas, and its current usage and water quality. Lake Biwa is classified as Type AA, the clearest water, because it is the most important freshwater body in Japan.

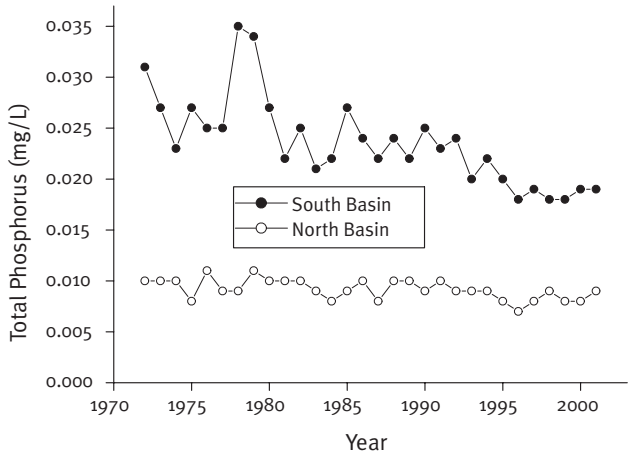
As the Water Pollution Control Law went into effect in 1971, the prefectural government set another stricter standard, which topped the national standards for industrial wastewaters, as well as revised the Pollution Control Ordinance[4]. The revised ordinance adopted a license system for installation and change of specific facilities using hazardous materials; strengthened effluent standards on hazardous substances as severe as environmental standards; and established an additional standard for antimony, as antimony pollution only occurred in Shiga Prefecture..

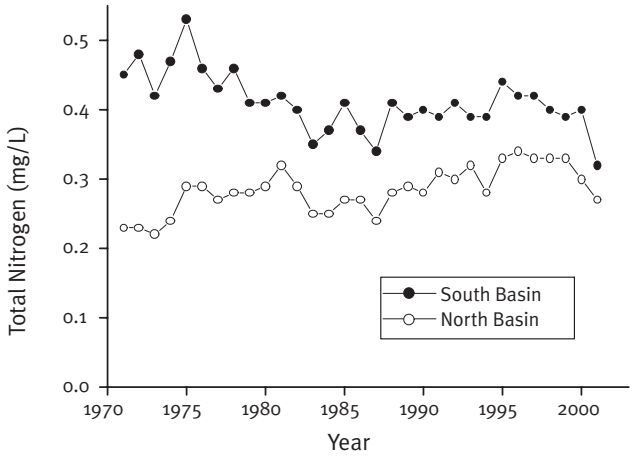
In short, the central and prefectural government's policy of the 1970s for water pollution control was to achieve and comply the environmental standards by controlling industrial wastewaters, based on the type of receiving waterbody. With all the above efforts, the water quality of Lake Biwa has complied with the environmental standards for human health up to the present time.

In the wake of the freshwater red tide in 1977, the Eutrophication Control Ordinance was enacted in 1979. The ordinance prohibits the use, sale, and gift of synthetic detergents containing phosphate; sets the very first nitrogen and phosphorus standards for industrial effluent in the world; and formulates guidelines for the appropriate use of artificial fertilizers and the management of irrigation water in agriculture, and for appropriate treatment of livestock wastes and gray waters from domestic sources (guidelines which were to control non-point sources of nitrogen and phosphorus). The ordinance is highly regarded, since it recognized the need to reduce the external loading of nitrogen and phosphorus to prevent lake eutrophication, and that comprehensive and well-planned countermeasures are indispensable for addressing the problem. Such countermeasures are necessary, since nitrogen and phosphorus may drain from a wide range of sources which often cannot be readily differentiated from the victims in this issue, a fundamentally different characteristic from point source pollution.

The Eutrophication Control Ordinance of Shiga Prefecture had a tremendous influence on the water quality control of lakes and environmental movements in Japan. Six years later after its implementation, the national Water Pollution Control Law was revised, setting down effluent standards of nitrogen and phosphorus for lakes for the first time. In addition, with a view to taking comprehensive and systematic actions to improve water quality of lakes, a Special Law for Lake Water Quality Conservation was enacted in 1984 at the national level, in which each local government in charge of a designated lake has to formulate a water quality conservation plan every five years.

With the enforcement of the Eutrophication Control Ordinance, the phosphorus concentration of the South Basin has apparently decreased. However, environmental standards for





Figures 5 and 6. Total Phosphorus and Total Nitrogen Concentrations in Lake Biwa (Source: Adapted from Shiga Prefecture Environmental White Papers).

phosphorus (0.01 mg/L) and nitrogen (0.2 mg/L) have not yet been achieved for the entire lake (see Figures 5 and 6).

To protect the water quality of Lake Biwa, Shiga Prefecture has the strictest industrial wastewater effluent standards in Japan. Factories and establishments have installed highly advanced facilities for wastewater treatment to comply with these standards. In addition, the construction of treatment plants for human wastes and treatment facilities for communities' wastewater have been facilitated in Shiga Prefecture since the late-1970s under the framework of the LBCDP, as well as the construction of sewerage system, the population coverage of the latter being far below the national average in the 1970s. All the treatment facilities are capable of removing nitrogen and phosphorus. The population coverage of sewerage treatment in Shiga Prefecture is today greater than 70%, compared to the national average of 60%.

With the above-noted infrastructure, pollution loading to the lake from point sources in its catchment area has been considerably reduced. However, improvement in the water quality of Lake Biwa has not been apparent because of the lake's long water retention time, and because of persistent pollutant loading from non-point sources in the catchment area. Unfortunately, very little activity has been implemented beyond those dictated in the Eutrophication Control Ordinance to control pollution loading from non-point sources in Shiga, even though the importance of the latter is highly recognized[5]. The reduction and reuse of irrigation return flow from paddy fields are the only countermeasures that have been attempted, and which have not yet produced any effective results.

In the mean time, the prefectural government enacted the Basic Environment Ordinance in 1996, with the goal of promoting and implementing its environmental policies toward sound and high quality environment. One of its fundamental policies is to achieve a harmonious coexistence of nature and humans, while other policies are directed to developing a recycling-oriented society, achieving a sound environment with citizens' participation, and contributing to the solution of global environmental issues. This ordinance was lead by the Reed Belt Conservation Ordinance, which is to protect and cultivate

Table 1. Legislative Framework for the Management of Lake Biwa and its Catchment Area.

Objectives	Name of laws and ordinances
Long term objectives and guidelines for environment policy	• Basic Environment Law • Basic Environment Ordinance* • Mother Lake 21 Plan*
Regulation on water withdrawal and diversion	• River Law*
Pollution control	• Water Pollution Control Law*: Environmental standards for human health, living conditions, and eutrophication control • Special Law for Lake Water Quality Conservation*: Conservation plan for water quality including chemical oxygen demand (COD), total nitrogen and total phosphorus • Ordinance for more stringent prefectural effluent standards based upon Water Pollution Control Law*: Effluent standards for human health, living conditions, and eutrophication control • Pollution Control Ordinance*: Addition of control subjects and parameters Eutrophication Control Ordinance*: Regulation on detergents, industrial effluents, fertilizers, etc. • Domestic Wastewater Control Ordinance[6]
Regulation on development	• National Land Utilization Planning Law: National land use plan and general plan of land use • City Planning Law: Urbanization-designated and -restricted areas • Law Concerning the Improvement of the Agricultural Promotion Area: Agricultural developing area • Forest Law: Regional forest plan • Natural Parks Law • Natural Environment Conservation Ordinance • Prefectural Natural Parks Ordinance • Environmental Impact Assessment Ordinance
Conservation of Ecosystems	• Nature Protection Law • Wildlife Protection and Hunting Law • Natural Environment Conservation Ordinance • Reed Belt Conservation Ordinance*: Conservation, preservation, and ordinary areas • Designated as a Ramsar Convention Wetland* • Appropriate Leisure Use Ordinance*: Regulatory zoning of pleasure boats, prohibition of the re-release of invasive fish, and etc.
Conservation of Landscape	• Landscape Conservation Ordinance: Lake, roadside, and river landscape areas

*A law or ordinance referred to in this document.

reed belts in and around the lake. Reed belts are original scenery of Lake Country, Shiga, habitat for a wide range of fish and birds, a natural barrier for shore protection, and a water purification facility. The lake also was designated as a Ramsar Convention site in 1993. Restoration of littoral ecosystems and wetlands are one of the major challenges today in regard to the lake.

Consistent with the above, another major environmental issue for Lake Biwa today is the adverse effects of invasive species. In regard to the overgrowth of Canadian pondweed (*Elodea nuttallii* and *Egeria densa*), an invasive weed to the lake, the prefectural government has studied the ecological functions of weeds, including these invasive species, as well as the most effective way to frequently harvest the weeds. Further, as the damage to native and endemic fish from invasive fish became apparent in the 1990s, the Ordinance for Appropriate Leisure Use of Lake Biwa, prohibiting the release of invasive fish once they were caught, was enacted in 2002. A subsidy system for buying invasive fish at a rate of about US$2-3/kg from fishermen also has been implemented as an extermination measure. However, none of these countermeasures have yet had a noticeable effect on invasive fish; precautionary measures may, in fact, be the only way to prevent the invasion of exotic species.

4.3 Enabling Environment

4.3.1 Legislative Framework for the Management of Lake Biwa

In the River Law, the governor of Shiga Prefecture is appointed as the administrator of Lake Biwa. This is an exceptional case in Japan and only applicable to Lake Biwa. This situation exists because then-governor of Shiga Prefecture refused to transfer the administrative right of the lake to the central government when the River Law was revised in 1964. At that time, the administrative right for the other major rivers and lakes, including Lake Kasumigaura, the second largest lake in Japan, were all transferred to the central government. From that point on, the prefectural government has taken on major responsibility, as well as significant power and authority, for Lake Biwa. The innovative and wide-ranging ordinances described in Section 4.2 resulted from the efforts of the prefectural government to fulfill its responsibility. The prefectural government is today carrying out the management and conservation of the lake and its watershed within the framework of the legal system shown in Table 1 (Note: "Laws" are national-level; "Ordinances" are prefectural-level).

A major challenge for the Shiga Prefectural Government today is to develop a new legal system not only to protect, but also to restore and revitalize, the lake and its coastal ecosystems that were damaged by LBCDP and other development works.

4.3.2 Changes in Administration System

The prefectural government is directly in charge of the management and conservation of Lake Biwa and its catchment area. To manage the lake and its catchment area appropriately, and to respond to the demands of the times, the prefectural government has continuously evolved its administration system and structure. It has a history going for the integration of relevant administration organs for that purpose. Table 2 summarizes the changes in the administration system of the prefectural government.

As shown in Table 2, the pollution control administration of the prefectural government began in 1970 with one division. It was strengthened in 1972, becoming an independent administration unit in 1974. In 1979, the system was reorganized to address the eutrophication problem, with the enactment of the Eutrophication Control Ordinance. Incorporating into divisions for forestry and sewerage administration, the latest reform was made in 1996, to implement a new framework for the promotion of watershed management.

4.3.3 Monitoring and Research Capacity

Lake Biwa is the most-studied lake in Japan, with a rich data base. Its water temperature and transparency have been monitored by the Fishery Experiment Station since 1922. The current monitoring system, consisting of 48 in-lake stations, was established in 1966; the focus of monitoring in Shiga Prefecture thereby was shifted from industrial pollution to lake water quality as a whole. The monitoring of the lake is carried out today mainly by the Institute of Public Health & Environment

Table 2. Changes in Environmental Administration System of the Shiga Prefectural Government.

Year	Department and division in charge of Lake Biwa and its catchment area
1970	Department of Welfare (Antipollution Measure Office)
1972	Department of Planning, Life Environment Bureau (Antipollution Division, Drinking Water and Waste Management Division, Nature Conservation Division, Prefectural Life Division)
1974	Department of Life Environment (Antipollution Division, Environmental Policy and Waste Management Division, Nature Conservation Division, Prefectural Life Division)
1979	Department of Life Environment (Environment Office, Waste Management Division, Nature Conservation Division, Prefectural Life Division)
1996	Department of Lake Biwa and the Environment (Water Policy Administration Division, Environmental Policy Division, Waste Management Division, Ecological Lifestyle Promotion Division, Nature Conservation Division, Forest Conservation Division, Forestry Administration Division, Sewerage Construction Division, Sewerage Planning Division)

Source: The entire organization of the Shiga Prefectural Government is accessible at the website: http://www.pref.shiga.jp/b/kokusai/siryou/soshikimei/index.html#03

Science, a prefectural research laboratory established in 1972, together with the Lake Biwa Works Office of Ministry of Land, Infrastructure and Transport. Such longtime monitoring has revealed, for example, that the dissolved oxygen concentration at the bottom of North Basin was being depleted.

The prefectural government also has continued efforts to enhance its research capability in order to address the management and conservation of Lake Biwa and its watershed. The efforts include the establishment of the Lake Biwa Research Institute in 1982, and the University of Shiga Prefecture and the Lake Biwa Museum both in 1995. Together with other research institutes located around the lake (e.g., those of Shiga University and Kyoto University), those research organs comprise a cooperative framework for comprehensive studies on Lake Biwa and its surrounding catchment area.

4.3.4 Environmental Education

Each year, primary school children in the 5th grade take a 2-day work-study program called the "floating school" on *Uminoko*, a ship built by the prefectural government exclusively for environmental education. The program began in 1983, and since then more than 300 thousand children have embarked the ship. In 1995, the "Lake Biwa Museum" was open. As the best learning center about Lake Biwa, it welcomes more than 600 thousand visitors every year.

4.3.5 History of Citizens' Movement

The history of citizen-based movements for Lake Biwa cannot be described without referring to the Soap Movement. The movement originated in the beginning of the 1970s with a soap use campaign by homemakers who were concerned about babies' diaper rash and housewives' eczema caused by synthetic detergents. In 1977, however, it changed its focus with the outbreak of red tide in the lake, shifting to a boycott campaign of phosphate-containing synthetic detergents for the conservation of lake water quality. This was a result of people coming to know through the mass media that synthetic detergents might cause eutrophication (red tide). With the participation of a wide range of organizations, this citizens' movement, which was started by women's consumer groups, spread throughout the prefecture rapidly, and established the "Citizen Forum for Conservation of the Aquatic Environment around Lake Biwa (Biwa-ko Forum)" in 1978.

Meantime, the Shiga Prefectural Government, which also had intended to regulate the use of phosphate-containing synthetic detergents to control eutrophication of Lake Biwa, strongly supported the Soap Movement, starting discussion about developing an ordinance for that purpose. Detergent manufacturers responded strongly against this movement of the prefectural government, deploying an extensive campaign against the regulation of synthetic detergents. Ironically, this campaign made more people in the prefecture more knowledgeable about the issue of phosphate-containing synthetic detergents.

Backed by strong public support, the prefectural government enacted the Eutrophication Control Ordinance in 1979. It was an attempt for the first time in Japan to regulate not only the activities of companies, but also of farmers and ordinary people. The Soap Movement , born in the Lake Biwa watershed, expanded to become a nationwide movement to purge synthetic detergents. Within three years, most of the prefectural governments in Japan had initiated some actions directed to the detergent issue. Thus the Eutrophication Control Ordinance of Shiga Prefecture had a tremendous influence on the water quality control of lakes and environmental movements in Japan, as previously mentioned in Section 4.2.

Shortly after enactment of the ordinance, the detergent manufacturers, who had initially strongly opposed the enactment of the ordinance, changed their production processes to start making synthetic detergents containing no phosphate. As a result, no detergents containing phosphate are produced or sold in Japan today.

The Soap Movement is especially significant because it was led by women; because it highlighted that citizens were responsible for the degradation of lake water quality; because it facilitated enactment of the ordinance by the local government; and because it changed national policy on water quality management. It is known and described as the first and most successful case of citizens' environmental movement in Japan. With this movement, women's participation in society also was significantly promoted in Shiga Prefecture, where people at that time were very conservative. It produced many women activists, who have led environmental movements in Shiga Prefecture from that point on. Another outcome of this movement was the establishment of "Environmental Cooperatives," in 1990, which specialize in promotion of the use of environmentally-sound commercial products.

This movement, however, lost its goal and impetus shortly after the advent of synthetic detergents containing no phosphate. The percentage of people in Shiga Prefecture who do not use synthetic detergents, but rather soaps, is less than 30% today, even though it exhibited a high participation of 70% in 1980. With the complexity of environmental issues and the diversified values of people today, the Biwa-ko Forum has been searching for an alternative goal to the Soap Movement. However, it has not yet been successful. By the same token, the citizens' movement in Shiga Prefecture has not been very active since the late 1980s, with the exception of a few unique activities, such as "Fire-fly Monitoring" by thousands of citizens.

In Japan as a whole, the activities of NGOs and not-for-profit organizations (NPOs) also were finally acknowledged by the general public through very active involvement of volunteers in the Kobe earthquake of 1995 and the 1997 oil spill of the Russian tanker "*Nakhodka*." To that end, the Shiga Prefectural Government established the "Ohmi (Shiga) Network Center" in 1997 for NGOs and NPOs, with the goal of promoting and supporting the voluntary and social activities of citizens.

At the same time, more integrated and concerted efforts by local people in individual sub-watersheds of rivers flowing into the lake is indispensable to watershed management for Lake Biwa. One of the very first efforts for this purpose was to establish the "Akanoi Environmental Citizen Initiatives" in 1996, which is a watershed community initiative to clean up Akanoi Bay (located in south basin of Lake Biwa; one of the most badly polluted portions of the lake). In the Shiga Prefecture, there are many other watershed organizations today. Most of them, however, were founded by different departments of the Shiga Prefectural Government or local municipalities. Although those organizations strive for the same goal of the conservation of Lake Biwa's water environment, there is no coordination or concerted activities among the different types of organizations, mainly because of sectionalism among different administrative organizations. The morale and economic foundations of those organizations typically are not adequate for this purpose. Governmental organizations tend to demand outcomes within a short period and, therefore, do not financially support such organizations for more than a few years. Thus, a sound partnership between local governments and watershed organizations, and the fostering of those organizations with people's initiatives, remain major challenges.

4.3.6 Private Initiatives

A unique case of private initiatives in Shiga Prefecture was the formation in 1981 of the "Shiga Environment Conservation Association," which consisted of more than four hundred relevant local companies. This association originated from an information exchange group of personnel in charge of industrial wastewater treatment. Such associations were needed for industries in Shiga Prefecture to meet social demands for water pollution control, since they had to develop new technologies ahead of the other prefectures in Japan, for the removal of nitrogen and phosphorus from wastewater effluents.

When the Eutrophication Control Ordinance that established effluent standards for nitrogen and phosphorus in industrial wastewater was enacted, there was no major objection from the local industry. Rather, industry had to comply with the ordinance in order to get along with the neighboring communities. For the same reason, many factories make voluntary pollution control agreements with neighboring communities, in which stricter effluent or emission targets were established in most cases.

4.3.7 Global Cooperation

The Shiga Prefectural Government, for which the management of Lake Biwa is a high-priority issue, has committed itself to international cooperation and information exchange on lake issues for years. Consistent with this goal, it hosted the first World Lake Conference in Otsu in 1984, and founded the International Lake Environment Committee (ILEC) in 1986. The World Lake Vision, which was unveiled at the World Water Forum III in 2003, is another achievement made possible by strong initiatives on the part of the Shiga Prefectural Government.

5. Lessons Learned and Recommended Initiatives

5.1 Political Interest and Commitment

Political interests and commitments involving Lake Biwa, including opposing ones between the Shiga and central government or the downstream prefectures, have changed with time. As far as the Shiga Prefectural Government is concerned, its focus was originally placed on flood control and measures for water shortage, shifting to local development and economic growth in the 1950s/60s, and the control of pollution and eutrophication in the 1970s/80s. Shiga Prefecture's major concern today is to achieve the conservation of the lake and its littoral ecosystems. This goal resulted from reflecting changes in the values of the Shiga Prefecture population, in which the people came to realize the higher resource value of the lake as their living standard rose, and political efforts to fulfill their needs were undertaken. On the other hand, the political interest of the Shiga Prefectural Government always has been in confrontation with either the central government or the downstream areas. As previously described in Section 2.2, the LBCDP and the negotiation process for its inauguration eventually resulted in resolution of the relevant disputes.

The strictest effluent standards in Japan, and the enactment of the Eutrophication Control Ordinance, were realized by strong political commitment and initiatives of the governors at that time. However, they would not be possible solely on the basis of political interest and commitment. As illustrated in the Soap Movement, which eventually gave birth to the ordinance, they became possible because of strong public support.

- The higher the perceived resource value of Lake Biwa, the stronger the interest and commitment becomes. The political interest and commitment have come in different forms at different times in the history of the management of the lake, and they often are the end result, rather than the achievable objective. When opposing political interests and commitments clash, the process of dispute resolution must be instituted. Dispute resolution may sometimes be enhanced by such mediating factors as scientific knowledge, third-party initiatives and concerns, and innovative institutional arrangements.

- It is generally difficult to achieve sustainable management of lake resources without political commitment and interest. However, political commitment and interest alone will not achieve sustainable management of lake resources, since sustainability depends greatly on the synergy created by the basin communities, individual citizens, local industries and the local government, all facilitated by political interest and commitment.

5.2 Sustainable Institutions

The Shiga Prefectural Government, rather than the central government, has taken full responsibility for the management of Lake Biwa, and developed necessary infrastructure to fulfill its responsibility over the years. The prefectural government also has continuously improved its administration system to respond to the demands of the times. It has a history of administrative system integration toward further comprehensive conservation of the lake and its catchment area. However, the harmful effects of sectionalism among ministries and divisions still remain. Further integration of the administration system in the true sense of that purpose is a continuing necessity.

- Regardless of development or conservation goals, the comprehensive management of large lakes that support municipal, industrial and agricultural activities of significant magnitude, like that of Lake Biwa, will require very strong local government capacity to implement the needed infrastructure development projects, which typically may span decades.

- Many of the infrastructure projects for lake resource development and conservation will require decades of continuous construction works and sustainable management. Special institutional design, with integrated rather than sectoral arrangements, is quite useful for efficient implementation of these projects.

- Suitable institutional arrangements that satisfy local government needs to provide basic environmental services to the communities (e.g., sewerage, industrial waste management, etc.) are not necessarily sufficient to bring about the needed improvements in the environmental and ecological condition of the lake, since lake management will invariably require integrated management of water, air and land resources, encompassing such activities as control of non-point sources of pollution, restoration of ecological functions of land and riparian environments, etc. Accordingly, efficient mobilization of limited financial and manpower resources to deal with a range of interrelated environmental issues will require holistic and flexible institutional arrangements.

5.3 Financing Mechanism[7]

A major reason why Shiga Prefecture, a once-poor prefecture, could significantly manage its economic development and the conservation of Lake Biwa was the implementation of the LBCDP.

- The financial base of lake-region governments alone may not be sufficient to undertake the necessary development and conservation projects. As implied in the Special Law for Lake Biwa Comprehensive Development, and cost-sharing with the downstream local governments under LBCDP, the special legislation to facilitate mobilization of financial resources from the central government, including preferential subsidies, as well as from the downstream local governments that benefit from development of lake resources, can be of critical importance.

5.4 Legislative Frameworks

Since the Shiga Prefectural Government is a local government, and therefore in the best position to be knowledgeable about the issues facing Lake Biwa, it became possible to implement appropriate and proper management efforts to meet specific lake requirements and the needs of local communities. Such proper lake management and conservation have been realized, with implementation of a thorough legislative framework for that purpose.

- Lake management encompasses a wide range of environmental issues, each of which has to be properly addressed with specific legal provisions that will meet the particular requirements specific to individual lakes. The legal provisions to promote regional development, with the specific goal of developing the resource values of a lake, may or may not have adequate provisions for environmental and ecological needs of the lake and its catchment. It will be most useful to introduce and implement formal and informal legal provisions, including local government ordinances, which can meet specific needs of the local communities that must deal with such environmental requirements.

5.5 Stakeholder Participation[8]

Citizen initiatives in lake management can take many different forms. The housewives' initiatives in the promotion of the "Soap Movement" is well known in the case of Lake Biwa. Other well-known Lake Biwa examples include an NGO activity specializing in local water-culture studies, with "Fire-fly Monitoring" by thousands of citizens, the nation's first "Environmental Cooperatives" that specialize in promotion of the use of environmentally-sound commercial products, and a watershed community initiative to clean up the Bay of Akanoi, the "Akanoi Environmental Citizen Initiative." These and other citizen initiatives constitute an essential part of environmental governance that must deal with the extremely complex issues typically involved in lake management.

Many relevant lessons can be learned from the LBCDP. The following are lessons learned from LBCDP, in terms of stakeholder participation:

- For a lake as complex as Lake Biwa, the resolution of conflicting resource-use interests among sectors, of severely strained relationships between the upstream, downstream and riparian local governments, and of the development impetus of industries versus the environmental conservation initiatives of citizens

and local NGOs, etc., stakeholder participation has been, and will continue to be, an essential part of lake management. While there is no set formula for bringing about successful stakeholder participation, not to mention the amicable resolution of conflicts themselves, the stakeholders must accept the need to live with conflicts that may be significantly ameliorated with mutual facilitation over the course of continuous dialogues.

- The central government often can play a crucial role in resolving conflicting interests among the riparian local governments, both in terms of being part of the river-lake basin institutional system and through political facilitation, often accompanied with legal, financial and institutional provisions. In the case of Lake Biwa-Yodo River management, the central government played dual roles; both as an important part of the river-lake basin system and as a facilitator with legal, financial and institutional provisions.[9]

5.6 The Linkages between the Lake Management Program and the National and Regional Water Resources Management Efforts

The LBCDP was devised to meet the projected water resources needs of the Keihanshin Industrial Belt to serve the thriving Japanese economy in the early 1970s. While water resources remain as important a factor as they were 30 years ago, the subsequent environmental and ecological concerns in lake management have evolved and grown to become as important a national agenda as water resource development.

On one hand, the fact that Lake Biwa management has had strong linkages with the broader national and regional water resources management efforts has greatly facilitated achievement of goals for Lake Biwa that the local government alone could not have achieved (i.e., implementation of the LBCDP). On the other hand, the strong linkages between regional and national water resources management efforts did significantly affect the environmental and ecological integrity of the lake watershed and its coastal zones. It is important, therefore, for local government to be aware that it also receives due support from regional and national governments for the conservation of lake environments.

In contrast, the lake management program of local government may influence national policy with respect to water quality management within the entire water resources management framework. As an example, the Eutrophication Control Ordinance prompted the revision of the Water Pollution Control Law, and enactment of Special Law for Lake Water Quality Conservation.

5.7 Scientific Information and Research

Underestimating the adverse effects of the water level control on the littoral ecosystems was one of the major failings of the LBCDP. Although many researchers were mobilized in the preparatory study of the project, even these individuals could not accurately predict the issues currently facing Lake Biwa. This illustrates the limitations of science; that is, science does not always help decision makers make the right decisions. However, science and scientific knowledge can reveal and repair the failures. Indeed, lake management is not feasible without adequate scientific knowledge. Noting that the long-term monitoring of Lake Biwa detected oxygen depletion at the bottom of the lake's North Basin, the local research capability that makes possible a long-term field study is indispensable to lake research. To this end, the prefectural government has established a series of research institutes, as well as utilizing the results of studies of these organizations.

Furthermore, scientific knowledge is meaningless unless it is widely disseminated and becomes common knowledge among the public. In the Soap Movement, enactment of the ordinance was made possible because people came to know the effects on eutrophication of phosphorus in synthetic detergents. Consistent with this reality, the prefectural government has continued its efforts to promote a common understanding of the lake issues among people with environmental education, including the previously-noted floating school and Lake Biwa Museum.

- Sustainable lake management is synonymous to sustainable use of lake resources. Sustainable use of lake resources cannot be achieved unless the respective water resource users agree on basic principles in resource availability in the past, in the present, and in the future, with due protection and conservation measures collectively introduced. While scientific knowledge today is still too limited to determine *how* a particular lake may behave with regard to the sustainability of its resource values over time, making judgments on the sustainability of resources without scientific knowledge in regard to possible natural and anthropogenic variances would be futile. A scientifically well-informed decision is important, not because the decision will always be correct, but because the decision can be assessed scientifically and updated to reflect new scientific findings over time. While there is no good measure of the appropriate level of investment in scientific studies for lake management, the level of funds wasted because of the lack of needed scientific data for lake management far outweighs the required financial investment for addressing the latter.

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Disclaimer

1 Transportation capability of Shiga Prefecture has also improved significantly with the construction of motorway-topped levees around the lake, which was not however the primary objective of the construction.

2 In Japan, financial arrangements for the construction of sewerage system generally come 50% from the central government and 50% from local governments. However, within the framework of LBCDP, additional financial arrangements (15%) eventually came from the central and downstream local government; thus, Shiga Prefecture only bore 35% of the construction cost. The operational costs of wastewater treatment facilities are borne by each municipality and user. Although users in Shiga Prefecture pay about US$2/$m^3$ of wastewater, municipalities have to make up a large funding deficit.

3 The national government has protected rice cultivation farmers in full scale with its agricultural policy for many reasons. The financial revenues to rice are very high because of price supports. In addition, since most farmers cultivate part-time, they prefer rice, which is the least labor-intensive farming in Japan.

4 Any industrial wastewater must comply with effluent standards in the Water Pollution Control Law and ordinances. There is no other regulation for industrial wastewaters, since such laws and standards were made after a long negotiation process among the relevant ministries.

5 Shiga Prefecture prioritized the control of point sources for eutrophication control simply because its cost performance was believed to be better than for non-point sources. It also should be noted that erosion of farmland is not serious in Shiga Prefecture because most farmlands are terraced and bounded paddy fields.

6 The ordinance demands all houses be connected with sewerage system within three years after the completion of the construction in the area. However, there is no penalty for violation of the ordinance.

7 There is no specific financial mechanism in Japan for water management, except for the charge of wastewater, as well as tariffs for tap water. Most public works, including the construction of sewerage system, lack financial mechanisms to recover the expenses. This is mainly due to the political fact that public works have been implemented for job creation and local economic development. For the same reason, there was no evaluation mechanism for public works when LBCDP was in progress. However the idea to analyze cost-benefit and cost-effectiveness of public works at the planning stage and evaluate administrative performance is becoming more common today, although such mechanisms are still not fully developed.

8 Most laws and ordinances today demand public comments through public hearing etc., to the finalization of plans. Some ordinances, including the Appropriate Leisure Use Ordinance and Mother Lake 21 Plan, dictate the establishment of local people's organizations to fulfill the objectives.

9 The central government happened to play the crucial role in mediating between Shiga Prefecture and the downstream local governments in the preparatory process of LBCDP, mostly because the central government had power, including financial power through budget and allocation rules sharing revenues between central and local governments, to resolve the conflict and was in the position of a third party. However, the situation today is much more complicated, since a wider range of stakeholders are invited into the decision-making process. As a result, dispute resolution is getting more and more problematic.