6 Evolving History of Lake Biwa and Yodo River Basin Management

Masahisa Nakamura · Yoshihiko Ogino · Michio Akiyama · Kunihiro Moriyasu

Abstract The management story of the Lake Biwa-Yodo River Basin may be told in many different ways. It is told here as an intricate but dynamic history of management challenges involving the upstream Lake Biwa region and the downstream Yodo River region, with factual illustrations of associated policies, programs, and specific actions for water resources development, flood control, and environmental and ecosystem concerns. These factual illustrations are also interpreted by the contributing authors with views reflecting their professional backgrounds, as well as their interests and opinions on the conflicting and contested issues.

Keywords Water resources • Flood control • Lake Biwa Comprehensive Development Project • River improvement plan • Basin governance

Introduction

This chapter aims at presenting a general overview of the evolving history of Lake Biwa-Yodo River Basin (hereafter referred to as the Biwa-Yodo Basin) water management, with special focus on flood control, water resources development, environmental, and ecosystem concerns. It reviews the special features of the basin that have required the region to overcome many historical challenges in managing this lake-river basin system.

Although the emphasis was given in this chapter to introduce to the readers a factual review of the evolving courses of events, the interpretive views expressed in different sections of this chapter are not necessarily concerted, because the professional and disciplinary backgrounds, and the thoughts and opinions toward contentious issues, differ significantly among them. Specifically, Section 6.3 and part of Section 6.4 were contributed from a river engineering and planning expert focusing on flood control. He portrayed an official view toward the need for judicious implementation of the project components stipulated in the Management Plan. Section 6.3 and part of Section 6.4 were contributed from an agricultural water policy specialist actively promoting the demand-side water management that he believes has been seriously lacking in the Biwa-Yodo Region. Section 6.5 was contributed by an economic geographer with water management policy expertise on the upstream and downstream dynamics on water and environment. Lastly, the remaining sections, 6.1 and 6.6, and cross infusion of all the section contributions to collectively address the evolving water governance challenges facing the Biwa-Yodo Basin, were synthesized by an environmental policy researcher specializing in lake basin management. Lastly, the making of the Yodo River Improvement Plan was prepared with the help of those involved in either side of the contentious process.

M. Nakamura, Professor (✉)
Research Center for Sustainability and Environment, Shiga University, 2-5-1 Hiratsu, Otsu, Shiga 520-0862, Japan
e-mail: m-nakamu@biwako.shiga-u.ac.jp

Y. Ogino, Professor Emeritus
Osaka Prefecture University, 1-1 Gakuen-cho, Naka-ku, Sakai, Osaka 599-8531, Japan

M. Akiyama, Professor
School of Environmental Science, The University of Shiga Prefecture, 2500 Hassaka-cho, Hikone, Shiga 522-8533, Japan

K. Moriyasu, Former Managing Director
Biwako River Office, Kinki Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism, 4-5-1 Kurotsu, Otsu, Shiga 520-2279, Japan

6.1 Overview of Lake Biwa and Yodo River Basin

6.1.1 Physical and Geographical Features

Lake Biwa had a naturally constricted and shallow river stretch a few kilometers downstream of the southern edge of the lake, restricting the flow out of the lake to cause

Hiroya Kawanabe et al. (eds.), *Lake Biwa: Interactions between Nature and People*, DOI 10.1007/978-94-007-1783-1_6,

occasional flooding. The distance between this stretch and the northern jurisdictional boundary of the greater Osaka metropolitan region is only a few dozen kilometers. The management history of Lake Biwa water may be characterized by the legacy of flood control conflicts stemming from this inescapable physical reality.

The lake measures 63.5 km in a north-south direction and is divided into two sub-basins. It has a total surface area of 674 km^2, a volume of 27.5 billion m^3, and a shoreline length of 235 km. Its catchment area is nearly five times the area of the lake itself, and its boundary more or less coincides with that of the prefecture, constituting 96% of prefectural land. The catchment area consists of forest-covered hills and mountains (60%), paddy fields and other farmlands (25%), and urban and industrial areas. The prefectural capital, Otsu, located at the southern end of the lake, has an approximate population of 355,000. There are five major rivers flowing into Lake Biwa from the surrounding mountain ranges. There are also more than 100 small coastal streams and irrigation channels draining into the lake, many containing irrigation return flows and urban and agricultural runoff from across the catchment area, measuring 3,848 km^2.

With Lake Biwa and its watershed occupying most of the upper catchment portion, the Yodo River Basin is one of the most extensive river systems in Japan. Encompassing portions of six prefectural jurisdictions (Shiga, Osaka, Kyoto, Hyogo, Nara, and Mie Prefectures), it has a total catchment area of 8,240 km^2 and the main river course length of 75.1 km. The Seta River is the only natural outflowing river from Lake Biwa. The Seta River is called the Uji River along a stretch of some 20 km within the Kyoto Prefectural boundary. It is joined at the Hirakata confluence point with the Kizu River from the east originating in Mie Prefecture, and the Katsura River from the west originating in Kyoto Prefecture. Below this confluence point is the mainstream Yodo River stretching toward the Osaka Bay in the south, for a distance of approximately 20 km. The Ina River joins the mainstream Yodo River approximately 5 km upstream of the Osaka Bay. The Kizu, Katsura, and Uji Rivers contribute 18%, 15%, and 64%, respectively, of the flow to the Yodo River at Hirakata. The Keihanshin (meaning Osaka, Kyoto, and Kobe) metropolitan region as a whole depends almost exclusively on the Yodo River for industrial, municipal, and agricultural waters. Lake Biwa accounts for water supplies totaling about 20 billion m^3 per year, serving as many as 14 million people. In addition, the Seta River water is also used for hydropower generation at Uji, some 15 km downstream of the lake (see *Fig. 1*).

The management history of the Yodo River System may be characterized as that of conflict between the upstream Shiga Prefecture and the downstream *Keihanshin* area. For centuries, the communities immediately surrounding Lake Biwa experienced severe flooding of their agricultural fields, due mainly to the naturally constricted and shallow river stretch a few kilometers downstream of the southern edge of the lake. This natural barrier had been serving well in protecting the downstream population centers from inundation. The downstream and the central governments finally agreed in 1905, after a historic flood in the Lake Biwa region in 1896, to dredge this stretch, and construct a weir structure (this original weir, named the *Nango* Weir, was replaced in 1961 by the Seta River Weir constructed at a short distance downstream). With the construction of the Nango Weir, and the ability to control the lake water level, the frequency of flooding and the associated flood damages along the lake shore and inland were drastically reduced.

6.1.2 Flood Control

The Lake Biwa population always wanted the flood water to be quickly released downstream to save the riparian lands from inundation, while the downstream Osaka population always wanted the flood water to be kept within the lake to save the highly populated metropolitan area. The Lake Biwa lowland farmers, however, had to yield to the downstream political and economic powers over the course history. It was not until the record flooding in 1896, inundating the land around the lake for some 220 days, when the downstream and the central governments finally agreed to the construction of the Nango Weir. The weir served the flow control purpose well for several decades till a new need arose, i.e., to supply water to the rapidly growing urban and industrial centers in the downstream region.

6.1.3 Water Resources Development

The major use of Lake Biwa water had historically been for paddy irrigation, by channelizing and barraging the riparian feeder rivers and the outflowing Yodo River and its tributaries. It was in the late-nineteenth century when the first large-scale water resources development project was implemented. Realizing the potentially serious decline not only of its political status but also its economic status, the then newly appointed Kyoto Governor foresaw the need to develop the Kyoto economy by linking Kyoto with Lake Biwa by a canal to withdraw the lake water. He engaged a

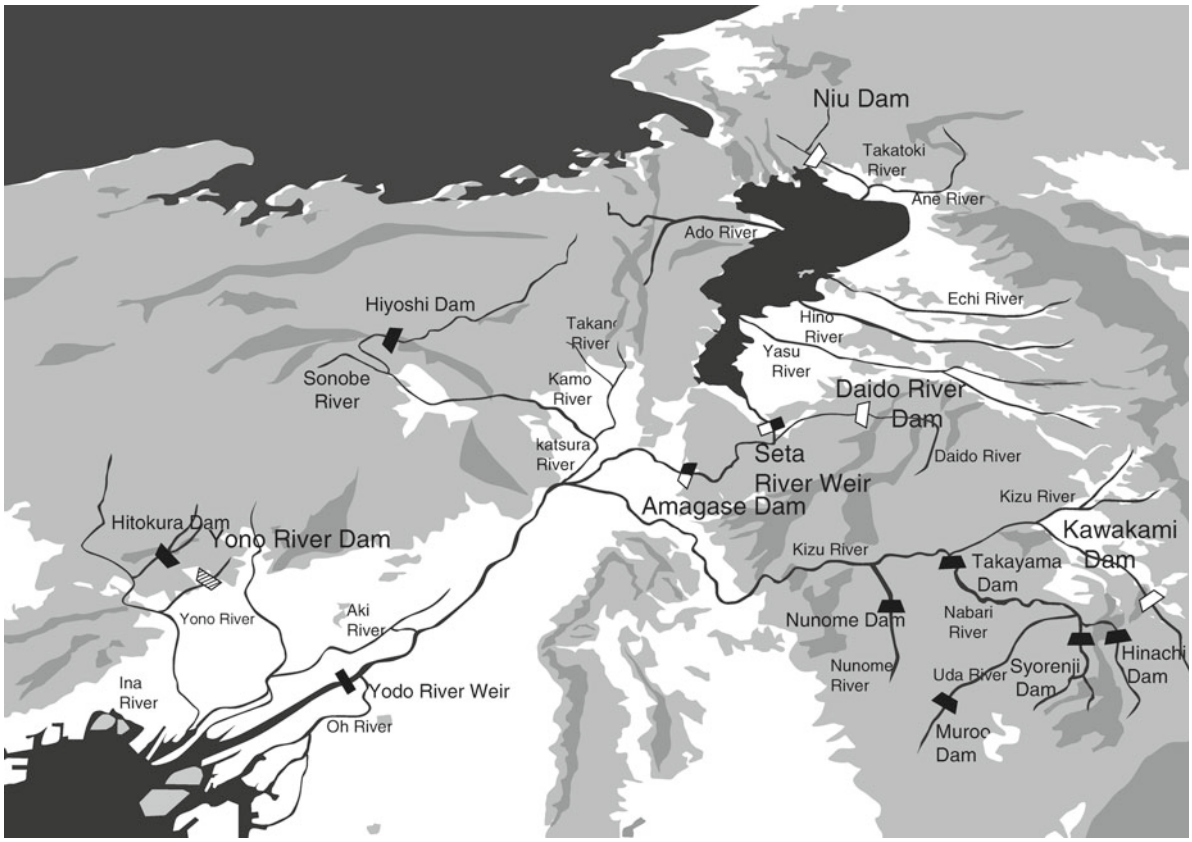

Fig. 1

Bird's eye view of the Lake Biwa and Yodo River Basin (Niu, Daido-River, Kawakami Dams, proposed to have been constructed in an earlier plan, have been subjected to debate whether or not to proceed with the plan. Yono River Dam, also in the earlier plan, was agreed not to be constructed. *Amagase* Dam and the Seta River Weir have been agreed to be renovated. See Section 6.5 for details).

young engineer who succeeded in constructing the canal connecting Lake Biwa to Kyoto in 1890, saving this water-constrained city from a serious economic decline.

The second large-scale water resources development project took shape when Osaka began to regain its industrial strength in the early 1950s after the Second World War devastations. The existing water rights from the Yodo River flow had already been exhausted, however, and by the early 1960s, Osaka was already eyeing the use of the abundant Lake Biwa water.

6.1.4 Lake Biwa Comprehensive Development

Osaka wanted more lake water to be released downstream, particularly during the drought periods, through the existing Nango Weir, which had been constructed more for flood control purposes than for water resource development. It was replaced in 1961 by the Seta River Weir constructed at a short distance downstream both for flood control and water resource development. More than a decade of heated political exchange took place between the downstream local governments (mainly Osaka Prefecture and Osaka City), the National Government, and the Shiga Prefectural Government with regard to the potential gains and losses of this action, in terms of accrued economic benefits, financial burdens, and environmental impacts of transforming Lake Biwa into a sort of man-made reservoir. Increasing the amount of flow through the Seta River channel meant the need for enlargement of the weir capacity, as well as for dredging of the constricting channel. However, reconstruction of the weir to provide a greater water volume in the lake, in preparation for extreme droughts, also meant an increased

probability for flooding damage around the lakeshore lands. Combined with the need to protect the downstream Yodo River from still imminent flooding, the ultimate solution was to construct a levy around the lake to impound more water within the lake in anticipation of possible droughts, and in preparation for protecting both the downstream Yodo River and Lake Biwa coastal areas from flooding.

This agreed scheme of Lake Biwa water resource development is called the *Lake Biwa Comprehensive Development Project* (hereafter referred to as *LBCDP*, see Section 6.4 for details).

6.1.5 Evolving Challenges

The Shiga Prefecture was a reluctant party in LBCDP, insisting the need for totally rehabilitating the coastal infrastructure such as water intake, fishing and navigation facilities, as well as the possible adverse effects on the shoreline ecosystems, particularly, on the habitat environment of fish species, including the indigenous ones. The reluctance of the Shiga Prefecture, however, stemmed more from the psychological rejection of its residents to the notion that the upstream region had to continue to endure a long history of sufferance to occasional flooding of its coastal region for the benefit of the downstream region, and then having the downstream region demanding the release of more water exclusively for its own convenience and economic gain.

While the LBCDP accomplishments have brought about significant overall benefits to the Biwa-Yodo region, there remained unresolved legacies, unfinished businesses, and emerged challenges necessitating such new policy initiatives. The Lake Biwa Comprehensive Conservation Plan, (hereafter referred as LBCCP), is one, and the Yodo River Improvement Plan (hereafter referred to as YRIP), is another. LBCCP is a plan being developed and implemented by Shiga Prefecture and, therefore, touches little on the issues facing the entire Biwa-Yodo Basin, while YRIP is a plan being developed as a river management plan, rather than a river basin management plan, to be implemented as a trans-jurisdictional national government plan. Among the important issues facing LBCCP is financing of the component programs pertaining to, basically, restoration of the lake ecosystem. Among the important issues facing YRIP, on the other hand, is the development of an institutional framework more suitable for basin management than river water management that will be able to meet the emerging governance challenges (see, Section 6.5 for details).

6.2 Brief History of Lake Biwa Flood Control

6.2.1 A Legacy of Lake Biwa Flood Control

Two Major Issues Facing Lake Biwa—Yodo River Flood Control

Within the Yodo River Basin, there are several climatic zones affecting the precipitation patterns of the three major sub-basins, one in the north covering the Lake Biwa watershed, another in the east covering the Kizu River watershed, and still another in the west covering the *Katsura* River in the west. The Yodo River, which originates at the confluence point of the three tributary rivers, however, has one of the most stable flow characteristics among the major rivers in Japan, thanks to Lake Biwa acting as a huge natural regulating pond. Because of this stable flow, the Yodo River had historically been able to serve as a major transportation route of agricultural products from across Lake Biwa and other commercial goods between the upstream eastern Kyoto along the Kizu and Uji Rivers, all the way down to Osaka Bay. It also served as a mode of passenger transportation between Kyoto and Osaka. With Lake Biwa providing ample and stable flow throughout the year, the Yodo River has had an enduring impact on the economic, cultural, and political dynamics of the entire Kinki Region. The evidence remains today in the form of thriving metropolitan regions of Kyoto, Osaka, and Kobe. The water management of the Yodo River System, however, has historically been dictated by two major flood protection concerns, namely:

- Reduction of flooding risks endured by the Lake Biwa shoreline and lowland communities for the upstream's sake; and
- Improvement of river embankments with stronger and higher levies along the Yodo River and its tributaries for the downstream's sake.

These issues have not yet been fully resolved, as discussed later in this chapter.

Constraining Topography of Lake Biwa

There are some 120 or so in-flowing rivers to Lake Biwa originating from the surrounding mountains. These short and steep rivers discharge the collected precipitation from the mountainous terrains almost instantaneously into Lake Biwa, quickly swelling the lake to impede the inflowing river water, eventually causing flooding not only along the coastline, but also along these river channels. A more

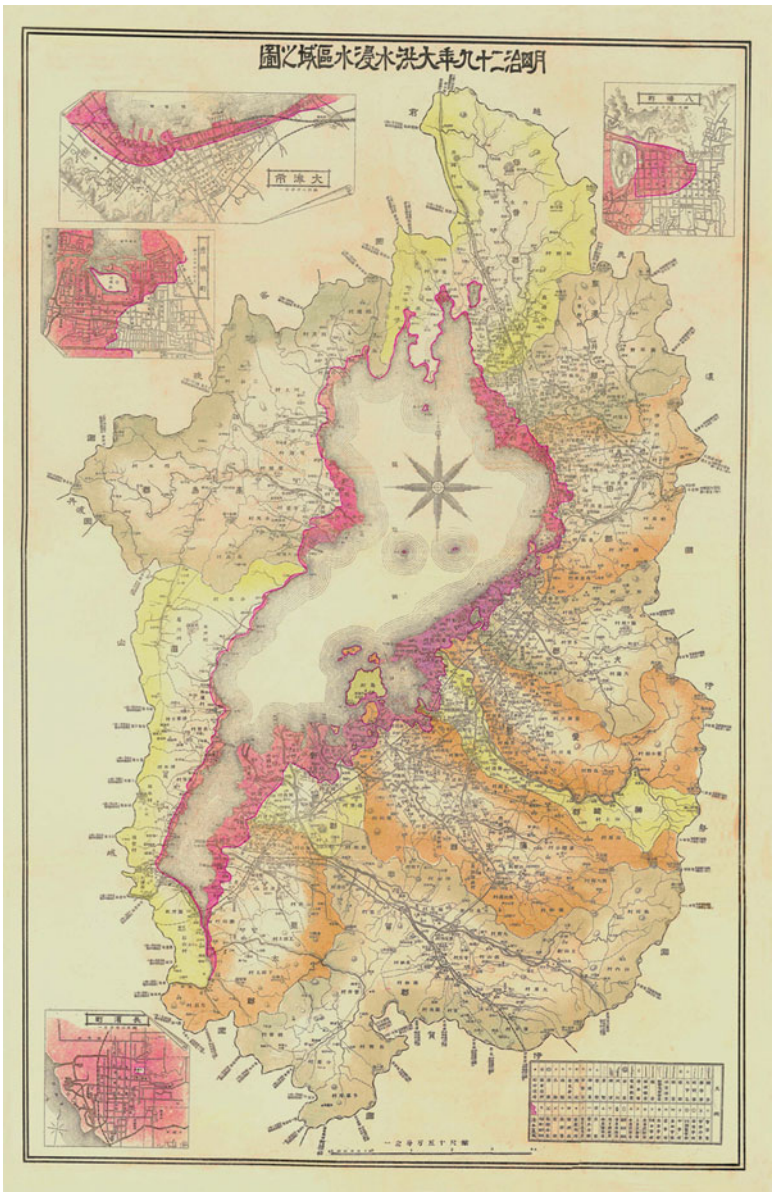

Fig. 2
Inundated areas in red during the Great Lake Biwa flood of 1896 (The land occupied by the prefectural government offices in the center of Otsu City was completely inundated. The surface area of Lake Biwa is estimated to have increased by 30%).

serious concern is that the Seta River, the only outflowing river from the lake, is naturally constricted a few kilometers downstream of the lake outlet, at the protrusion of Mt. Dainichi. This constraining topography causes the lake level to rise rapidly, and inundate the surrounding land during heavy rainfalls periods related to typhoons and other climatic conditions, historically causing hardships to paddy farmers.

A record-breaking flood took place in September 1896. The rainfall over the period of just 10 days from September 3 to 12 was 1,008 mm, or more than half the usual annual average of 1,900 mm, with a dramatic one-day record of 597 mm on September 7 alone. The lake water level rose up to 3.76 m above the normal level (designated as the Biwako Basic Surface Water Level, or B.S.L.), and caused unprecedented flooding around the lake, inundating most of the towns and villages around the lake and along the inflowing water courses. Altogether 14,800 hectares are recorded to have been flooded, with the inundation lasting for as long as 237 days before completely being receded (*Fig. 2*).

Upstream–Downstream Conflicts over Dredging of Seta River

Since the mid-nineteenth century, there have been a number of proposed attempts to dredge the Seta River to increase its discharge capacity for the lake water, particularly to compensate for the above-noted natural topographic flow constriction. These proposed attempts by the upstream farming communities met with severe opposition by the political powers and commercial interests in the downstream population centers. The simple dredging along the shallow and constricting stretch of the Seta River would mean sending flood water downstream, causing damages to population and commercial centers, rather than to upstream farmland and villages. The downstream region wanted the flood water to be kept upstream as long as possible, allowing its gradual release over a prolonged time. The evolving history of events to overcome this extremely complicated and conflicting case of flood management is reviewed in the next sections.

6.2.2 From Premodern to Early Modern Times

Premodern Times (Seventeenth to Nineteenth Centuries)

The first recorded event of Seta River dredging was in 1670. Responding to petitions from people living near the lake, the *shogunal* administration carried out the dredging. Subsequent appeals for dredging were repeatedly refused, one reason being that the dredging destroyed an important strategic point on a military route for the defense of Kyoto. Another was that a reduction in the lake water level also affected the defenses of the then-important military strongholds of Hikone and Zeze (Otsu) Castles. A final major reason was the objections of people living downstream, who feared a greater risk of flooding. During the two centuries before the modern era, 20 formal requests for dredging were made, but it was only allowed five times. It was twice carried out at the cost of the local administration, with private contributors bearing the cost burden for the remaining times. Even when local people were willing to organize and pay for the work themselves, the administration refused permission.

The people living along the lake grew frustrated with the administration for ignoring their heartfelt petitions and took matters into their own hands. Under the guise of harvesting freshwater shellfish, *Corbicula sandai*, they laboriously dug up the river bed and carried away the sediment. The administration at that time did not know what to do about the dissatisfaction of the lakeshore residents. As a kind of response to the long-ignored ardent wishes of the people, the boats were exempted from taxation of the clam harvest until the modernization started. This exemption was practically an acknowledgement that the effect of the clam fishing boats was equivalent to dredging, and was instituted to appease the local people.

Early Modern Period

In the very first year of the Meiji government era (the first modernized government, 1868–1912), there was a major flood that the local government (Otsu Prefecture) took as a cue to undertake the first large-scale dredging since 1831 of the Seta River. While the dredging took place to some extent, the lake remained placid for some years. The lake level rose to 2.71 m above B.S.L. in 1885, however, causing extensive flooding both around the lake and downstream along the Yodo River. During May to September in 1889, the lake level remained at a height between 1.4 m to 2.0 m above B.S.L., a situation that made paddy plantation impossible around the lake. Coincidentally, in the same year, the construction of the Seta River Bridge (length 405 m) was started by the National Railways Tokaido Mainline. Being very concerned that the eighteen pillars of the bridge might interfere with the outflow from Lake Biwa, the Lake Biwa Flood Control Alliance Committee was organized to carry out campaigns to petition the national and local governments for a reduction in the number of bridge pillars. Determined to ensure the issue was resolved once and for all, the slogan was "construct the bridge pillars that do not impede the flow." Joined by the Shiga Governor, this campaign turned into a movement to petition for instituting the Seta River dredging works. A series of petitions was presented to the national government to allow for the dredging, to receive the state subsidies, and to have a project established under direct government control.

At the same time, however, having experienced flood damage in 1885, the downstream residents along the lower reaches of Yodo River also feared that dredging would put them at greater risk. The Yodo River Improvement Action Association was formed, and petitioned for cessation of the Seta River dredging, and for the national government to initiate a large-scale Yodo River improvement project. These opposing interests evolved into a serious political issue.

Facing these circumstances, Mr. Tohru Okoshi, the national government official appointed as governor of Shiga Prefecture, who feverishly believed in the need for the dredging to take place, sent repeated appeals for dredging of the

Seta River to the Home Minister during 1891–1892. It finally resulted in the decision by the Home Ministry to carry out the dredging during the next year (1893) to the extent that it would not increase the flooding danger downstream. Governor Okoshi invited members of the downstream Yodo River improvement action association in Kyoto and Osaka to attend a gathering to celebrate the completion of dredging. In his address to the gathering, he said, "Now, let's join forces and push for a greater Yodo River improvement."

6.2.3 Dawn of Full-Fledged Lake Biwa and Yodo River Flood Control Infrastructure Development

Yodo River Flood Management Works Report: Founding Report of Future Lake Biwa Flood Control Policy

Being catalyzed by the successful dredging undertaken in 1893, the Meiji government urgently formulated a plan for Yodo River improvement. The plan was developed on the basis of the major findings of the Yodo River Flood Defense Works Report compiled mainly by Dr. Tadao Okino, head of the Osaka Construction Field Office of the Home Ministry, in which the Lake Biwa water levels were extensively analyzed. This report also was the foundation for later basic policies to control flooding around Lake Biwa. The main thrusts of the report included the following:

- Reducing Lake Biwa's normal water level by increasing the discharge rate of the Seta River channels during the winter period;
- Constructing a weir across the Seta River to enable adjustment of discharge rates and lake water levels;

In essence, the Report stipulated the following three basic principles that formed the basis of an engineering approach in Lake Biwa flood water management and the related policies; namely:

- To reduce the Lake Biwa water level before flooding occurs, so as to increase the receiving capacity of the lake for the expected influent flood flows.
- To reduce the duration of the Lake Biwa flooding risk by increasing the draining flow of the Seta River, thereby reducing the lake's swelling water volume.
- To reduce the downstream flooding risks by completely closing the weir at times of peak discharges to Yodo River from the Katsura and Kizu Rivers.

For ease of reference, a chronology of Lake Biwa-Yodo River management activities is provided in *Table 1* and discussed in the following sections.

Yodo River Flood Management Works (1896–1909): River Improvement and Weir Installation

Japan's first Rivers Act was passed by the Imperial Diet in March 1896. Following this legal basis, the Yodo River Improvement Scheme was implemented by the national government as outlined in the Yodo River Flood Defense Works Report. Including the whole upstream and downstream river systems from Lake Biwa to the mouth of the Yodo River discharging into the Osaka Bay, this was the first river improvement project in Japan based on a comprehensive river plan. From 1900 to 1908 the project included the thorough dredging of the Seta River and the first construction of a weir in 1905. Still in force after construction of a new replacement weir in 1961, these principles stipulated in the Plan still operate today (*Fig. 4*).

The old weir (the Nango Weir) was opened and closed entirely by manual labor. It took 1 day to completely open the weir, and 2 days to completely close it. Nevertheless, the weir operation decreased the flood damages. Over the period of 30 years prior to the weir installation in 1905, the Lake Biwa flooding occurred 17 times, and twice, the lake water level rose to more than 2.4 m over the normal level. Over the period of 14 years after the weir construction and dredging, relatively small-scale floods occurred twice, with the lake water level rising to only as high as 1.5 m over the normal level, an impressive contribution by the improvement works (see *Fig. 3*).

Yodo River Control Project Phase 1 (1943–1952): Dawn of Lake Biwa Region Comprehensive Development

During the First World War, Japan made great strides in industrial development, particularly with regard to the increased scale of hydroelectric projects. Industrial development was also accompanied by hugely rising demand for water. Along the Yodo River, people also sought for ways to make more effective use of Lake Biwa water. By 1940, the Yodo River Control Project was announced, with the aim to control flooding and promote water supplies. When the Phase 1 of the Project was launched in 1943, the wartime difficulties, including the lack of supplies for construction works, and their steeply rising prices, hindered the needed rapid achievements. Thus, the plan aimed to keep the lake level lower than usual, as follows:

- For flood control purposes, the Lake Biwa water level (measured at the gauging station located at the Torii River confluence point to the Seta River) was to be

Table 1

History of Lake Biwa – Yodo River flood management plans

Name of plan, duration	Objectives and outlines
1. Yodo River Improvement Works (1896–1909)	♦ Seta River Dredging
	• Increase channel width to 110 m and depth to more than 3.0 m
	• Increase discharge capacity from 50 to 200 m^3/s
	• Weir construction (completed in 1905)
	♦ Lake Biwa planned water level
	• Pre-lowering of water level (water level to be reduced by 0.9 m below normal during flood seasons)
2. Yodo River Control Project Phase I (1943–1952)	♦ Seta River Dredging
	• Increase discharge capacity from 200 to 400 m^3/s
	♦ Lake Biwa planned water level
	• Planned high water: Torii River Mark of +0.8 m
	• During receding inundation period: Torii River Mark +0.3 m
	• During flooding: Torii River Mark of ±0.0 m
	• Ensure downstream water supply: Torii River Mark of ±1.0 m (Plan Phase 1)
3. Yodo River Improvement Master Plan (1957–1967)	♦ Seta River Dredging
	• Increase discharge capacity from 400 to 600 m^3/s
	• Construct new weir (completed in 1961)
4. Yodo River System Project Master Plan (1971–2007)	♦ Seta River Dredging
	• Increase discharge capacity from 600 to 800 m^3/s
5. Lake Biwa Comprehensive Development Project (1971–1997)	♦ Seta River Dredging
	• Increase discharge capacity from 600 to 800 m^3/s
	♦ Lake Biwa planned water level
	• Planned high water level: B.S.L. +1.4 m
	• Flood period level: Setat B.S.L. –0.2 m during period between June 16 and August 31, and –0.3 m during period between September 1 and October 15 (lowered from previous ±0.0m)
	• Water supply discharge level: Planned low level B.S.L. –1.5 m, with financial compensation measures to be made for the level lower than B.S.L. 2.0 m
	♦ Lake periphery flood management
	• Construction of levy and pumping stations, etc.
6. Yodo River Infrastructure Master Policy and Yodo River Infrastructure Master Plan (2007 – present)	♦ Seta River Dredging
	• Increase discharge capacity from 600 to 800 m^3/s

maintained at +30 cm, above the normal level of ±0 cm, during the nonflooding period. The water level was allowed to rise up to +80 cm for flood inflows during the flooding period.

- For the water supply purpose, the planned low water level was set at −100 cm. The amount of water to be held within the lake between the low water level of −100 cm and the high water level of +30 cm (during the nonflooding period) would be 920 million m^3 for downstream domestic, industrial, and agricultural uses.

Although carried out under direct government control, many problems worked against completion of the project in 1952. Dredging of the Seta River remained a continuing major challenge.

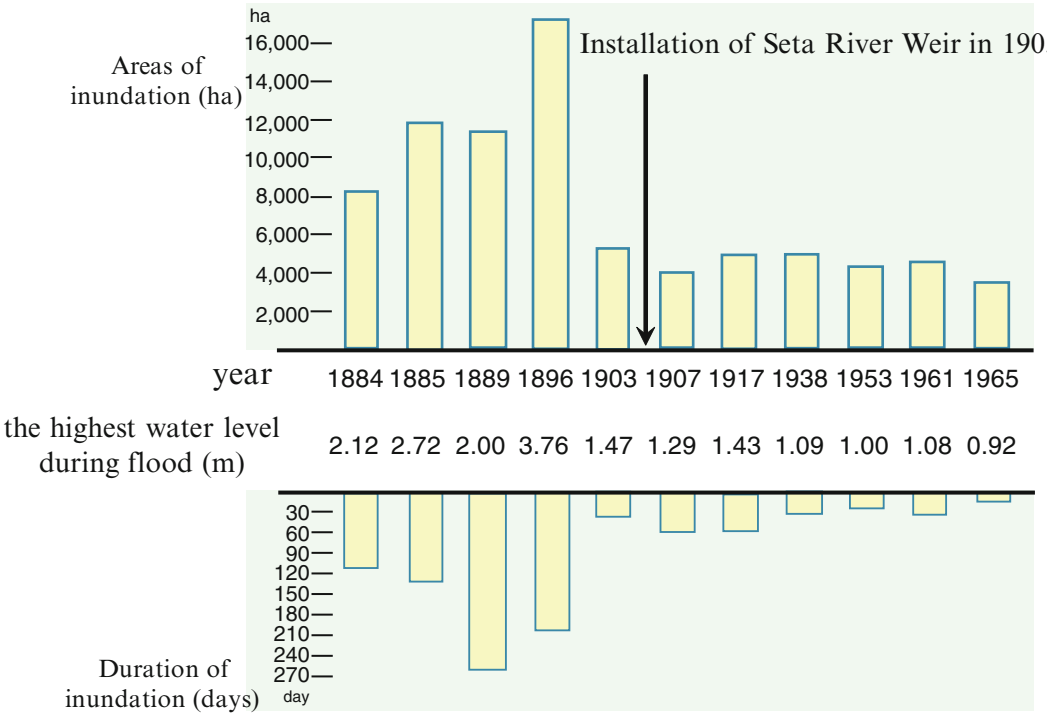

Fig. 3
Extent of inundation before and after the Seta River Weir installation.

Fig. 4
Seta River Weir today (The Seta River Weir was constructed in 1961, replacing the Nango Weir constructed in 1905).

Yodo River Improvement Master Plan (1957–1967) and Installation of New Weir

In September 1953, Typhoon No. 13 inflicted significant damage to the large areas of the Yodo River catchment. This prompted the development of the Yodo River Improvement Master Plan, which included the revision of the discharge capacity targets for the Yodo River System. The plan included even more thorough dredging of the Seta River and the construction of a new weir. The outdated weir, completed

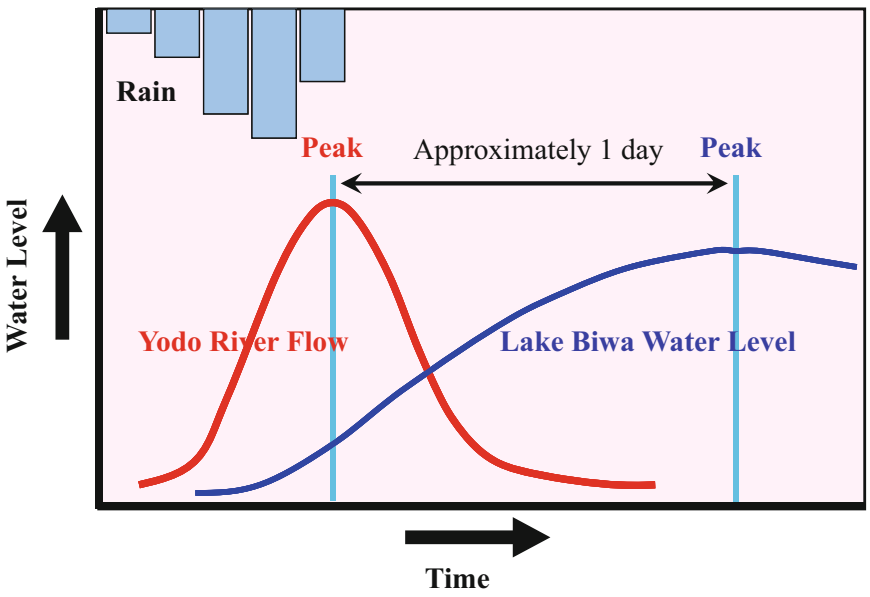

Fig. 5
Time difference between the peaks, respectively, of the Yodo River flow and of the Lake Biwa water level.

in 1905 had to be replaced with a new, mechanically controlled weir in 1961. The new, precision-control weir would now be fully closed and fully opened in just 30 min.

Relationship Between Seta River Dredging and Weir

The dredging of the Seta River and operation of the weir are inextricably linked. The weir controls the Lake Biwa water level in such a way that, under predicted heavy rains, the lake level may be reduced to lower than the normal level and, in turn, the dredged river bottom at the lake outlet would allow flooding water stored in the lake to be quickly released when the downstream flooding risk has been sufficiently reduced. Dredging alone, however, would pose the problem of causing the lake water level to decrease too much at times when there is little rain. The weir prevents this from happening by holding back the water and allowing the lake to function as a reservoir for downstream water uses. The dredged channel, in turn, allows passage of the amount of water required by the downstream, as regulated by the weir.

Synchronizing Weir Operation with Hydraulic Behavior of Yodo River and Lake Biwa

Under conditions of heavy rains, the peak discharge from Lake Biwa can be controlled, whereas the Lake Biwa reaches its peak water level more slowly (approximately one day) than the peak flow in the Yodo River, because of the topographic and hydraulic characteristics of the upstream Biwa Lake and the downstream Yodo River catchment area. This results in a "time lag" between the impacts of heavy rains on Lake Biwa versus the Yodo River (*Fig. 5*). This lag is actually beneficial for managing the Yodo River flooding. When there is heavy rain, the Lake Biwa discharge may be restricted or completely shut off. Once the downstream flow starts to subside, the weir operation may be synchronized to allow discharge of lake water, thereby allowing the lake water level to slowly decrease (*Fig. 6*). Applying this principle, the weir may be operated in such a way that dredging would not increase the risk of downstream flooding. When it rains, the rise in water level can be kept within certain bounds, such that the duration of peak water level may be promptly reduced.

Conflicts over Fully Closing Seta River Weir

Before the Seta River Weir was installed, people living downstream strongly opposed dredging of the outflow channel, arguing that Lake Biwa was a self-regulating natural lake. They believed that increasing the flow capacity would upset the lake's natural equilibrium. Once the weir was installed, however, it became possible to carry out large-scale dredging of the Seta River. The increase in the discharge capacity of the Seta River allowed lowering of the Lake Biwa water level at times of floods, therefore, reducing the flooding damages around the lake. However, the weir would have to be kept fully closed to prevent lake water passing down to the Yodo River at times when it is

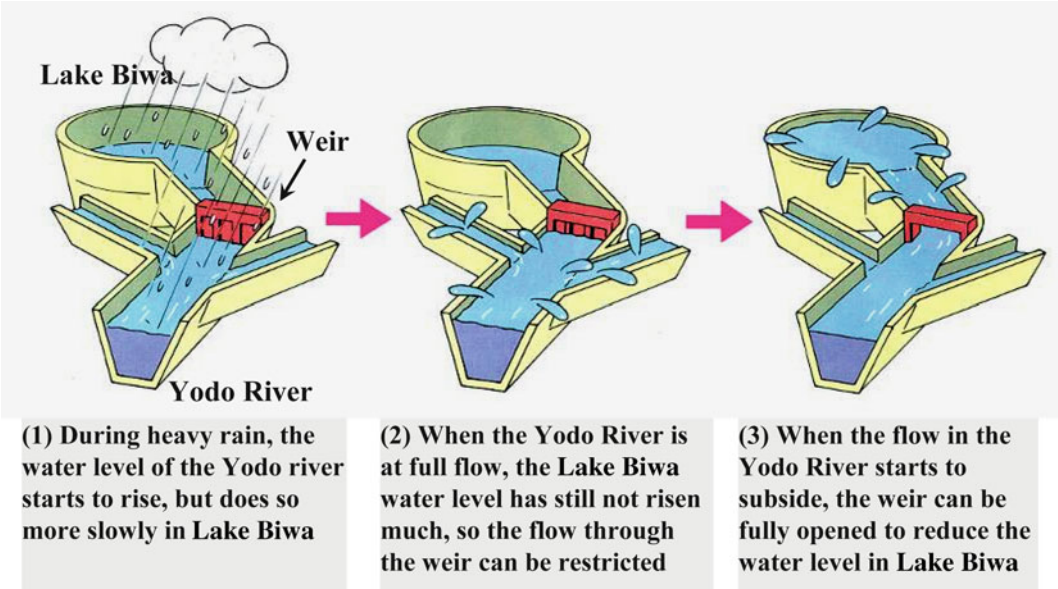

Fig. 6
Synchronized weir operations.

already on the verge of flooding with waters coming from the Katsura River and Kizu River watersheds. Thus, what is beneficial for upstream, that is, opening the weir at times of flooding, is not likely to be beneficial for downstream residents, being the fundamental cause for the upstream–downstream conflict.

For example, in 1917, when a restoration work was being carried out in the wake of flooding cause by a broken embankment downstream at Otsuka (at the western bank of the Yodo River across the city center of Hirakata City today), the citizens of Osaka and Shiga Prefectures submitted a petition against the dredging, and a counter-petition in favor of the dredging, respectively, to the central government. The dispute only subsided when the Emperor visited to inspect the completed work. As another example, in the flood season of 1972, the Shiga Prefecture strongly opposed keeping the weir fully closed, by strongly protesting to the central government. Similarly, in 2006, the Shiga Governor made an urgent request to the central government to, as far as possible, avoid completely closing the weir. To date, the weir operation policy at times of flooding has remained a major issue of contention between upstream and the downstream interests.

6.2.4 From the LBCDP Era to the Present

Having turned out to be a 25-year plan (1972–1997), rather than the originally anticipated 10-year plan (1992–1981), LBCDP has expended 1.9 trillion Japanese Yen. The broader goal of the project was set at developing and managing Lake Biwa in order to contribute to the sound development of the Kinki Region and to the well-being of everyone who relies on the lake. Specifically, the objective of LBCDP was to make proper and effective use of Lake Biwa's resources, while conserving the lake and its surroundings, improving the quality of polluted lake water, and protecting the natural environment.

The policies of the project were guided by three main concerns.

- Management of Lake Biwa water quantity to further reduce flooding around the lake
- Development of the water resources for downstream users, as well as for Shiga Prefecture
- Improvement of Lake Biwa water quality and conservation of the natural environment

Practical targets included development of water resources for the downstream use amounting to a maximum 40 m^3/s at times of droughts, construction of Lakeshore embankment for flood control around the lake, and dredging of the Seta River, together with installation of pumping stations to drain the inundated fields. Under the local development projects, including road construction, sewerage installation, establishment of nature conservation parks, solid waste disposal facilities, water quality monitoring stations, and irrigation return flow pollution treatment facilities were to be implemented by Shiga Prefecture

and the Water Resource Development Corporation, with financial support coming from the national as well as the downstream prefectural and municipal governments, apart from the due payment to be made by the Shiga Prefecture itself.

Planned Management of Lake Biwa Water Level

The purpose of LBCDP was to fulfill the water supply needs of the downstream Keihanshin (the general designation of the greater metropolitan region encompassing Kyoto, Osaka, and Kobe metropolitan regions), based on the arrangement to release the Lake Biwa water down through the Seta River Weir (at a maximum of 40 m^3/s during extreme droughts), as well as coping with the floods of a scale that may occur once in 100 years (a 100-year flood). Consequently, the maximum draw down level of lake water was set at −1.5 m (1.5 m below B.S.L.). In addition, a special arrangement was made for the Shiga Prefectural residents that any damages incurred due to the water level decline between −1.5 m and −2.0 m would be compensated by the national government and downstream local governments. The agreed process is that the contingency plan would be implemented for the domestic, industrial, and agricultural waterworks to continue to function when the lake water level declines toward −2 m, and that the compensatory payments would be made for wells that may run dry. Other provisions include compensation to the fisheries to offset income losses related to reduced fish catches. On matters pertaining to the maximum water level, the planned high water level is set at 1.4 m above B.S.L. to cope with the 100-year floods, in conjunction with other countermeasures carried out around the lake. Thus, the Lake Biwa water level is controlled in the range of −1.5 m and +1.4 m as per B.S.L.

The Lake Biwa Flood Protection Plan was drawn up after considering the flood protection and water supply needs of the Yodo River system as a whole. There are three main strategies, including the following: (a) reducing the water volume in the lake during seasons prone to flood damages; (b) dredging the Seta River; and (c) other works, including embanking around the lake shore, sluice gates, and pumping stations to remove water from the flooded land. These strategies are elaborated as follows:

(a) Reducing flood season lake water levels: During the flood seasons, the lake water level would be reduced in advance to prevent lake overflow and consequent flooding of land near the lake. Depending on the period, the lake would be reduced to –0.20 m or –0.30 m. The lake was previously maintained at B.S.L. ±0;
(b) Seta River dredging: With the greater discharge capacity resulting from dredging of the Seta River, the swollen lake water volume, with the increased water level, could be reduced relatively quickly. The plan calls specifically for dredging to increase the discharge capacity from 600 m^3/s to 800 m^3/s, as measured at B.S.L. ±0 m.
(c) Peripheral flooding countermeasures. To prevent flooding of low-lying lands when the lake level rises, the sluice gates were installed on the feeder river channels:

Construction of lakeshore embankment (*Fig. 8*) and sluices to a crest height B.S.L. +2.6 m, with a planned high water level of B.S.L. +1.4 m.

Pumping stations to remove flood waters, including 14 facilities in six vulnerable areas. There also was an improvement of inflowing channels involving 13 rivers (*Fig. 9*).

Setting Flood Season Lake Water Level Limit

While water in the lake was previously maintained at B.S.L. ±0, the level is now set as B.S.L. –0.20 m from June 16 to August 31 and, from September 1 to October 15 at –0.30 m. This is intended both to reduce the time that the lake water level is higher than normal and to shorten the flooding period.

Seta River Dredging

The Seta River, the only outflow channel from Lake Biwa, was excavated to increase the lake water discharge rate. The increased discharge allows for lowering of the lake level in anticipation of increased rainy season water inflows. This "prelowering" of the water level also would allow the lake to accommodate the 100-year floods, with the lake level reaching its high water mark of B.S.L. +1.4 m. Further, the increased discharge capacity of the lake will enable the prompt reduction of its water level, which would lessen the potential flooding damages around the lake peripheries (*Fig. 8*).

Shoreline Flood Management Measures

Prevention of overflow from the lake, and removal of inundating water, was one of the major goals in the Lake Biwa Comprehensive Development Project. Consequently, the construction of the lakeshore embankment and the river

channel improvements were key elements. To allow for 1.2 m headroom over the B.S.L. +1.4 m planned high water level, the levy embankment was constructed up to the height of B.S.L. +2.6 m around the lake. Channel improvement of inflowing rivers also was carried out, and the pumping stations were installed to remove water that might spill over from flooded rivers to cause lowland inundation around the lake that was blocked by the levy structure.

Formulation of Weir Operating Principles

Even after the weir was installed, regulations for its operation were still undecided because of continuing opposing upstream and downstream interests. As LBCDP neared completion in 1992, however, upstream and downstream agreement had been achieved, and the operating regulations decided. At the same time, downstream water users in Hyogo and Osaka Prefectures were finally able to execute their acquired right to draw up to 40 m^3/s of water from the Yodo River during times of severe droughts. The Seta River Weir has been managed and operated based on these regulations since April 1, 1992.

Under these regulations, the planned peak water level is set at B.S.L. +1.4 m. Seasonally, during the potential flood periods, the level is reduced to B.S.L. –20 cm or –30 cm (between June 16 and October 15), while at other times, when there is a low risk of flooding, the water level may be allowed to reach B.S.L. +30 cm (between October 16 and June 15 the next year). Accordingly, water discharges through the weir are finely controlled to not exceed the regulated values. During times of downstream water shortages, the Weir would be finely controlled. If the Lake Biwa water level decreases to below B.S.L. –1.5 m, however, Ministry of Construction (redesignated as the Ministry of Land, Infrastructure, Transport, and Tourism since 2001) decides the weir operation policy, after consulting with the Governor of Shiga and the other prefectures concerned (*Fig. 7*).

Yodo River Improvement Master Plan (1971–2007): Management of Entire River System

The Rivers Act of 1896 was revised in 1964 to promote the integrated management of both flood control and water supply in the entire drainage systems. Based on the revised Act, the first Yodo River Improvement Master Plan was developed in 1965, covering the entire Yodo River and Lake Biwa. Recognizing the need for security for the increased population and the expanded industrial areas in the Yodo River basin against flooding, this plan had to be completely overhauled. It was eventually implemented in 1971 with the goal of preventing the damages even from the 200-year floods. As of 2010, based on the work carried

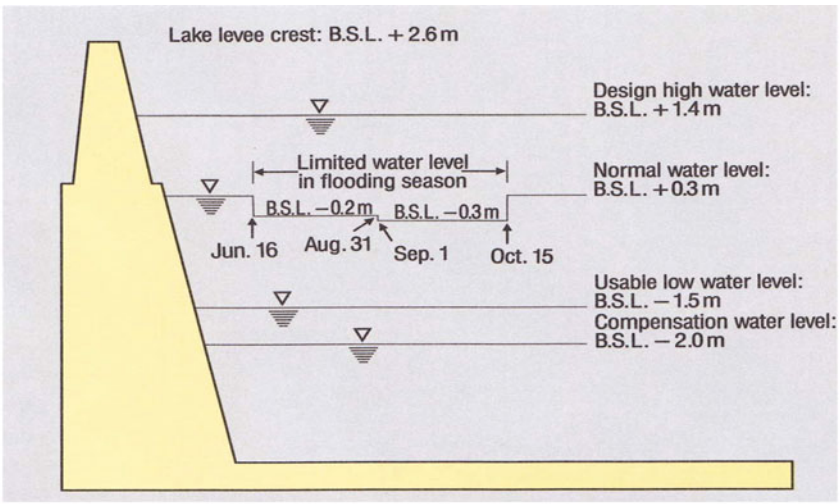

Fig. 7
Water level adjustment in Lake Biwa.

Legend

B.S.L.	Lake Biwa surface level (Tokyo Bay datum+84.371m)
Design high water level	Max. level according to flood control plan
Normal water level	Target level during ordinary conditions
Limited water level in flooding season	Pre-lowered level in anticipation of heavy rain
Supply discharge low level	Level reduced to sustain supply in dry spells
Compensation water level	Low level that triggers compensation measures

Fig. 8
Lakeshore embankment.

out under the plan, the objective of flood control is to prevent the 200-year floods at specific downstream reference points.

Fundamental Yodo River Management Policy and Yodo River Improvement Plan (2007–Present)

In addition to the concern hitherto restricted to flood control and water resource development, the 1964 Rivers Act was further revised in 1997, with the goal of dealing with rehabilitation and protection of the river environment.

In conformity to this revised Act, the Fundamental Yodo River Management Policy was formulated in August 2007, from which the Yodo River Improvement Plan was developed in 2009. The spirit of the Policy was, "rather than sacrificing one area of a region to protect another, the intention is to improve security from flooding in the entire river basin; and after the downstream flood control infrastructure development has been completed and as long as there would be no threat of flooding downstream, the Weir would not be completely closed."

Since the end of the nineteenth century, the fundamental concept of the Yodo River flood control was to lower the normal Lake Biwa water level in advance to offset flood season high water levels. The integrated flood management policy has consistently combined this prelowering before the seasonal inflow of water with dredging of the Seta River to increase the lake outflow capacity, and closing of the Seta River Weir to reduce downstream flood risks.

6.3 Water Resource Development in Lake Biwa Region

6.3.1 Overview

As was typically the case throughout Japan, the early motivation for water resource development in the Biwa-Yodo Basin was the water need for paddy irrigation. The lake region remained poor, sustaining their livelihood more or less exclusively on the basis of a rural agricultural economy. Despite its large quantity and close proximity, Lake Biwa water was not a viable water resource option for the riparian communities in the days when electricity was still not widely available for pumping water upland. Rather, the lake watershed communities had to resort to the diversion of the unstable feeder river waters for paddy irrigation and for meeting their daily needs. During the droughts, the upstream farmers would divert almost all of the river water, leaving little for the downstream users. While the upstream water users usually have the power to control the water, they also have to ensure the water use conflict with the riparian communities would eventually

Inae Pumping Station

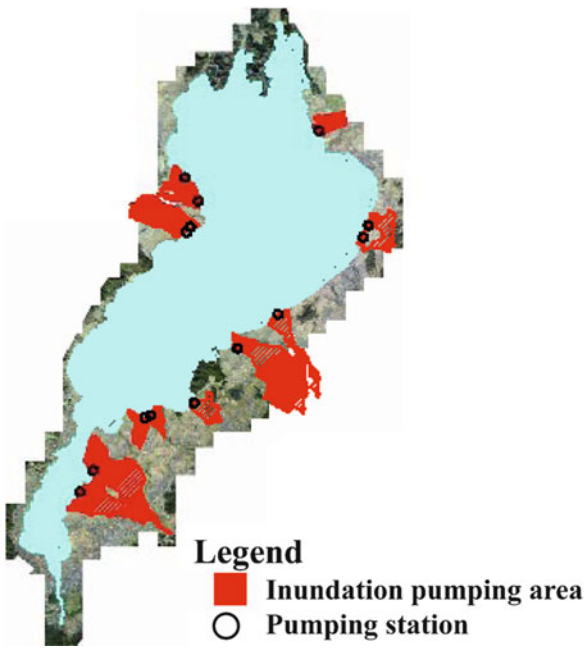

Fig. 9
Pumping stations and Inundation area around Lake Biwa.

be amicably resolved, by means of various sophisticated nonstructural measures for conflict resolution. One such example is the formation of water user associations for effective and equitable water distribution. Another example was unification of the individual diversion intakes in such a way there would be only one water user association along the same diverting river system. This irrigation water use culture evolved over the period of more than 300 years.

Unfortunately, however, even with such measures, the resolution of water use conflicts was always difficult. Specifically in the Lake Biwa region, the unique geo-topological and climatic conditions made paddy irrigation particularly problematic. Simply stated, frequently too little or too much water was available in many parts of the basin. In old days, the structural measures were limited to constructing impoundment ponds and/or earthen barrages to help ameliorate such hardships.

6.3.2 Water Needs and Management Challenges

On the other hand, the communities in the downstream Yodo River have had access to the water, mainly that originating from Lake Biwa, at many water intake locations. The stable water-abundant communities have grown over time to become today's Keihanshin economic region, with a high concentration of industries and populations. In addition, at times of heavy rain over the lake watershed, the flood control weir constructed at the discharging mouth of the lake was operated on the principle requiring the flood waters to be kept within the lake basin. The overall political and economic dynamics remained skewed in favor of the downstream interests over the upstream interests. However, by 1950s and 1960s, the structural measures included construction of large scale, multiple-purpose dams, together with installation of large-scale pumping stations for distribution of the abstracted water through the irrigation pipeline networks. The conjunctive use of river and lake waters was realized for the first time during LBCDP for flood protection and land development of the riparian lowland communities, and for generating additional water rights for irrigation, although its primary purpose was to allow more water to be made available to the downstream region during times of extreme droughts. The additional water rights and the traditional rights had to be properly realigned for equitable allocation.

The era of water resources development has lasted for decades, and by the mid-1990s, the projected severe water shortage for the urban and industrial sectors in the 1960s and 1970s seem to have been significantly moderated with the completion of a sufficient number of dams and reservoirs across Japan. By then, however, the negative impacts to the environment and nature by these hydraulic structures also have grown to become a major contentious issue in many parts of Japan, including in the Biwa-Yodo Basin. The growing concern for the environment and for the wasteful uses of the supplied water made the conventional approach of supply-side water management outdated. There is strong sentiment on the need for a paradigm shift from the supply-side water management to demand-side management.

6.3.3 Low Flow Regulation: Some Dictating Facts

As discussed in previous sections, management of Lake Biwa water, specifically its water level, has historically been highly contentious and conflicting, particularly with respect to supplies of water, and control of floods. Those living in the downstream Yodo River want Lake Biwa water to be kept within the lake during times of floods, and for water to be released downstream during drought periods. Combined with the fact that the demand for Lake Biwa water in the downstream Keihanshin Region has been predominantly for urban and industrial uses, while that in the upstream Lake Biwa region has been dominantly for agricultural use, there are some dictating facts about the ways with which a variety of policy tools has historically been introduced.

The Hirakata Gauging Station

The water quantities required under the water rights for satisfying the thirst of the downstream Yodo River are allocated at Takahama, immediately upstream of the Hirakata confluence point of Uji, Katsura and Kizu Rivers (see *Fig. 1*). At the Hirakata Gauging Station, the low flow regulation is set at 186.51 m^3/s during the irrigation season (May 1 to October 15) and at 169.71 m^3/s in the nonirrigation season. Of these water flows, the minimum requirement for environment protection and nature preservation is set at 85 m^3/s, which consists of 70 m^3/s allocated to the Oh River (Oh-kawa), 10 m^3/s allocated to the Kanzaki River (Kanzaki-gawa), and 5 m^3/s to pass through the Yodo River Big Weir (Yodogawa-Ohzeki). The quantities of water allocated for agricultural use is 16.8 m^3/s, and for industrial and municipal uses together is 101.51 m^3/s.

Ascription of Water Rights

Around 70% of the total water discharge at Hirakata comes from the *Uji* River, which originates from Lake Biwa. During the dry season, the daily releases from Lake Biwa are approximately eleven million m^3 (130 m^3/s) which corresponding to about 1.6 cm of Lake Biwa depth (1 cm of depth from surface corresponds to about 6.8 billion m^3). Based on the Yodo River Water Resources Development Master Plan (or the Yodo River Full Plan, described in detail in Section 6.3.4), 40 m^3/s was ascribed to the water level control of Lake Biwa through LBCDP, 15.175 m^3/s to the first stage Yodo River improvement works, 15.576 m^3/s to the natural base flow, and the remaining flow to various dams (Takayama, *Hinachi*, *Shourenji* and Hiyoshi Dams), and other water control measures (Yodogawa Ozeki Weir and Shorenji Water Intake).

Fig. 10
Torii River Gauging Station and Seta River Weir.

6.3.4 Key Water Resource Development Issues

Seta River Weir and Torii River Gauging Station (*Fig. 10*)

The water level of Lake Biwa, as related to drought and flood management, has always been the focal issue of contention between the upstream and downstream stakeholders. When the Nango Weir was completed in 1905, the baseline elevation of the Lake Biwa water surface, as measured at the Torii River Gauging Station, was determined to be 85.671 m against the Osaka Pail (or the standard seawater level of Osaka Bay). Thereafter, all construction works and water management decisions refer to this B.S.L. as the standard water level of Lake Biwa (Biwako Stand Level, or B.S.L. ± 0 m level). As an aside, this B.S.L. formed the baseline for determining various design parameter values comprising the structural and nonstructural interventions stipulated in LBCDP, including the planned high water level of +1.4 m (of which the free board height is +1.2 m), the planned Lake Biwa water levels during summer months (−0.2 m from June 16 through August 31, and −30 cm from September 1 through October 15), the maximum water level under normal weather conditions of +0.3 m, the usable water drawdown of −1.5 m, and the damage compensation water level of −2.0 m. In other words, the lake level has been meticulously controlled to make Lake Biwa function both as a flood control dam, and as a water supply reservoir, depending on the seasons and the prevailing precipitation phenomena at the time (*Fig. 11*).

Construction of Kyoto Canals and First Stage Yodo River Improvement Works

Prior to industrial development in the late-nineteenth century, the use of Lake Biwa water was limited to small scale drinking water supplies, paddy irrigation in the low-lying lands, fisheries, and navigation. At the dawn of the Meiji Restoration Period (1868–1912), however, the government was intent on developing industries, resulting in a critical need for hydropower generation and water resources. Notable in that respect were two major Lake Biwa projects. The first was construction of Lake Biwa Canals, and the other was the First Stage Yodo River Improvement Works. The Lake Biwa Canals were constructed between 1885 and 1912. Completed in 1890, the First Canal, with a capacity of 8.35 m^3/s, was designed to meet the navigation, hydraulic works, and irrigation needs. Completed in 1912, the Second Canal, with a capacity of 15.3 m^3/s, was designed to meet water supply and hydropower needs. The total design capacities of the two canals amounts to 23.65 m^3/s, being managed by the City of Kyoto for drinking water (12.96 m^3/s), industrial water (0.004 m^3/s), irrigation water (1.12 m^3/s), and other uses (0.781 m^3/s). The hydropower station constructed at Keage at the outlet of the Second Canal was the first such system in Japan and, together with the hydropower dams constructed in Uji River and Shizu River downstream of Lake Biwa, gave the lake an important role in energy production. (See also Topics 21)

The First Stage Yodo River Improvement Works was undertaken mainly to support the war footing in 1943

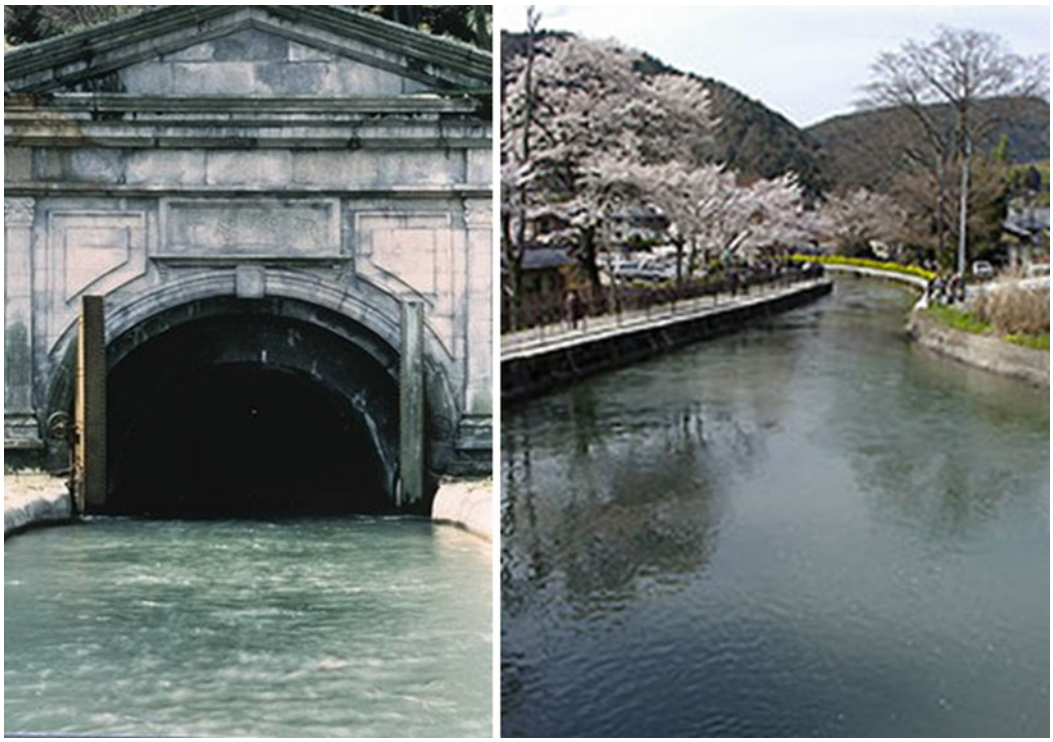

Fig. 11
Lake Biwa Canal inlet and open channel.

during the Second World War. Some 120 m^3/s of Lake Biwa water was to be supplied to industries, to drinking water supply, and to hydropower generation, for which the Lake Biwa water level was lowered down to −1.0 m B.S.L. by dredging the Seta River and realigning the Daido River confluence to the Seta River. The project was only partially completed in 1947 because of the ending of the war in 1945, was later succeeded by the Yodo River Water Resources Development Master Plan (the Yodo River Full Plan) of 1962, being finally completed through LBCDP in 1997 with modifications (see Section 6.4 for details).

Yodo River Water Resources Development Master Plan (Yodo River Full Plan)

To support rapid urbanization and industrialization after Second World War, the national government was intent on developing hydropower generation, urban and industrial water supplies, and irrigation systems. The Law Pertaining to Construction of Multipurpose Dams was enacted in 1957 to discourage wasteful investments in river management. In 1961, the Law for Promotion of Water Resources Development and the related laws were enacted to accelerate water resource development, with a provision to identify seven priority river systems to receive funds for integrated development. The Yodo River was included as one of the seven systems, enabling the development of the Yodo River Master Plan (also referred to as the Full Plan) for water resource development. The Full Plan acknowledged the water rights generated, respectively, by LBCDP (40 m^3/s), Takayama Dam (5 m^3/s), Shorenji Dam (2.49 m^3/s), Murom Dam (1.6 m^3/s), Hitokura Dam (2.5 m^3/s), Hiyoshi Dam (3.7 m^3/s), Hinachi Dam (1.5 m^3/s), and Nunome Dam (1.14 m^3/s). In 1964, the River Law of 1896 was revised, with the new stipulation for water rights and other relevant issues. Based on the Full Plan as a long-term water resources development plan, many water resources, irrigation, and river engineering construction projects were gradually undertaken over the following years.

6.3.5 Developing the Lake Biwa Comprehensive Development Plan

Soon after Second World War, and recognizing the need for a long-term, comprehensive resource development project for Lake Biwa, the Lake Biwa Comprehensive Development

Council was inaugurated in 1952. The Council members consisted of three groups, that is, the national government, three downstream prefectural governments, and the major water user associations. In addition, the Shiga Prefectural government, the reluctant but only upstream stakeholder, was also a member. The main objectives for establishing the Council was to reach an agreement for the downstream users, mainly the Osaka and Hyogo Prefectural governments, to have access to greater quantity of Lake Biwa water. The contention of the Shiga Prefecture was that the first priority should be to fulfill the local community needs, and to develop the infrastructure for local and regional economic development, with provisions for nature conservation and environmental protection.

The Council members elaborated on the assessment of the visible/invisible and/or tangible/intangible values, and on the responsible bodies for taking care of such values. Although the Minister of the Construction had the legal right to decide on the fate of the Lake Biwa water, it would not be possible to decide on the fate of the Lake Biwa water without having the agreement of the Shiga Prefectural government to the terms of the proposed plans and programs. Eventually, the downstream Osaka and the National Government accepted the view expressed by Shiga Prefecture that water resource development for the downstream should be accompanied with regional economic development of the upstream Lake Biwa region. Thus, the scope of the water resources infrastructure development projects stipulated under the Full Plan was expanded and, together with flood control and environmental amenity projects, the Full Plan was transformed into LBCDP of 1972.

It is important to note here that the water resources component of LBCDP involved intricate political settlements among the key stakeholders. The downstream residents insisted the planned drawdown of the lake water level should be −2.0 m, corresponding to 40 m^3/s of additional lake water discharge, as per the engineering computations performed by the Ministry of Consturction, reorganized into the Ministry of Land, Infrastructure, Transportation and Tourism in 2001. The Shiga Prefectural Government, on the other hand, considered the figures unacceptable, and insisted on the discharge to be 30m^3/s, corresponding to −1.5m of drawdown. The two were in strong disagreement, seemingly jeopardizing the conceptual basis of LBCDP. In March 1972, however, the Minister of Construction and the four Governors met and agreed to the Statement of an Exchange of Promises (*Moushiawase* in Japanese) stipulating:

1. The quantity of additional discharge from Lake Biwa at times of extreme droughts is agreed to be 40 m^3/s.
2. The maximum drawdown should be B.S.L.−1.5 m.
3. The Minister of Construction will honor the opinions of the prefectural Governors before making the final decision on the operation of the Seta River Weir during times of extreme drought.

The Statement in effect adopted the politically compromised figures of 40m^3/s and −1.5m, and, although the compensatory engineering works to be performed for the in-lake facilities to the drawdown level down to −2.0m, rather than just to −1.5m was not included in the Statement. Being inconsistent against the results of technical analyses, this political settlement later became a focal issue of discussion on the need for new Weir operational rules for meeting environmental and ecological needs. In other words, the Statement in a way reflects the implied societal consent to let political tensions supersede technical integrity. Having the regional economic development and the environmental enhancement project components added to the water supply and flood control components, the total budget of LBCDP eventually exceeded 1.9 trillion yen. The project, which was originally designed to be one of water resources development, was realized through an extremely intricate political compromise.

6.3.6 Irrigation Improvement Projects in Lake Biwa Surroundings

An extensive part of the lowland area of the Lake Biwa watershed is irrigated for paddy agriculture. The irrigation systems prior to LBCDP were typically limited to cascading of stream waters from the upstream impoundments and barrages. The Shiga farmers were keen to have these systems improved through LBCDP, and various irrigation improvement projects were undertaken with financial support from it. Three categories of the irrigation improvement programs were developed: (a) construction of new lake-water irrigation facilities to compensate for the lowered groundwater level; (b) regional economic development program; and (c) environmental enhancement program. The lake-water irrigation program had two components. One was construction of large-scale pumping stations and water distribution pipelines, and another was construction of the irrigation return flow recirculation systems. The regional economic development program involved farmland consolidation projects with improvement of irrigation and drainage canals/ditches and farm roads. The environmental enhancement program included development of rural wastewater systems. Described below are some typical cases of each of the three programs (*Fig. 12*).

Fig. 12
Ecologically sound irrigation return-flow drain.

Irrigation by Pumping of Lake Water

Today, some 30% of the total farmland of Shiga Prefecture, comprising about 24,000 hectares, is supplied with pumped Lake Biwa water. In addition, about 14% is supplied with river water mixed with lake water. The lands provided with these new irrigation systems used to be those least favorable for paddy agriculture for two reasons. First, they were located quite a distance away from stream water sources, and second, they were located in the low-lying areas prone to inundation (*Fig. 13*).

Recirculation of Irrigation Return Flows

The concentrations of organic substances measured as COD, and nutrients measured as Total Nitrogen (TN), have been increasing in Lake Biwa over the past decades. The irrigation return flows are regarded to have been partly responsible for the increases. The percentage contribution of agricultural nonpoint-source pollution loads are 13% for COD and 15.4% for TN, slightly less than those from the industrial point source pollution loads, except that pollution load reductions from nonpoint sources of pollution are much more difficult to address. The policy measures introduced in Shiga Prefecture include the recirculation of polluted irrigation return flows. The system, consisting of irrigation return flow collection reticulation networks combined with a pumping station attached to a return-flow collecting pond, is designed to minimize the discharge of pollutants into the lake. In addition, some of the drainage canals are recently being replaced with canals composed of gravels and filter materials supplemented with aquatic plants to reduce COD by oxidation and biochemical decomposition processes.

The irrigation return flows are also problematic, however, because of the so-called "irrigation mud-waters," generated during the paddling-planting and transplanting seasons. They contain high concentrations of suspended solids, and can result in serious negative impacts on the lake ecosystem. The recirculation of irrigation return flows is expected to significantly reduce the concentration of suspended solids. As of 2008, some 25% of the total 7 million m^3 agricultural return flow is subjected to recirculation. Introduced below are pilot project cases on the Hino River integrated irrigation development project and on the Akanoi Bay water quality conservation project.

Project Case 1: *Hino* River Integrated Irrigation Development Project

The Hino River basin stretches out from the central highland region of the eastern watershed of Lake Biwa. Within this basin, LBCDP provided for 110 diversion structures,

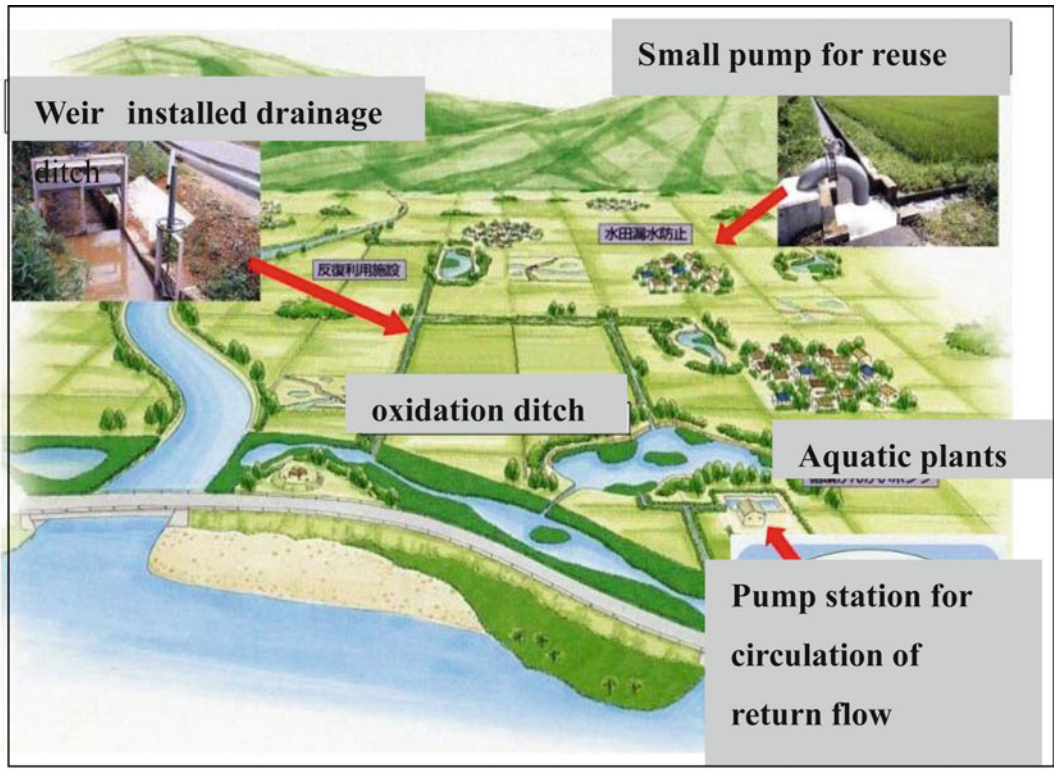

Fig. 13
Irrigation return flow circulation system.

150 farm ponds, 120 pumping stations for groundwater extraction and distribution, as well as for supplying water to the former wetland reclaimed as "polder" farmland. The operation and maintenance of these facilities were carried out individually by many small irrigation associations. Many of the inherent water use conflicts had to be resolved through individual agreements between, and among, the water user associations (*Fig. 14*).

Specifically, the Project, initiated in 1985, consists of construction of the Zao Dam in the upper reach of the Hino River, and a large scale lake-water pumping station with a 4-level boaster pump system to lift the lake water up to the elevation of 220 m. The water intake structure of the pumping station is located some 420 m into the lake to be able to withdraw water even when the lake level drawdown reached the compensation maximum of −2.0m. The maximum quantity of lake water withdrawn is 7.3 m^3/s, the lifting elevation is 60 m, and paddy area coverage is 3,000 ha. Together with the river water captured in the Zao Dam, a total land area of 5,210 ha is irrigated with this system. The lakeshore paddy lands, which used to be prone to inundation, were improved by the drainage network systems equipped with draining pumps. Working conditions and work productivity have been remarkably improved through this project. These newly constructed irrigation systems, however, are not free of problems. The complex maze of creeks containing rich biodiversity has been lost, and the lake-river-paddy linkages have been shuttered for the sake of converting the wetland paddy system to the dry-land irrigation paddy system. There is now the challenge of restoring some of the lost ecosystem properties.

Project Case 2: The "Whirligig Beetles – *Mizusumashi* – Plan" in the *Akanoi* Bay

The Akanoi Bay is a small embayment in the South Lake and one of the most polluted parts of Lake Biwa from urban and agricultural nonpoint-source pollutions, together with the pollution from domestic and industrial wastewater effluents. It has been experiencing occasional blooms of blue-green algae, and the Shiga Prefectural government has given a high priority to its restoration. The plan is called the "Whirligig beetle – *mizusumashi* – Plan." (*Fig. 15*)

Whirligig beetle, or "*mizusumashi*" in Japanese, is a freshwater insect known to feed on aquatic organic debris

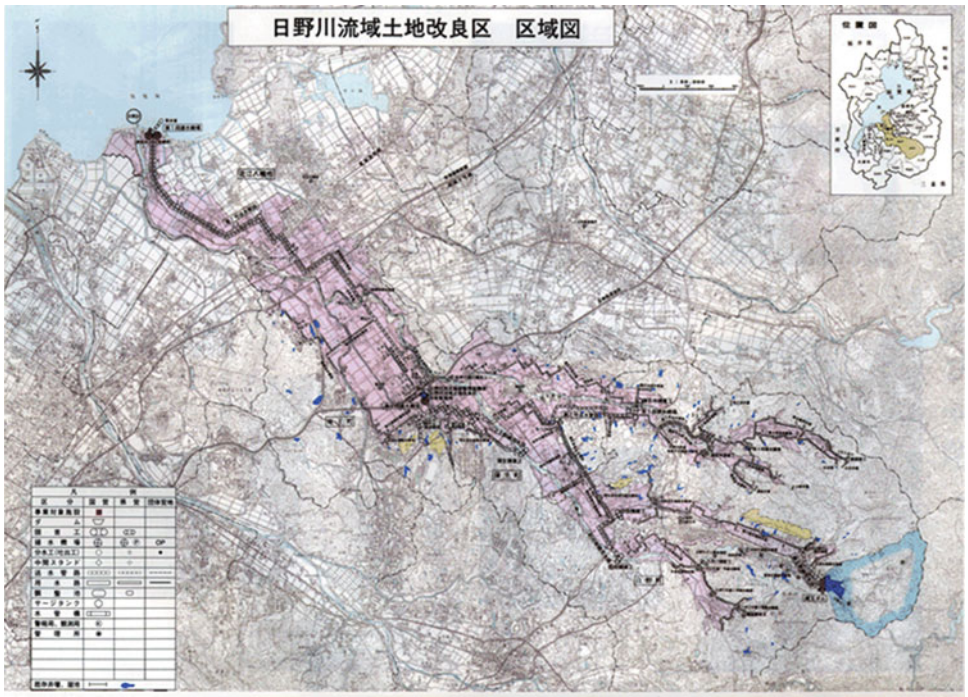

Fig. 14
Hino River project overview map (Source: Shiga Prefecture).

Fig. 15
Location of the *Akanoi* Bay Project (Source: Shiga Prefecture).

and planktonic matters, thus contributing to purifying the water in which they thrive. All of the Shiga Prefecture projects for purifying the agricultural return flow are collectively dubbed as the "Whirligig beetle, or *mizusumashi*, Plan".

The project consists of several engineering components, that is, construction of an oxidation ditch, introduction of aquatic plants for water purification, recirculation by pumping of agricultural return flows, and reconstruction of diversion structures, with a total expenditure of 1.63 billion Japanese Yen. According to the projected achievement, the target reduction of COD is from 199.0 to 85.0, of TN from 67.2 to 37.6, and of TP from 6.3 to 2.43 (all expressed in g/ha/day). At the same time, the plan aims at restoration of aquatic ecosystem health through citizen participation and environmental education.

6.3.7 Water Use Changes in Urban and Industrial Areas

Social Characteristics of Lake Biwa Catchment Area

Japan's population began declining in 2005. Together with the trends of falling birthrate and aging population already evident in the 1990s, Japan is ahead of other industrialized

nations in simultaneously experiencing these three trends. In contrast to these national trends, however, Shiga Prefecture is one of the few prefectures in the country where the population continues to grow. The prefecture's population aging rate is also among the lowest in the country. This is one of the key features characterizing water use patterns in the Lake Biwa region.

The population of Shiga Prefecture declined after the Second World War, reaching its lowest number of 830,000 in 1963. At that time, people and industries were moving into Osaka City, the center of the Keihanshin Area, with the city seeing its population grow to the postwar peak of over 3 million in 1965. The concentration of population and industries in Osaka City was a reason for the population decline in Shiga Prefecture.

Between the mid- and late-1960s, the Osaka metropolitan area expanded in size, resulting in a population decline in Osaka City, with an increased population in the periphery of the metropolitan area. The population of Shiga Prefecture, after reaching its lowest level in 1963, started growing again, and has since been increasing for nearly 50 years. The growth has been particularly significant along the Japan Railway Lake Biwa Line between the Konan (south of the lake) District where Otsu City (Prefecture's capital) is situated, and Koto (east of the lake) District.

Industrial Development in Lake Biwa Region

The locational pattern of industrial establishments in Shiga Prefecture has been greatly influenced by the population growth in the prefecture. Industrialization of Shiga Prefecture was triggered by the establishment in the late-1910s of textile industries such as sericulture, cotton spinning, and rayon productions. It resulted as one of the rippling effects of the development of industries after First World War. The accumulation of the rayon industry in Otsu City was particularly significant, raising the country's rayon output to be the world's number one producer before Second World War. Despite such industrial developments before Second World War, however, Shiga Prefecture was still seen as an agricultural prefecture because of its limited number of industrial activities. It was between the 1960s and early 1970s—the high growth period—that this characteristic fundamentally changed, with the prefecture starting to shift toward an industrial prefecture.

The industrial growth of Shiga Prefecture has much to do with the development of regional transportation systems. At the time of the first peak of industrial accumulation around 1960, the National Artery Road No. 1 was passed through the prefecture, soon to be followed by the National Artery Road No. 8. With the opening of the Shiga portion of the Meishin (Nagoya-Osaka) Expressway in 1964, together with the completion of the Biwako Ohashi Bridge connecting the National Artery Road No. 8 to the Kosei (west of the lake) District's National Road No. 161, the main transportation routes of the prefecture were fairly well-established. As a result, the Shiga Prefecture was connected not only to the Keihanshin Area through the national Artery roads, but also to the Tokai and Kanto areas through the national expressways.

It was in the early 1970s when the textile industry, once the pillar of the prefecture's industries, decreased its share of the prefectural industrial output, being replaced by electric and general-machinery industries. For nearly 40 years since then, these electronic and general-machinery industries, together with many different types of assembly industries, have characterized the industrial profile of the prefecture.

Relocation of Industries from Outside Shiga Prefecture

For the textile industry, established in Shiga Prefecture before the Second World War, Lake Biwa was a major attracting factor. Being constrained by the limited transportation access to the Japan National Railway system (now the Japan Railways) and a small number of regional roads, these industries were mostly confined to the lakeshore area.

On the other hand, during and after the high growth period, the development of road transportation networks with access to the designated industrial lands were a determining factor for industries to be located in the lowland as well as upland areas within Shiga Prefecture. In particular, the Meishin Expressway, which runs through the higher elevation along the foot of the surrounding mountains, allowed industries also to be located in high altitude areas with access to the connecting local roads. The establishment of industrial parks was an additional factor. When the road network was significantly improved in the early 1960s, some 59 industrial parks were constructed, including those in Omihachiman, Konankogyo, Kusatsujutaku, and Minakuchijutaku. The industrial complexes were initially developed in the lowland flat areas, but gradually spread to areas away from the lakeshore. Many of the large-scale complexes today are located in hilly areas, contributing to the concentration of industries in upland areas.

Industrial Water Use Characteristics

Many of the industries established in the prefecture, during and after the high economic growth period, were not

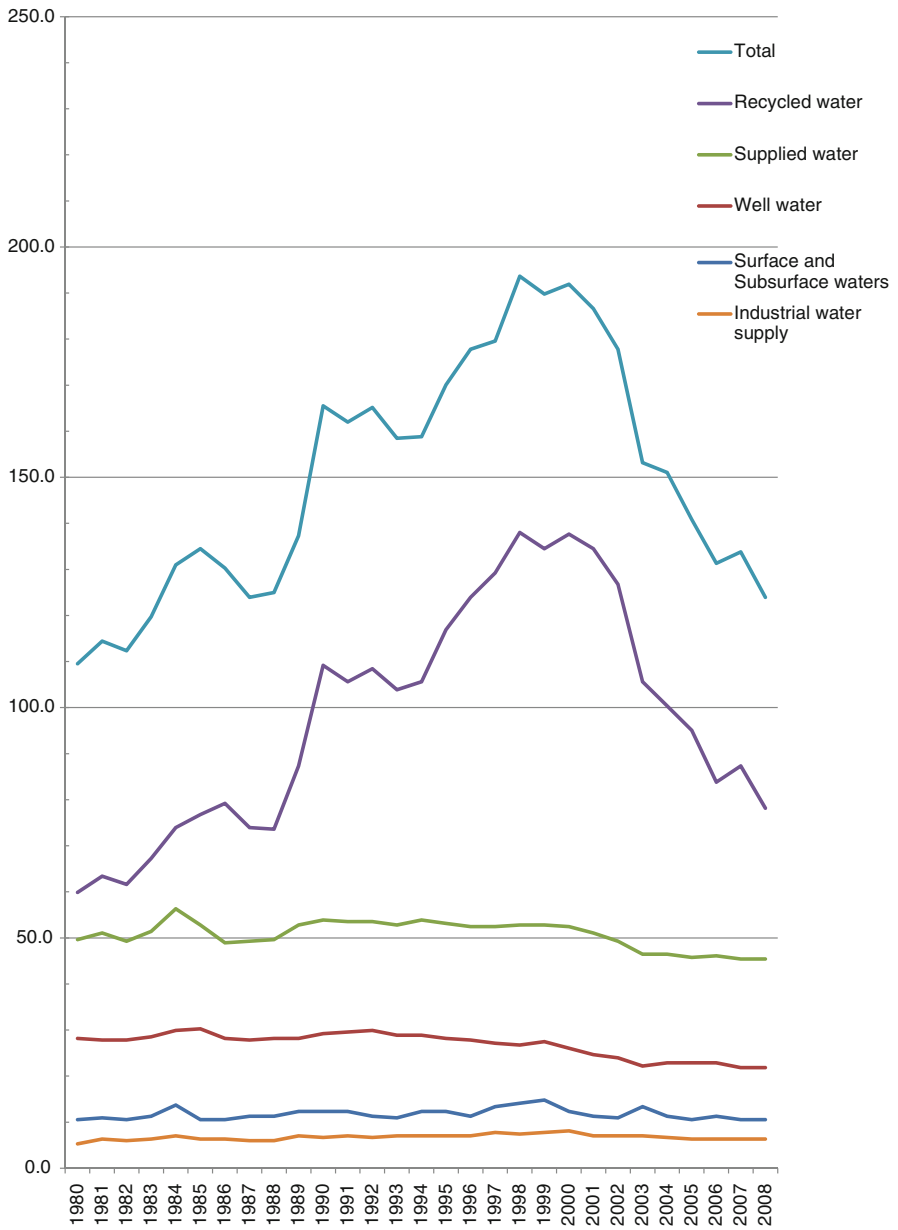

Fig. 16
Industrial water use in Shiga Prefecture by source (Supplied water + Recycled water = Total Industrial water supply + Surface and Subsurface waters + Well water = Supplied water).

dependent on the availability of water. Thus, the availability of local water sources was not a determining factor. *Fig. 16* shows that the total quantity of freshwater use increased 1.7-fold between 1980 and 1998 (the peak year). The quantity then started declining and, in 2008, was at the level of 20 years ago. However, the fact that there was little correlation between the total quantity of water used and the quantity supplied, and that the quantity of water recycled was correlated with the total quantity of water used, suggests that the demands for industrial water could be met by increasing the water recycling rate.

Historically, groundwater has been the major source of water for both agricultural and domestic purposes in Shiga Prefecture. Much of the industrial water has also been groundwater extracted from deep wells, and from subsurface infiltrations (nearly 75% in total). The dependency on public water supplies has been quite low, with this trend changing little since the 1980s. The diverse potential of a local water resource is a unique feature of the Prefecture. In summary, there is little direct relationship between the profile of the prefecture's industries and the use of water from Lake Biwa.

Urbanization and Water Demands

After the late 1960s, Shiga Prefecture was caught in the wave of urbanization and industrialization. Development of residential areas in the Konan and Koto Districts, as well as the growth of catering service industries to business establishments and general households has contributed to an increased demand for domestic and urban water supply.

With a population of approximately 1.39 million, the water supply coverage was 99.2% as of March 2007. The maximum water supply per day per person was 488 liters, a high value. The makeup of water sources in Shiga Prefecture is lake water (69.7%), deep and shallow wells (23.4%), surface and infiltration water (6.5%), and spring and other waters (0.3%). In contrast, river waters are not used at all. The dependency on groundwater, once a major feature of water use in the Lake Biwa catchment area, has been on the decline, being less than a quarter in recent years. In contrast, the dependency on lake water is increasing.

The water source composition varies among regions. In groundwater-rich regions such as the Koto Plain, houses and business establishments have tended to use their private wells, thereby providing little incentive for the introduction of water supply facilities. This has also been the case in the Kosei District. On the other hand, due to unstable groundwater supply and its low quality, the incentive for setting up water supply facilities has been high in the Konan and Koga Districts. Further, these areas also exhibited more industrialization and urbanization than other areas of the prefecture, with a significant increase in water demands — a driving factor for development of water resources.

In the 1960s, the Shiga Government began formulating a water supply development plan. In 1964, the piped water supply coverage in the prefecture was 42.3%, much lower than the national average of 62.8%. This low coverage was due to the fact that people in most parts of the prefecture could use groundwater as a water source. However, the Shiga government predicted this traditional water-supply system would not be able to meet the prefecture's future water demands if industrialization and urbanization continued in the future. During the period of conceptualization of LBCDP in the late 1960s and early 1970s, it was predicted that implementation of the Project would affect the groundwater in the catchment area, causing problems for those depending on. In response, a plan was evolved to shift the water supply source from groundwater to lake water. While cities adjoining Lake Biwa, such as Otsu City, had already been using the lake water, it was LBCDP that facilitated the gradual increase in the dependency on the lake water as a water source (see Section 6.4 for details). As a result, nearly 70% of the current water supply is supplied by the lake.

Lake Biwa is also the final destination of various types of water discharged in the catchment area, as well as the major source of water supply in Shiga Prefecture. The Lake Biwa catchment area has formed a water demand structure that cannot be seen in other areas. Therefore, the people who live in the catchment area invariably have to pay extra attention to their water use and wastewater discharge.

6.3.8 From Water Supply Management to Water Demand Management

The Yodo River Water Resources Master Plan, as transformed into LBCDP, is a supply-based plan of water management, meaning that new water demands would have to be satisfied by the newly developed water source. In other words, the new water users would have access to the needed quantity of water resources by way of constructing water impoundment structures such as dams and reservoirs, or in other ways for creating the additional water rights. The era of this supply-side water management has long passed in Japan, where the need for additional water has become more and more difficult to justify for the major water supply entities in the Keihanshin area because of a declining water demand. Further, the supply-based policy of water resource development resorting to dam construction in the past decades has resulted in a supply of water that far exceeds the demands. There is also strong sentiment against structural approaches of supply-based water management because of the unavoidable negative impacts to the environment, and social disorders and conflicts. The call for change in water resources management from that based on supply, to that based on demand, seems to be a natural change in its paradigm.

The fulfillment of the new water demands can be achieved through: (a) transfer of existing water rights, (b) reorganization of water facilities such as dams and reservoirs, and (c) temporary transfer of water rights, collectively characterized as the water demand management options. The Kinki Regional Bureau of the Ministry of Land, Infrastructure and Transportation, Government of Japan, has indicated the need for the following process in realizing demand-based water management:

1. A thorough investigation of actual water uses and demands
2. Revision of the water right system, particularly with regard to the ban in water right transfers

3. Reorganization of the water resource facilities
4. Restructuring of the drought coordination committee

Demand-based water management, combined with the promotion of various water saving practices, should be sufficient to provide for new water demands. The paradigm shift from supply-based management to demand-based management also means a shift from "construction" to "management," complemented with nature conservation and environmental protection. Such a shift would be realized only through wide-ranging participation of the stakeholder organizations, including the general public. The hardcore structuralism in the Ministry of Land, Infrastructure and Transportation (MLIT), however, is strong, *in* maintaining that the prevailing climate change has been seriously affecting the supply capacity of dams across Japan much less than the design capacity determined decades ago, cancelling the effects of reduced demands.

6.4 LBCDP: Its Frameworks, Accomplishments and Emerged Issues

The primary purpose of LBCDP was to promote economic development of the Keihanshin region by transforming Lake Biwa to a type of artificially regulated reservoir capable of providing additional 40 m^3/s of water through the Yodo River at times of extreme droughts, in order to ameliorate their adverse impacts (i.e., shoreline protection from erosion, reconstruction of the water intake facilities, renewal of ports and harbors, etc.) and those caused by flooding (levy construction around the lake, feeder river flood mitigation facilities, reconstruction of the Seta River Weir, etc.). The design maximum drawdown at times of extreme droughts is 1.5 m below B.S.L., and the design maximum is 2.5 m above B.S.L. The newly created water resources would be able to generate socioeconomic benefits for the downstream Osaka and Kobe regions in the form of urban and industrial development. Shiga Prefectural residents, on the other hand, felt that they might be forced to simply accede to downstream demands for additional water without any direct benefit from the transaction. They were more likely to suffer from the additional discharge of lake water through the Seta River Weir, since it would necessitate alteration of existing, or the construction of new, lakeshore facilities for coping with the lowered lake water level. Thus, the contention of Shiga Prefecture was that the development of additional water resources should not only benefit only those living in the Keihanshin Region, but also those living in the Shiga Prefecture. Thus, LBCDP added the additional objective of contributing to the socioeconomic status of Shiga Prefecture by providing for the improvement of environmental and amenity enhancement infrastructure around the lake shore.

6.4.1 Legal Framework

With such considerations in mind, the "Special Measures Act for Lake Biwa Comprehensive Development" was enacted in June 1972. Article 3 of the Special Act stipulates that LBCDP would be drafted by the Governor of Shiga Prefecture and be approved by the Prime Minister, with the project funds coming mostly from the national government and downstream local governments. A total of 22 project categories were identified and included in LBCDP. Those component projects falling under "regional development" were carried out mainly by the National Government, and relevant prefectural and municipal Governments. The water resources development projects and the Lake Biwa flood control projects, on the other hand, were implemented by the Water Resources Development Public Corporation (*Fig. 17*).

Thus, the conceptual basis of the comprehensive development plan was based on the following considerations:

1. Since those living around Lake Biwa have historically made their livelihoods from the lake, the lake should not be considered as a mere water impoundment or reservoir.
2. The lowering of the lake water level should be kept within limits considered reasonable to those immediately affected.

The balancing of the conflicting interests of Shiga Prefecture upstream and the Keihanshin Region downstream required development of a conceptual framework unique to the water resources management policy-making institution in Japan.

6.4.2 Financial Framework

As a major national water resources development project, with flood control and regional environmental and economic development for Lake Biwa and its watershed, LBCDP needed a special scheme for financing the component projects. The Special Measures Act for Lake Biwa Comprehensive Development was specifically developed for the purpose. The structure of the financial scheme is illustrated in *Fig. 18*. Briefly, it includes the following special measures:

1. *Preferentially elevated subsidy rates:* For some categories of component projects included in LBCDP, the

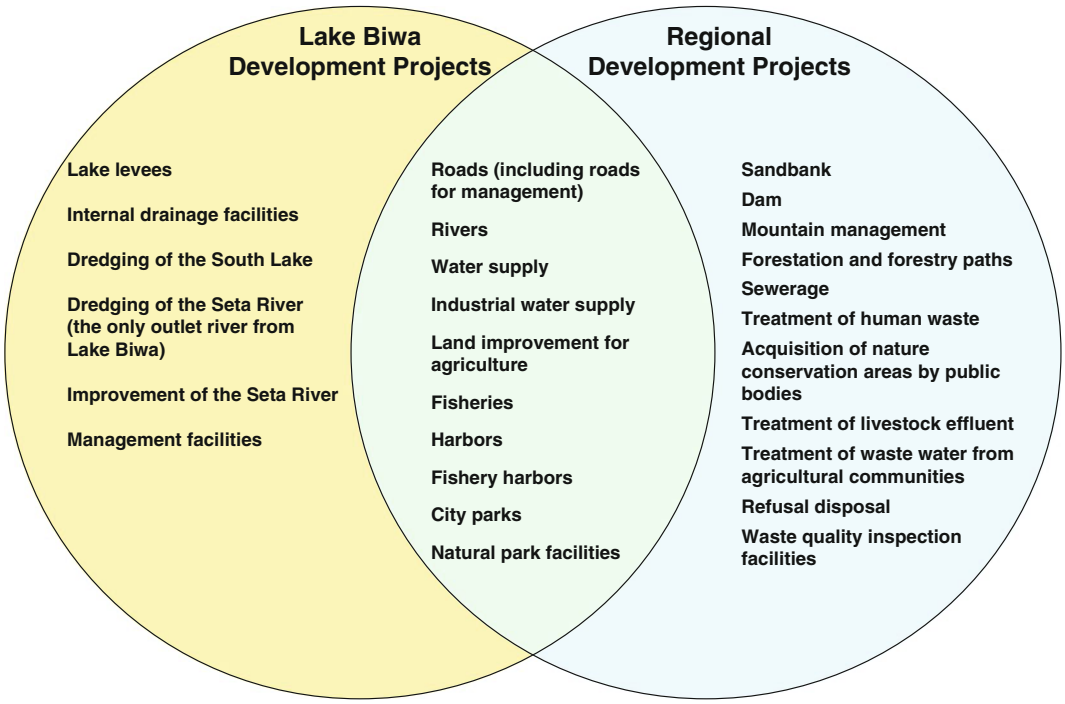

Fig. 17
Sub-projects in the Lake Biwa Comprehensive Development Project.

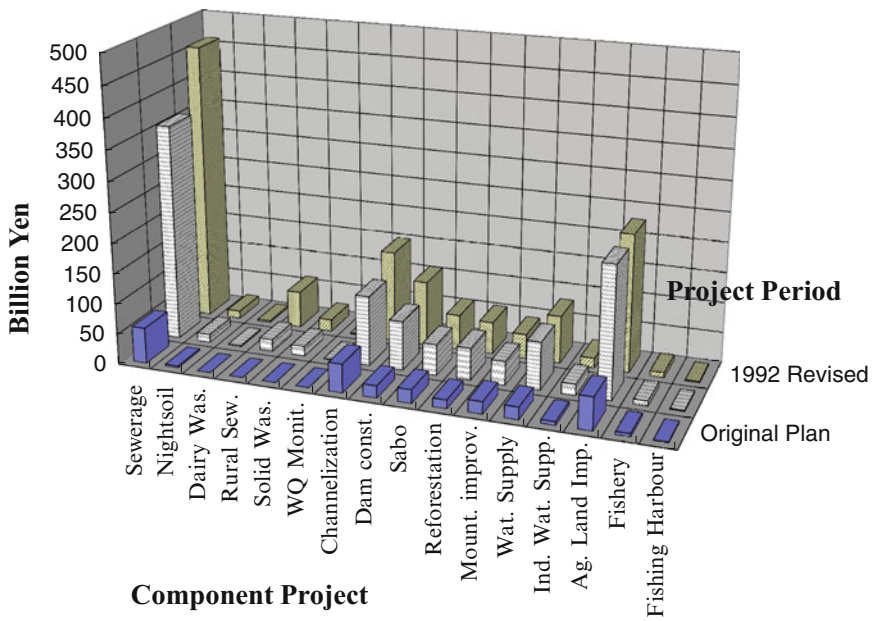

Fig. 18
LBCDP budget structure.

national government provided for "preferentially elevated subsidy rates;"
2. *Financial compensation by the downstream local governments:* The downstream prefectural and municipal governments benefitting from LBCDP agreed to make certain compensatory payments to Shiga Prefecture for the construction of needed facilities and their operations and maintenance. The cost sharing would be based on the extent of water rights allocated out of the newly generated 40 m^3/s resulting from LBCDP. The total compensation from the downstream governments amounted to be 60.2 billion yen. In addition, Osaka and Hyogo Prefectures were required to pay an additional 5 billion yen as a loan to Shiga Prefecture.
3. *Lake Biwa management fund*: At the completion of LBCDP in 1996, Shiga Prefecture was permitted to establish what is called the "Lake Biwa management fund," totaling 10 billion yen, that will be used to undertake projects for maintaining the Lake Biwa water environments and also to maintain and management of the constructed facilities.

6.4.3 Extension of the Act and Inclusion of Water Quality Improvement Projects

This Act was valid only for a 10-year period, to be terminated in March 1982. However, the social and economic conditions of the nation, as well as the surrounding situation of the lake and LBCDP, have changed drastically during the period, with the surfacing of many new issues not adequately taken into account at the time of enactment. In particular, because of the slowdown of the Japanese economy since the first oil crisis in 1973, the national government spending on public works was severely curtailed, and LBCDP was able to achieve only 40% of the goals stated in the Project plan by the end of March 1982. In addition, the forecasted water demands by the downstream Osaka region actually began to decrease soon after the oil crisis in 1973, casting serious doubt about the validity of the very basis of LBCDP.

Furthermore, Lake Biwa water quality began to deteriorate much faster than anticipated, necessitating revision of the original component projects. Thus, the Shiga Prefectural Government consulted with concerned downstream governments and the national government in order to:

1. Extend the validity period of the Act for an additional 10 years to allow for the completion of the initially planned projects
2. Revise the list of component projects by adding projects dedicated specifically to water quality management
3. Maintain the current special financing measures for project implementation

The "Partially Revised Special Measures Act for Lake Biwa Comprehensive Development" was enacted, promulgated, and put into force in March 1982. Four new categories of projects added to the original list of 18 project categories include such items as agricultural dairy waste management facilities, rural community wastewater treatment systems, solid waste management systems, and water quality surveillance and monitoring systems. The total expenditure increased significantly from the original 427 billion yen to 1.525 trillion yen. Together with the originally planned expenditure of 351 billion yen on water resources development and flood control facility development, the total expenditure eventually reached 1.9 trillion yen. *Fig. 19* provides details of the costs of component projects.

The upstream and downstream local governments also reached a consensus in May 1982 that stipulates: (a) the need to establish a forum of joint study by the concerned local governments on the management of the water quality of Biwa-Yodo Basin; (b) the joint financial obligation of the downstream governments to be ¥ 36.0 billion; (c) the extension of the pay-back period for the ¥ 5.0 billion left over from the previous years for an additional 10 years; and (d) the actual release of 40 m^3/s to commence only after the compensatory works have been completed.

6.4.4 LBCDP Accomplishments and Legacies

Flood Control

Lowered Peak Water Levels by Dredging the Seta River

As shown in *Fig. 20*, the increased discharge capacity of the Seta River resulting from the regular dredging practiced since late nineteenth century has lowered the annual peak lake water levels. Notable also was the risk reduction in flooding achieved for the lowlying areas along the lakeshore.

Lowered Flood Peak Water Levels by Prelowering

The lowering of the lake water level before the annual flood season, would lead to the peak lake water level being held down. For example, there was an average rainfall of 257 mm over the period of 9 days in July 2006 over the Lake Biwa catchment area. Because the lake water level was initially at −0.2 m below B.S.L., the peak level was being held to below the peak level experienced in July

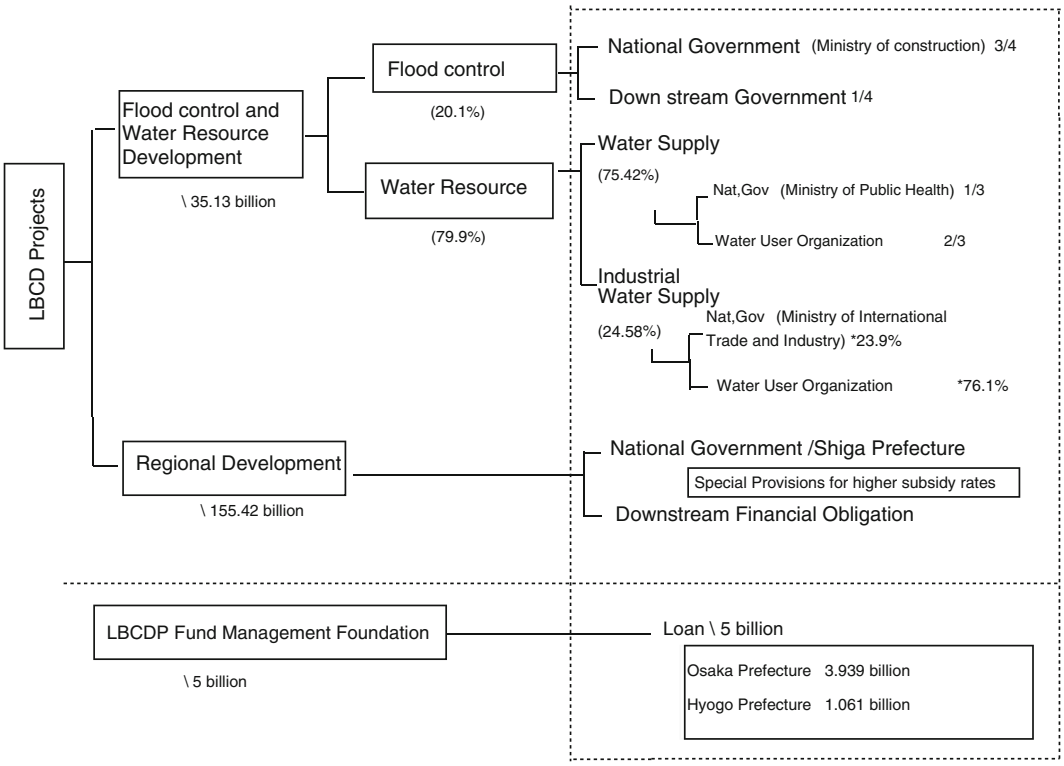

Fig. 19
LBCDP expenditure.

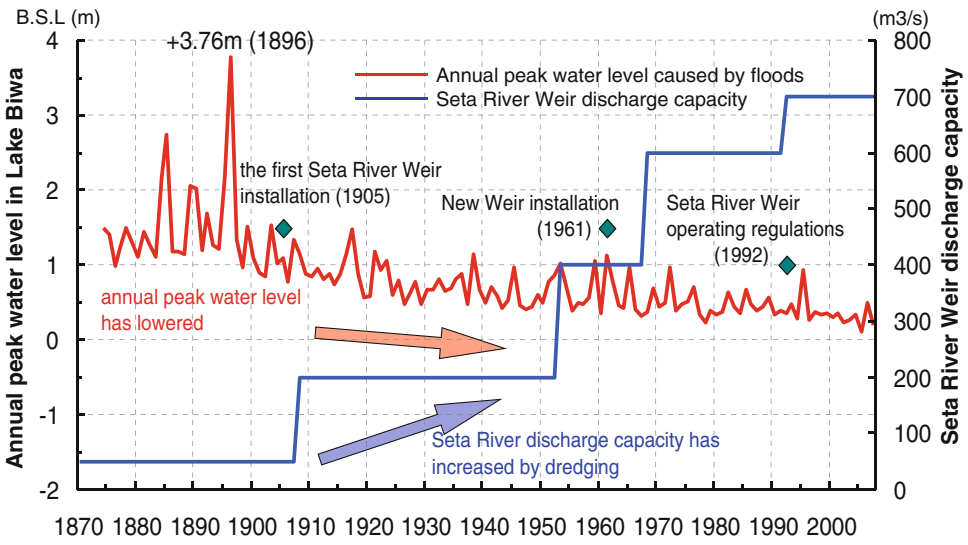

Fig. 20
Dredging the Seta River has brought down the annual peak water level in Lake Biwa.

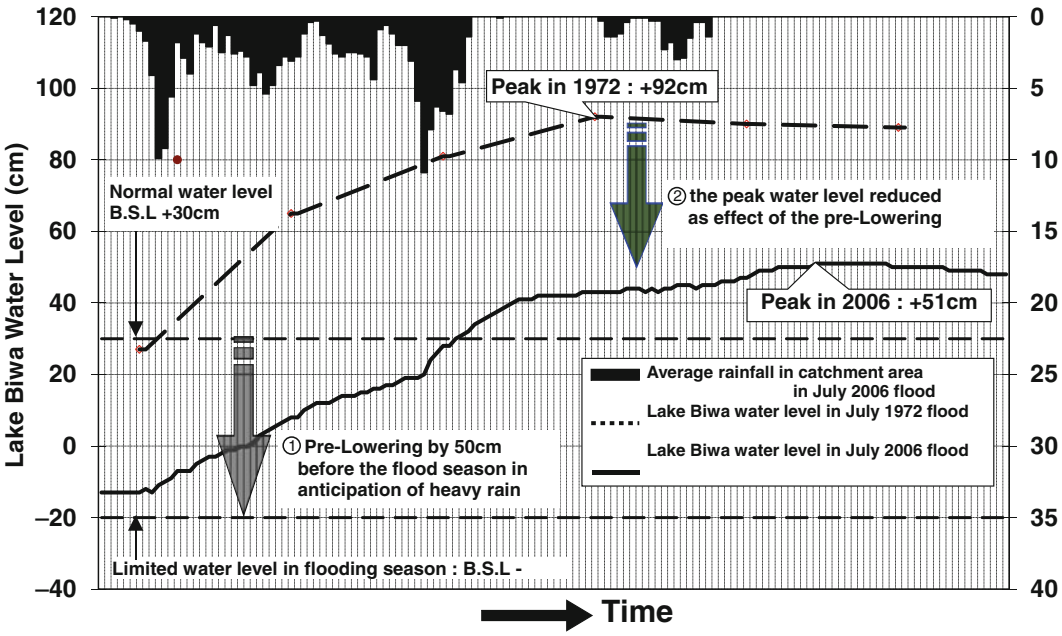

Fig. 21
Reduction of peak water level as a result of pre-lowering.

1972, when there was an average rainfall of 320 mm over the period of 5 days (*Fig. 21*).

Reduced Area and Days of Inundation near the Lake Biwa shoreline

Measures against the inundation caused by the trapping of feeder-river flood water behind the embankments around the lake could be reduced by pumping the inundation water out into the lake, and also by increasing the lake water discharge capacity through the Seta River Weir to the Seta River. For example, although the peak water level of the lake in July 1995, and that in 1972, were both at +0.93 m, the extent of flooding in the former was much less than in the latter in terms of the number of days of inundation (*Fig. 22*).

Water Resources Development

As an example of LBCDP achievement in water resource development, the record drought of summer 1994 did not pose any severe threat in terms of water shortages, despite the fact the lake water level declined down to the historical record of −1.23 m. The number of days of water use curtailments during the 1994 drought was 44 days, or less than 50% of that experienced during the 1973 drought when the maximum decline in water level was only −0.54 m (*Fig. 23*).

Expanded Wastewater Treatment Systems

Among the allocation of public funds invested for LBCDP components, sewerage was highest, followed by land improvement and road construction. Thus, they also are important in regard to impacts on the lake environment.

Sewerage

Sewerage construction was pursued primarily because of its capacity to contribute significantly to the improvement of Lake Biwa water quality, apart from its role in improving the living environment of the people. As a result, the proportion of service coverage in Shiga Prefecture, which had been far below the national average, surpassed the national average by the time LBCDP was completed. Many of the municipal governments within the prefecture, however, face a serious financial burden in having to repay the loan portion of the construction cost, in addition to the heavy costs of operation and maintenance, despite the fact the subsidies by the national and prefectural governments in connection with LBCDP was significantly higher than similar undertakings nationally.

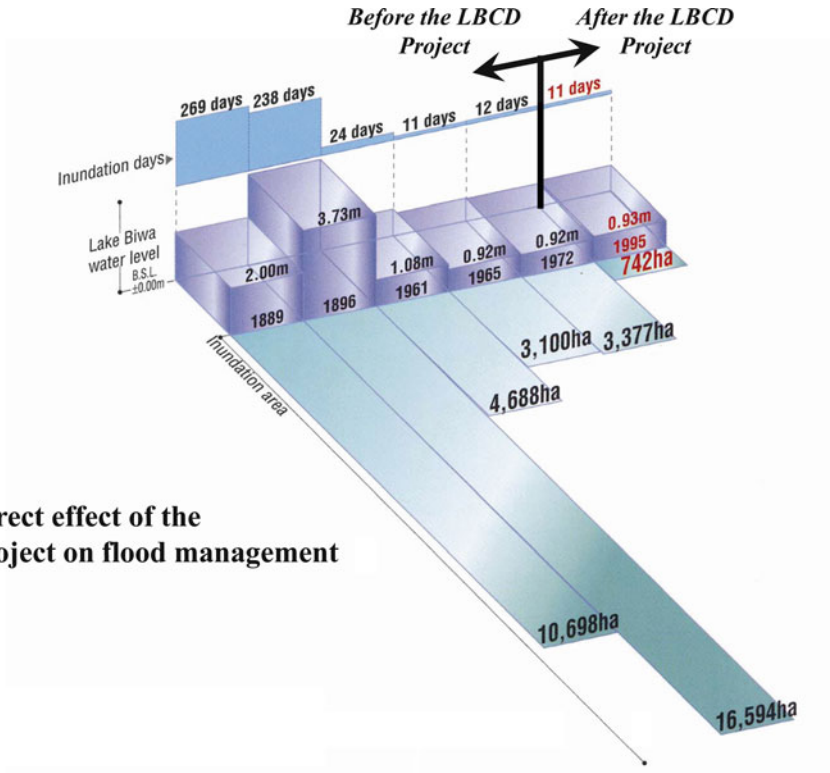

Fig. 22
Reduction in Area and Days of Inundation near the Lake Biwa shoreline.

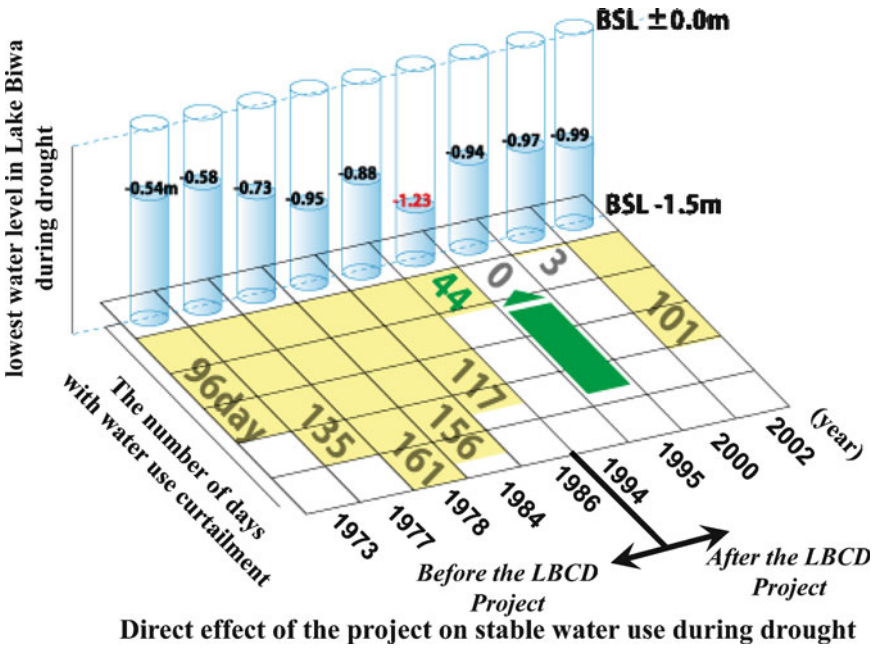

Fig. 23
Reduction in days of water use curtailment after LBCDP completion.

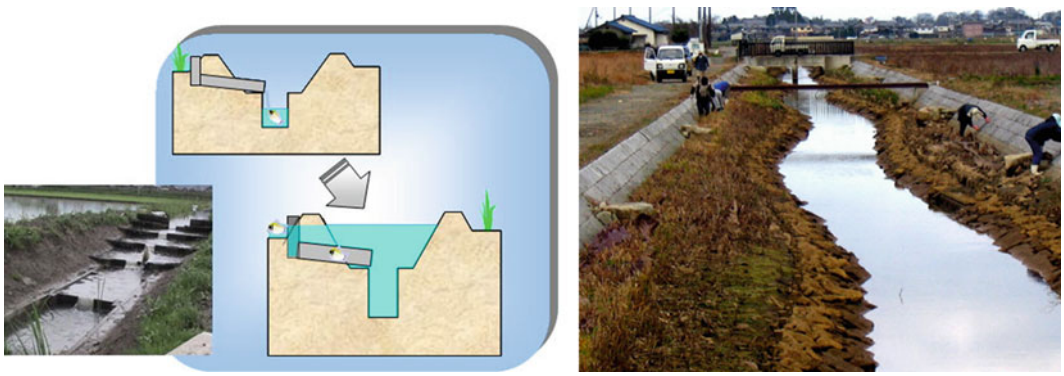

Fig. 24
Fish ladder and draining-ditch aquatic habitat restoration work (Photos: By courtesy of Shiga Prefecture).

Rural Community Sewerage Project

The facility construction for LBCDP related Rural Community Sewerage Project, under the jurisdictional prerogative of the Ministry of Agriculture, started in 1982. A total of 415 units for some 162,000 people have been completed to date, of which 220 units for some 85,000 were financed via LBCDP. The prerequisites to qualify for this project included: (a) the number of beneficially households is more than 20; (b) the number of people to be included in a single project site should be less than 1,000; (c) the area to be served by the system is not within the planned service coverage area of the public sewerage system administered under the jurisdiction of the Ministry of Land, Infrastructure, and Transportation; and (d) the subject household area belongs to the priority area for agricultural infrastructure development. The effluent quality from these treatment plants are generally of high quality, far exceeding the effluent standard. The individual rural homes not served by the Project are provided with onsite treatment units, for which the Ministry of Health and Welfare provide some subsidy.

The treatment facilities within this project scheme are not equipped to treat industrial effluents, unlike the case with the municipal wastewater systems. One of the features of this sewerage system is that the communities themselves take direct responsibility for its operation and maintenance, and also bear their costs as the responsible bodies in the management of these facilities.

Rural Nature Conservation Plan

Emphasis is also given to the restoration as well as enhancement of the Lake Biwa rural environment, particularly with respect to ameliorating the affected ecological habitats. Specifically, a project dubbed as "the water beetle project" has been promoted since 2006. The project aims at improvement of stream water quality, landscape preservation, and conservation of agricultural resource values. The project is financially supported by the prefectural government, and is carried out by the rural communities, with the advice given by the panel of experts. Some 28 projects, such as one shown in *Fig. 24* of construction of fish ladder and in-stream water purification, have already been completed.

Regional Economic Development

Land Improvement

Deployment of the land improvement project, including farm land consolidation, is high for Shiga Prefecture, among the prefectures in the Kinki Basic Planning Region. The irrigation system in the Lake Biwa watershed has evolved over the past several decades with a number of land improvement projects. Today, the paddy water may be managed individually, thanks to the separation of irrigation and drainage, conversion of land to allow for irrigated dry-land paddy agriculture, and paddy land consolidation. They have also helped the farmers to self-support farm management. In spite of such improvements, however, the number of farmers in the watershed has declined, and most of the remaining farmers have transformed themselves to part-time farmers. These new systems and practices also have turned out to have damaged the natural ecosystem and biodiversity, which are subjects of major concern today for those involved in paddy agriculture to pursue.

Roads

For Lake Biwa to meet both its flood control and water supply needs through LBCDP, the lake water level has to be

accurately regulated on the basis of a set procedure, meaning the lake had to be levied in response to flow control at the Seta River Weir. The constructed levies had a flatted top to accommodate passage of vehicles for levy maintenance. The Shiga residents quickly saw the potential of this levy road to be transformed into a major transportation route around the lake, with link roads connecting to major coastal communities and to the existing transportation networks.

The implications of this levy-cum-ring road are many. For example, it has had significant benefits to the local and regional economy. It is used both as a local commuter road and as a means of transporting local commercial goods. It also had a significant impact on the association of the population with the lake. The lake shore, which was hardly accessible before its construction, became quite accessible, not only physically but also psychologically. The scenic view of the lake has changed. Those who previously only felt remotely connected to the lake began to feel much closer to it because the lake is visible from the ring-road. Before its construction, the lake water was hardly accessible from the shore for the casual lakeshore visitors because the passage toward lake was being prevented by the wetland paddy fields, as well as the thick and tall aquatic vegetation, mainly of reeds. It turned out to no longer be the case because much of the land between the levy and the lakeshore has been converted to recreational parks. People now have a close-range view of the lake, in addition to a distant view. On the other hand, the environmental and ecological integrity of the shoreline also has been drastically deteriorated by the construction of the levy-cum-road structure, as well as by the drastic increase in the extent of shoreline activities, making the subject one of the most serious concerns emerging from LBCDP.

Coastal Zone Management

For centuries, growing rice in the complex network of creeks connecting numerous paddy fields was a major form of agriculture along the shore of Lake Biwa. The farm land consolidation policy in the postwar agricultural reform, however, gradually transformed the wetland paddy agriculture to more dependable dry-land paddy agriculture. Though the paddy production became more efficient on dry lands, the farmers' mobility continued to be confined to the lakeshore land due to lack of accessibility. The construction of the levees as part of LBCDP, however, had a dramatic impact on both their life-style and their professional scope. The levees now prevent them from using the lakeshore as temporary agricultural land during the dry season, a customary agricultural practice for centuries prior to the construction of the levees. Further, with the levees serving as an important transportation means along the lake, the farmers no longer need to be confined to the lakeshore land. They can choose professions other than farming. Also, the extent of the shoreline farm lands was reduced through the newly introduced LBCDP policy for the government to purchase the farmland for public use. Finally, the relative importance of this previously primary industry was also decreasing, leading to migration of the population out of the shoreline communities.

Prior to LBCDP, the main stakeholders using the coastal environment were those living in proximity to the coasts, including wetland paddy farmers, fishermen, reed harvesters, tour boat operators, and others affiliated with related professions, whose livelihoods depended on the resource values provided by the lake. Thus, the management objectives and the means for achieving them were rather straightforward. Today, 40 years after inauguration of LBCDP, the stakeholders have grown in number and in kind, and their vested interests have also greatly diversified, making their modes of engagement much more flexible.

Changed Economic Profile of Downstream Region

Industrial Maturation and Change of Policy Concerns

After exceeding the national average in 1981 and reaching among the tops in ranking in the 1990s, the per capita income of Shiga Prefecture has continued to increase, today being in the top third or fourth place among the 47 local governments. Although the proportion occupied by the tertiary industry is higher than that occupied by the other industrial categories in other prefectures, in terms of the gross prefectural product, the proportion of the secondary industry is higher than that of the tertiary industry in the case of the Shiga Prefecture. As previously discussed, the relocated industries from the downstream region to Shiga Prefecture in the 1970s and 1980s have contributed to this trend.

Japan's industrial profile has changed significantly over the past decades because of several major factors. First, her economy transformed from a developing one with a high growth rate in the 1960s and 1970s, to a mature one with a low growth rate in the 1980s. Trade globalization since the second half of the 1980s has also had a major impact on its industrial profile, particularly since many of the manufacturing industries began to relocate their facilities overseas, while decreasing the number of newly established industries within Japan. This brought about what is called the deindustrialization problem, that is, firms began to reorganize the production networks, consolidating and reorganizing

their production facilities and related operations to fewer and fewer numbers. Shiga Prefecture was among those that began to experience this dilemma. When an industrial facility is closed, it can be readily noticeable, but if the functions of an establishment change, this change would not be so readily apparent. For example, an industrial establishment dedicated to manufacturing may transform itself to one dedicated to a research-and-development function. Although such a change would not be easily observable, the impact of this transformation could be profound, in that the overall industrial capacity may be significantly changed.

Further, such a change would impact the employment situation. In the 1960s and 1970s, the surplus labor in the entire region of Keihanshin was absorbed by the accumulation of industries within itself, contributing to its stable employment profile. However, this situation no longer holds today. This is typical of an economy in maturity, with a likely tendency toward a new unemployment problem. The industrial policy, therefore, has to facilitate the conversion of the existing labor force in a way that allows it to be able to cope with the emerging needs, or to stimulate the new business responsive to the emerging market needs under economy in maturity.

Expansion of Metropolitan Area

The economic geography of the Lake Biwa region is highly sensitive to the regional mobilization of goods and services that, in turn, depends on the availability of regional transportation networks. In the early 1960s, the transportation networks began to be expanded toward the eastern part of Lake Biwa, enabling the network to be connected to that of Keihanshin through the already-existing network in the southern part. The networks have grown to reach the Kosei (the western part of Lake Biwa) with the completion of Japan Railway (JR) Kosei Line in 1974, and Kohoku (the northern part of Lake Biwa) by the completion of the Hokuriku National Motor Expressway in 1980. Additionally, they were linked through the nodal points within the Lake Biwa region (such as Maibara in the north), with Japan's major transportation arteries developed in 1960s, connecting the Keihanshin region with such megalopolises in the east as Nagoya and Tokyo.

6.4.5 Environmental Conservation Problem and Lake Biwa Lawsuit

Being a massive infrastructure development project, it was feared from its onset that implementation of LBCDP would have serious implications for the lake's ecosystem integrity, inviting not only heated debates on its merits from the scientists and the mass media, but also strong opposition from various environmentalist groups. Among them was a citizen group formed of concerned scientists and citizens who filed a lawsuit against the central and local governments, particularly with respect to the damage caused to the lakeshore environments by the construction activities across the entire shoreline (levy construction), by the construction of a man-made island (on which an oversized wastewater treatment plant was to be constructed), and by dredging carried out in the South Lake and along the river mouth of the Seta River. The trial started in 1976 and was concluded in 1989, with the court decision refuting most of the plaintiffs' claims. Although this trial had only limited impact in the implementation of LBCDP, it did contribute greatly to the movement toward ecosystem restoration, which ironically subsequently became the main theme of the post-LBCDP policy.

6.5 Post-LBCDP Developments

6.5.1 Changes in Downstream Water Demands

As previously discussed in Section 6.3, the management of the Lake Biwa-Yodo River water has been greatly affected by the water demand profile in the downstream Osaka Bay region, particularly in relation to its industrial activities.

Implications of Changes in Industrial Profile Along Osaka Bay Region

Over the course of decades spanning two World Wars, many nuclei of small industries scattered throughout Osaka, Kobe, and their surrounding suburbs were consolidated to form a major industrial zone called the Hansin Industrial Belt stretching around the Osaka Bay area. By approximately the 1950s, this industrial zone gradually expanded in two major directions, that is, toward Himeji, the western part of Hyogo Prefecture (called the Higahi-Harima region), toward Sakai and the surrounding municipalities and northern Wakayama Prefecture (called the Senshu region), and also alongside the Yamato River toward Nara in the east and alongside the Yodo River toward Shiga Prefecture in the north (Lake Biwa region). The Bay region industrial complex, in particular, evolved to specialize in water-intensive, basic material type industries, while the inland region evolved to specialize in processing and assembly type

industries that were less water-intensive. The former industrial complexes began to face serious problems by the early 1970s. The first problem was industrial pollution created by the complexes. There were many cases of environmental pollution incidents, compounded by serious human health issues. The second problem was the land subsidence along the Osaka Bay coastline due to the over-extraction of groundwater during the postwar industrialization. The typhoon-induced high tides in 1961 inflicted serious damages to the coastal region, due in large part to land subsidence, accompanied with a loss of several hundred human lives. Further, there was a water shortage problem. The increasing demand for industrial water, accompanied by the need to curtail over-extraction of groundwater, motivated the politicians and governments in the region to seek a greater water release from Lake Biwa to the Yodo River. This eventually led to the inauguration of LBCDP.

Regional Development Policy and Redistribution of Industries

Japan's evolving regional development policy also had a significant impact on the management of the Biwa-Yodo Basin. The major emphasis in Japan's post–Second World War regional development policy was to reduce the excessive pressures put on major metropolitan areas. In the Kinki Basic Planning Region (encompassing Fukui, Mie, Shiga, Kyoto, Osaka, Hyogo, Nara, and Wakayama Prefectures) within the Osaka Prefecture, the number of factories in Osaka City was about 60% of the total number in the Planning Region in 1965, when the population of Osaka City surpassed 3 million at its peak. Osaka City also had 52% of the number of workers in the Planning Region, and 53% of the industrial shipments. It was much the same with regard to Kyoto, in relation to the Kyoto Prefecture. The law introduced in 1964, restricting the siting of large-scale factories, was aimed at restricting large-scale factories in parts of the Municipal boundaries of Osaka, Kyoto, and Kobe, as well as in the connecting Hanshin Belt Zone. However, it turned out that the only designated area available to accept those relocated factories was the Harima Industrial Park in the Himeji Prefecture, west of the Hyogo Prefecture.

The need for a legal basis for industrial relocation was addressed with the provision for development of the Kinki Basic Planning Region Improvement Plan, as stipulated in the Kinki Basic Planning Region Improvement Act of 1963, in which the Region was divided into the existing metropolitan zones, suburban improvement zones, urban improvement regions, and conservation zones. The relocating industries and workers were supposed to be settled in industrial parks located in the urban improvement zones to be established in areas approximately more than 50 km outside of the existing metropolitan regions (the eastern Lake Biwa zone, the central Tamba zone in Kyoto Prefecture, the Harima zone, the Wakayama zone). Although the aim of this new policy measure was the diffusion of industries out of the metropolitan centers, it was not necessarily uniformly accomplished. Since housing and industrial developments tended to seek the available land along the major transportation routes, such as JR Tokaido and other private railroad lines, as well as the Meishin National Expressway, the eastern Lake Biwa zone was a popular destination for relocation, in contrast to the other zones, resulting in an imbalance in industrial activities and population distribution among the urban improvement zones.

Changing Water Demands

Over the past decades since the inauguration of LBCDP in 1972, the water demand structure in the Biwa-Yodo Basin has undergone significant transformation as a result of changes in the industrial economy. First, over the period between the mid-1970s through mid-1980s, the declining economic growth brought about a change in the mode of industrial production. Specifically, the industries had to overcome the energy price hike triggered by the successive oil crises in 1973 and 1979. They had to adjust their processes to achieve higher production efficiency by curtailing energy and water uses. Further, the industrial structure has changed from one primarily focused on manufacturing basic industrial goods, to one more focused on the assembly of manufactured goods. This change has also led to lower water consumption per unit of production output. In addition, over the period between the mid-1980s through today, a large number of industries shifted their production base to overseas, to take advantage of lower labor and facility development costs. The strong value of the Yen after the Plaza Accord in 1985 also helped this trend, also contributing to a direct decline in industrial water demands in the region.

There are emerging efforts being made for structural transformation and revitalization of the Osaka Bay region economy today through large scale projects in information technology and service economy in response to economic globalization. However, these newly formed large-scale projects, or even the relocation of large-scale domestic production facilities, do not seem to be increasing the water demands.

6.5.2 Restoration of Ecosystem Integrity and Water Quality

Differences in Upstream and Downstream Perceptions of Water Quality

The upstream and downstream jurisdictional entities in the Biwa-Yodo Basin have experienced long-term conflicts arising from the management of water quantity. The conflicts have been somewhat mediated through the compensatory transactions from the downstream and central governments to the upstream Shiga Prefecture, through LBCDP. The conflicts have not existed for water quality in the sense that everyone wants improved lake water quality, although it is not clear how much improvement is needed, or who will bear the costs of the improvement. Parts of the expenditures on water quality improvement are defrayed through the natural and environmental conservation component of LBCDP. Although the original expectation was that the amount of investment under this category would be sufficient to realize significant improvement in lake water quality, the improvement was only marginal at the time LBCDP was completed in 1997. The Shiga Prefecture wanted the downstream governments to continue to contribute financial resources, even after LBCDP, for improving the lake water quality.

If the scope of water quality improvement is confined to water supply, asking the downstream water users for more funds would not be easily justified. The quality of the drinking water was already more than satisfactory, thanks to investments made in the 1990s for advanced treatment technologies, the cost for which were also borne by themselves. They were not experiencing any taste and odor problem, even during algae blooms. Thus, they would see no point in utilizing more funds to improve the overall quality of Lake Biwa water.

The issues pertaining to ambient lake water quality are different from those pertaining to drinking water quality. First, the ambient water quality target levels for lakes in Japan are expressed in terms of such quality parameters as Chemical Oxygen Demand (COD), Total Nitrogen (TN), and Total Phosphorus (TP), these parameters being used mainly to assess the state of eutrophication. This is in addition to their suitability as drinking water sources for human consumption. The Shiga Prefecture and its residents want to reduce, if not eliminate, the incidence of algal blooms associated with eutrophication, maintain the ecosystem health for aquatic fauna and flora, eliminate invasive species, and improve sediment quality. The concern of the Lake Biwa residents encompasses a broad spectrum of intangible benefits to be shared and enjoyed by people over many generations to come. How convincing such an argument would be depends not only on the willingness of the population to pay for such long-term objectives, with full understanding of the value of protecting the lake and its basin, but also on its capability to pay. The implication is that the emerging structure of the basin-wide water resource management would be dictated by the capability of the people and governments to adjust to emerging water quantity and quality factors, many of which were unknown at the time of inception of LBCDP.

Lake Biwa Comprehensive Conservation Plan (LBCCP)

Though it took much longer than originally projected (25 years, rather than 10 years), basically all the approved LBCDP component projects were properly completed by 1997, under each of the three major project categories, that is: (a) water resources development for Shiga and downstream water users; (b) flood control around Lake Biwa and along the Yodo River, and (c) environmental infrastructure development along the Lake Biwa shoreline and around the watershed. While the downstream governments acknowledged LBCDP accomplishments, their gained benefits were more of an expectancy nature, that is, more water during times of severe droughts (which may happen once in 10 years), and reduced loss of property and human lives from major flood incidents that may happen once in a few hundred years.

On the other hand, the benefits gained from LBCDP for the Shiga government and its residents were more direct and explicit. They saw ports and harbors renovated, levies and embankments constructed around the lake that also now serve as a major artery road around the lake, paddy lands extensively improved with large-scale pumping facilities for irrigation with lake water, and even basic urban infrastructure provided for industrial developments. The Shiga population has increased by nearly three quarters of a million over the period of LBCDP implementation, and its per capita income, which was previously ranked as one of the lowest among the 47 prefectures, increased to be among the top incomes, thanks largely to the transformation of the Shiga economy from being primarily agricultural in nature to being primarily industrial, due in part to migration of population and industries from the downstream Osaka region to the Lake Biwa watershed.

This dramatic change in the profile of Lake Biwa watershed, now very urbanized and industrialized, also meant the paddy-wetlands along the lakeshore, which

used to provide prolific fish habitats, have been lost. During the same period, quite extensive land conversions also have taken place, for example, from paddy land to housing and industrial estates, forest land to industrial estates, etc. Thus, despite the introduction of significant structural and nonstructural environmental control measures, the water quality and ecosystem integrity of the lake and its watershed began to deteriorate. While the point source pollution load has been significantly reduced as a result of the sewerage coverage implemented during this period, the restoration of the natural self-purification capacity lost through transformed land uses, remained as a major challenge at the time of LBCDP completion.

Consequently, toward the terminal years of LBCDP, the Shiga government decided to pursue a new post-LBCDP project focusing on ecosystem restoration. In March 1997, Shiga Prefecture compiled the results of the deliberations of a national council established for this purpose, and prepared a plan called the Lake Biwa Comprehensive Conservation Plan (LBCCP), dubbed "Mother Lake 21 (ML21)." The plan emphasizes that the ultimate solution to the problems facing Lake Biwa lies in restoration of the natural and ecosystem capacities of the coastal zone and watershed, while also pursuing the revival of an environmental culture to allow such retransformation to occur. While Shiga Prefecture wanted the national and downstream governments to be sympathetic to enactment of a special legislation for financial arrangements to help it achieve its long-term ecosystem conservation objective for Lake Biwa, the response from the national and downstream governments was not so accommodating. They courteously declined to facilitate financial arrangements to the Shiga Prefecture.

What then is the ML21 Plan? In fact, it is more a vision than an infrastructure development plan, as in the case of LBCDP. It is not accompanied by any legislated special financial provisions. Those projects that fall within the framework of this vision are financed basically under sectoral budgets, with some preferential subsidy based on their merit within already-existing sectoral plans and programs. Specific elements of the ML21 plan are as follows:

(a) *Targeted Geographic Coverage*
The target area was set to include the jurisdictional area of the Shiga Prefectural Government, although it also takes cognizance of the implications to the downstream Yodo River region;

(b) *Planning Horizons*
The specified period is 22 years, from April 1999 through March 2020, in two phases; the first is from 1999 to 2010, and the second from 2010 to 2020. The provisional long-term planning horizon has been set at 2050.

(c) *Measures of Achievement*
Plan categorized the measures of achievement in terms of improvement: in overall quality of Lake Biwa water, in water infiltration and retention capacities of watershed soils, and in natural environment and landscape ecology. It also stipulated the need for promotion of citizen engagement and networking at sub-basin levels across the watershed. Information dissemination and research promotion were also an important component.

(d) *Compatibility with Other Plans*
The comprehensive conservation plan is meant to be consistent with plans formulated by the central government, including the Comprehensive National Development Plan, the National Land Use Plan, and the Basic Facilities Plan for the Kinki Region, as well as plans formulated by the prefecture, including its long-term vision called New Lake Country Story 2010, and its Environmental Master Plan.

Appraisal of First 10 Years of LBCCP (1998–2010)

In March 2010, with the first phase of LBCCP having reached its terminal year, and the second phase about to be launched, the LBCCP scientific advisory committee issued a review report of the first phase, with recommendations for the second phase. The report's appraisal is that the Plan has generally played a significant role as a long-term vision for Lake Biwa, with the first phase attaining some significant achievements.

Specifically, in regard to improved quality of Lake Biwa water, the achievement during the first phase has been significant, particularly in regard to water transparency and the concentration of TP. In contrast, the rate of reduction in the TN concentration was not as impressive as that for TP. In fact, the altered balance between the phosphorus and nitrogen concentrations has led to a change in types and numbers of phytoplankton species, that is, a decreased variety of species but an increased number of smaller, and more nuisance, species thriving in lake water. Further, the dissolved oxygen concentration in deeper parts of the North Basin has been exhibiting a decreasing trend. The COD has actually gradually increased during the period, a puzzling phenomenon whose implications are not yet clearly understood scientifically. In terms of the inflowing pollution load, the point-source contribution has been significantly reduced, although the nonpoint contribution remained much the same as 10 years before.

In regard to improved water infiltration and retention capacities of the watershed soils, the results are not so

significant. Between the fiscal years 1997 and 2006, the areas for agricultural and forest lands, respectively, decreased by 0.5% and 5.5%, while the areas for housing land and for road, respectively, increased by 7% and 8%, the rates being comparable to, or exceeding, the nationwide averages. Such simple measures indicate the preservation of forest and farmland for rainwater infiltration has not been progressing in the desired direction. The appraisal document states that there must be serious consideration given to halting the ever-increasing trend of land conversion from ones exhibiting natural water infiltration and retention capacities to ones that do not. It is also pointed out that, for forest land to improve water infiltration and retention capacities, the forests themselves have to be well-maintained through thinning and clearing of nuisance vegetations. However, of the artificially forested land requiring such maintenance, only 65% of the land was maintained as of fiscal year 2008. Thus, the appraisal report proposes that the Plan needs a more strategic approach in strengthening the institutions for undertaking maintenance operations, even to the extent of exploring a policy for developing "the green corridor" all the way from the mountain ranges through flat land toward the Lake Biwa shorelines. Additionally, the appraisal report points out the need for the existing water use practices to be further refined to minimize wasteful use of irrigation waters, by devising appropriate instrumentation. It further points out the need to assess the viability of existing irrigation water recycling schemes, giving due considerations to their cost effectiveness for the purpose of the LBCCP. The emerging issues included the deteriorating forest lands due to spreading tree damages from insect pests and nuisance animals. The report points out, more profoundly, the need for the Japanese forest industry to gain competitive strength over inexpensive imported forest products so that an institutionalized system of forest maintenance would be established both for providing for economic viability and for healthy forest land.

The report also points out that the first period target was not very clear for the on-the-ground implementation of plans and programs, particularly with regard to "land acquisition for ecosystem restoration." Further, the activities stipulated under this category were limited in number and extent of spatial coverage, indicating the inadequacy of the pursuits under this category of activities, with most of the issues identified before the LBCCP still remaining problematic. Further, there are issues and problems that did not exist before the LBCCP that are posing major threats to the natural environment and landscape ecology of Lake Biwa, including such problems as the loss of habitat for indigenous species of fish, and the prolific growth of macrophytes in the South Basin of Lake Biwa, particularly in relation to the changed operational procedure of Seta River Weir, all indicating that the future of the LBCCP is directly linked to the Yodo River System improvement policy.

Amendment to the Lake Water Quality Law

The Lake Water Quality Law (the Law concerning Special Measures for Preservation of Lake Water Quality, 1984) was amended in 2005, noting that the stagnant achievement level of water quality targets that is only a little over 50% as in 2004 (see Chap. 7 for details in the case of Lake Biwa). The Amended Law provides for the establishment of special area for nonpoint pollution control, that is, requiring pollutant load control measures from nonpoint sources and formulates plans to implement measures within the designated urban areas and farmlands. The new policy tools under this amendment include new regulatory standards, specification of categories of aquatic plants to be protected, and notification of the permitted activities in the lakeside environment protection areas. Although these policy tools, such as development of an emergency action plan water environment improvement, are expected to serve well for the enhancement of ecosystem properties of Lake Biwa, many of the included measures, including the establishment of protection and preservation areas (e.g., the reed bed protection areas) are already part of the Lake Biwa ordinance.

6.5.3 The Changed Agenda

Amended River Law of 1997

The first River Law in Japan was enacted in 1896 after the occurrence of a series of large-scale floods in previous years. The first Law was subsequently revised in 1964 with the aim of delineating the responsibility of the Central Government and Local Governments in managing the different classes of rivers, and to set the basic design figures for flood control for each class. Over more than three decades, the 1964 Law played an instrumental role for post–Second World War Japan to meet various river management needs, including flood control and water resources development.

The 1964 River Law was amended in 1997, basically to cope with increasing public outcries against the lack of a consultative process involving potentially affected local stakeholders and environmental citizen groups that strongly accused the river improvement works of having caused serious ecological damages to the riverine

environments. The Amended River Law now includes some important provisions to address these points. For example, Article 1 stipulates the purpose to be "to contribute to land conservation and the development of the country, and thereby maintain public security and promote public welfare, by administering rivers comprehensively to prevent occurrence of damage due to floods, high tides, etc., utilize rivers properly, maintain the normal functions of the river water by maintaining and conserving the fluvial environment" (Ministry of Land, Infrastructure, Transport, and Tourism 1997). It also stipulates the need for each river administrator to establish a plan to improve the river concerned, that is, the "*River Improvement Plan*" (hereafter referred to as *the Improvement Plan*) in accordance with the "*Fundamental River Management Policy*," (hereafter referred to as *the Fundamental Policy*) specified for river.

To fulfill the stipulated purpose, the 1997 River Law provides for three feature considerations that did not exist in the Original 1964 Law:

(a) The concept of "river environment" as being equally important as flood control and water withdrawals for consumptive and nonconsumptive water uses
(b) The need for broader participation of stakeholder groups and sectors in the process of developing a river improvement plan
(c) The process of acceptance and approval of the river improvement plan through a societal and political process of consensus building

In regard to the concept of river environment, the Law aims to facilitate the necessary protection and maintenance works to protect animal and plant habitats, and also to preserve the scenic and other intangible values associated with a river system. The Law also stipulates the need for the river improvement plan to be consistent with the Comprehensive National Development Plan and the Basic Environment Plan of the regions.

To address the goal of broader stakeholder participation, the Law stipulates the responsibilities of river administrators to:

- Consider opinions from persons with relevant experience or an academic background when necessary
- Take necessary measures, such as public hearing, etc., to reflect the opinions of the people concerned whenever necessary
- Consider opinions from concerned prefectural governors and mayors in advance, as provided in Government Ordinances

Regarding the process of consensus building, it is to take place in several steps over a period of a few to several years, to ensure that the considerations identified in items (a) and (b) above would be properly integrated in the formalized process.

Development of Yodo River Improvement Plan

The Amended Law stipulates the process of formulating the Fundamental Policy and of developing the Improvement Plan, to be administered by the river administration division of the Kinki Regional Bureau (hereafter referred to as the Bureau) of MLIT in the case of the Yodo River. The process takes the following process:

(a) *Fundamental Policy*
- A draft Policy to be prepared by MLIT
- The draft to be reviewed by the Infrastructure Development Council established under MLIT
- The adoption and announcement of the Policy by MLIT

(b) *Improvement Plan*
- A draft to be prepared by the Bureau, appropriately reflecting the broad public sentiments and vested interests
- The draft to be revised as appropriate, resorting to, as needed, the expert opinions and the affected parties
- The draft to be provisionally finalized
- The draft to be accepted by the prefectural governors within the Yodo River basin
- Adoption and announcement of the finalized Plan by MLIT

In the case of the Yodo River system, the process included preparation of a few more intermediate outputs by the River Basin Committee, to be elaborated below. They area *Proposed Conceptual Framework* (hereafter referred to as the *Framework*), a *Provisional Basic Plan*, and *the Basic Plan*.

For the Yodo River system, the Fundamental Policy was issued in August, 2007. The Improvement Plan was declared as being completed, and was published in March, 2009 by the Bureau. It was after almost several years of intense and heated exchange between the Committee, the Bureau, citizens, NGOs, and various local governments.

The following is a brief account of the long, complicated and controversial sequence of events that took place between early 2001 to data.

Establishment of River Basin Committee

In February 2001, the Bureau took on the process of developing the Improvement Plan, and launched the process of forming the *Yodo River Basin Committee* (hereafter referred to as the *Committee*) as a body consisting of

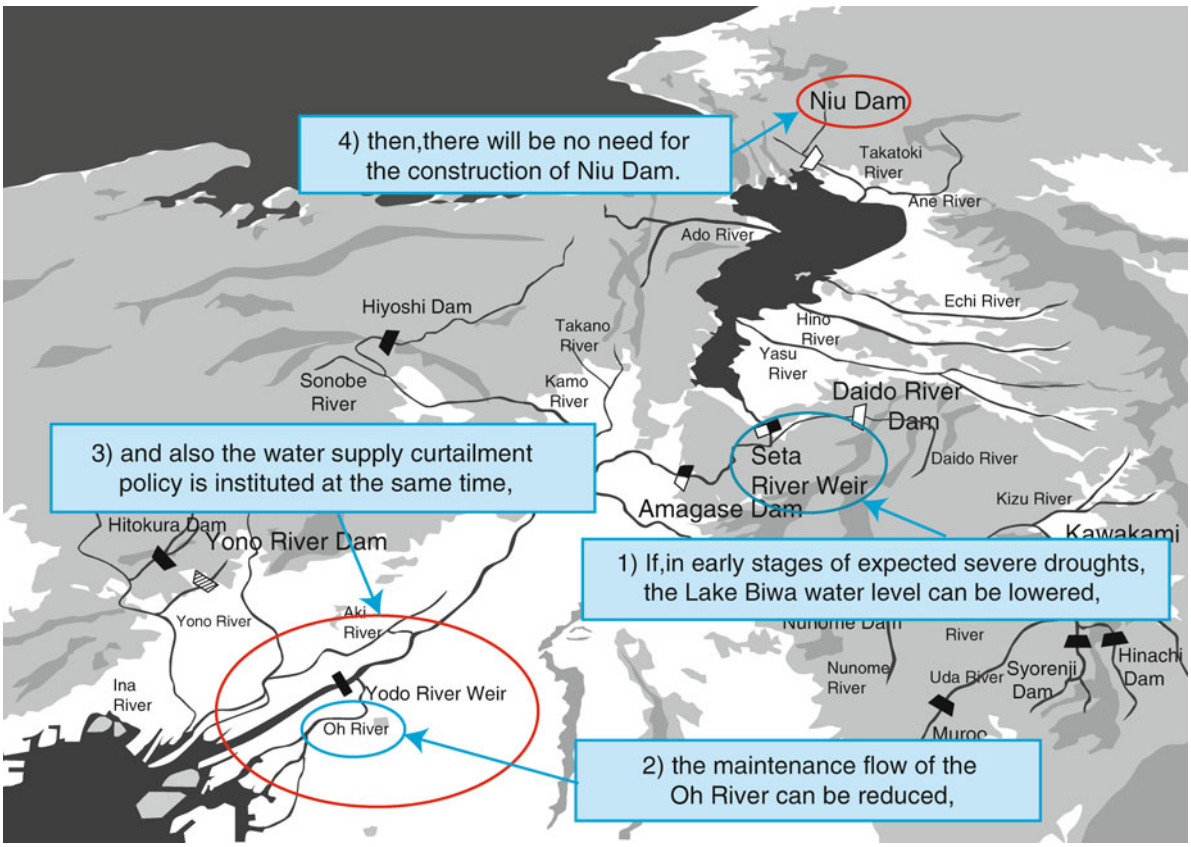

Fig. 25

Some Contentious Points argued by the Committee against the Need to Construct the *Niu* Dam (If, in early stages of expected severe droughts, the Lake Biwa water level can be lowered, the maintenance flow of the *Oh* River can be reduced, and also the water supply curtailment policy is instituted at the same time, then, there will be no need for the construction of *Niu* Dam).

"persons with experience or an academic background." The hope was that the Bureau would be able to benefit from close collaboration with the Committee in its pursuit of the development of what could be an extremely complicated and conflicted Improvement Plan needed to meet the expectations of the basin population over next 30 years or so. It would have to fulfill their overall needs, that is, flood control, water resources provision, and environmental and ecosystem services of the river system, for the subbasins represented by local governments, with different priorities and parochial vested interest fostered over centuries. Among many other issues to be elaborated in the Improvement Plan was an issue of whether or not to proceed with the construction of four dams (*Yono-River*, *Daido-River*, *Niu*, and *Kawakami* Dams) and the renovation of an existing dam (*Amagase* Dam) (see *Figs. 25* and *26*). Prior to the establishment of the Committee, these dams were in some preparatory phases of construction.

Proposed Conceptual Framework

At the outset, the Bureau decided that the Committee members to be selected totally independent of any involvement of the Bureau itself, so that the established Committee would not be regarded as being biased for or against a particular set of sector or stakeholder interests. The Bureau also agreed for the Committee to prepare a conceptual framework for development of the Plan. By January 2003, the Committee completed the Framework and submitted it to the Bureau. Under the part pertaining to river improvement, it stressed the following four factors:

- The precautionary principle, based on a holistic framework of analysis
- The need to enhance the cultural, traditional, historical values and features, while ensuring the river improvement needs are met by the entire basin and the society as a whole

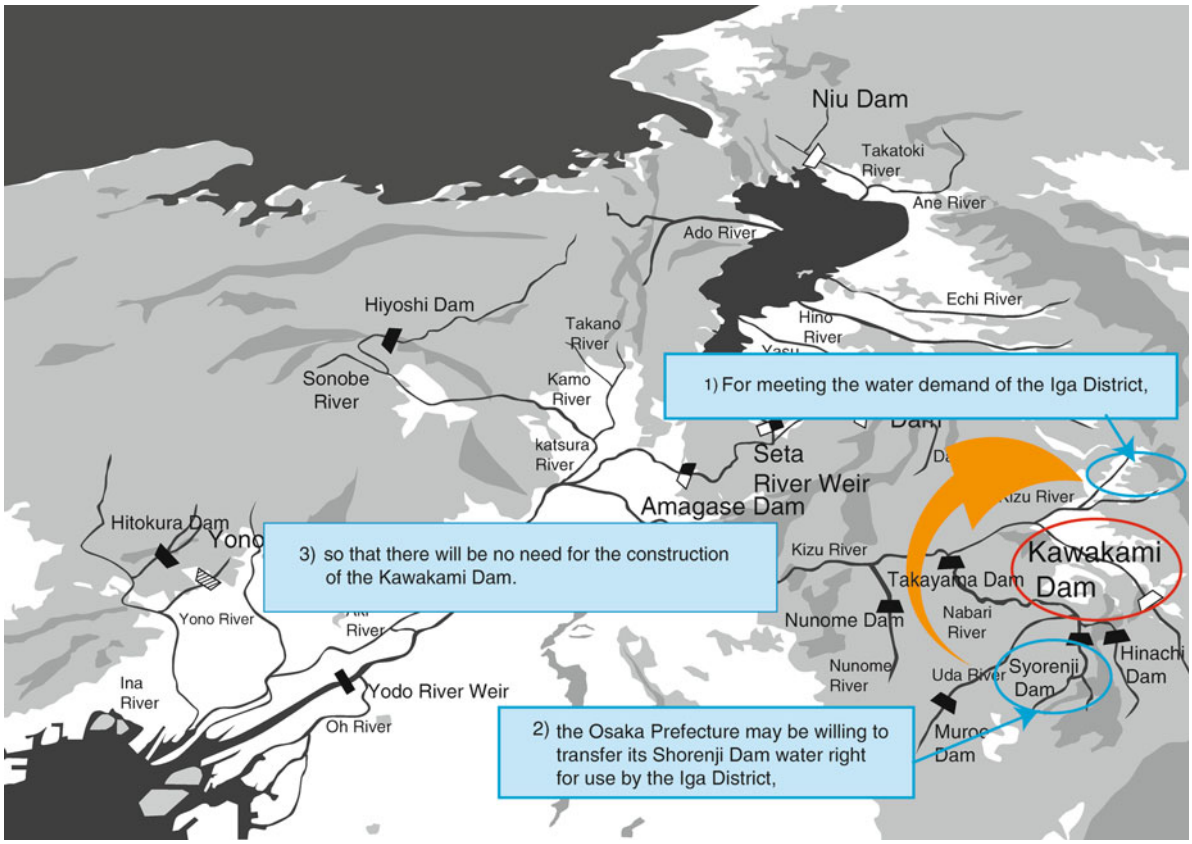

Fig. 26

Some Contentious Points argued by the Committee against the Need to Construct the *Kawakami* Dam (For meeting the water demand of the *Iga* District, the Osaka Prefecture may be willing to transfer its *Shorenji* Dam water right for use by the *Iga* District, the Osaka Prefecture may be willing to transfer its *Shorenji* Dam water right for use by the *Iga* District, so that there will be no need for the construction of the *Kawakami* Dam).

- The mechanism wherein the basin citizen at large would play an important role
- The need to implement planning assessment and pursue adaptive management

Further, under the part pertaining to the fundamental philosophy, the *Framework* recognizes the need to conserve and restore the river ecosystem, and states that "the ultimate goal of this Amended River Law is the preservation and recovery of a river ecosystem." It also states "the implementation of the Improvement Plan should not result in reduction of the existing species of flora and fauna, nor should it result in further deterioration of the ecological integrity that is so crucial for sustainable living of the people." Finally, it pledges that "it is the grave duty of the present generation to succeed the rich natural environment of the Yodo River system properly preserved and restored for the future generations."

Issues of Dam Construction

In regard to the construction of dams, including those already in the process of construction, the *Framework* states that, "The dams should not, in principle, be constructed in view of their possible serious impacts to the natural environment of the river basin system, and, if the construction of a dam is to be pursued, it should be only after all alternative possibilities have been exhaustively examined to prove that the attainment of the river management objective would be possible only with its construction, and the society at large would support that conclusion. As for the possibility of increasing precipitation due to climate change and the consequent societal consent with the need for dam construction, the decision will have to be made adaptively." The *Framework's* progressive assertion was regarded by the media as possibly influencing the mindset of the general public that have long wondered whether or not the use of their tax money

for large-scale public works such as dam construction would continue to be justified.

In the meantime, the major downstream water users, such as Osaka City, Osaka Prefecture, and Hanshin Water Supply Corporation quietly took advantage of the ideas imbedded in the Framework regarding the those dams that they agreed to with MLIT and the Water Resources Development Cooperation to share the construction costs. They in effect admitted that future demands for water that they had projected decades ago have proven wrong, and the storage capacity of the dams allocated for such purposes would no longer be needed. The very presence of the Committee seemed to have made it easy for them to make that move, about which they had long been in a bind.

Yodo River Improvement Basic Plan

Taking full note of the *Framework*, the Bureau formulated and made public the Basic Plan in June 2004. Development of the Basic Plan required an unprecedented collaboration between the Bureau and the Committee, conducting a total of hundreds of joint activities consisting of expert group meetings, workshops, on-site observation tours, and consultative meetings with local residents. The Basic Plan made clear that the conventional approaches concerning river improvement would have to be fundamentally revised, based on the recommendation stipulated in the *Framework*. The five main points stipulated in the Basic Plan were as follows:

1. Flood control, water resource development and management, and environment and ecosystem considerations would be placed within one unified framework. Major emphasis previously had been placed only on the first two considerations, seriously neglecting environment and ecosystem considerations.
2. Utmost priority would be given to protecting human lives, meaning that the conventional approach to flood control, that is, containing the projected floodwaters in dams and their excess within the river embankments, would have to be reconsidered. The Plan should now include a range of structural and nonstructural approaches, including minimization of flood damages and saving of human lives by temporarily vacating people in the potentially high-risk residential areas, with a range of risk avoidance measures supported by proper forecasting and information sharing. The policy shift to be achieved in the Plan therefore is from "flood control" to "flood management."
3. Construction of new water control facilities would be minimized by directing the policy toward more rational use of the existing facilities, greater water demand management, and more rigorous implementation of nonstructural measures.
4. The perimeter land between the water channel and the embankment, often used for gardening, sporting grounds, golf courses, and other uses without permits, will have to be cleared to allow for greater leverages for flood control and restoration of ecosystem integrity.

Construction of dams should be avoided if at all possible, giving full consideration to their potentially adverse effects on river environment during their construction, and taking the severe hardships to people living in the areas designated to be submerged fully into account. If they are to be constructed, a thorough and convincing explanation should be given to, and be accepted by, the basin community at large, regarding its necessity, urgency, and environmental impacts.

Over the next four years, however, a number of complicated turn of events took place, involving various societal sectors with conflicting views on this particular decision by the Bureau. Those communities and residents who had already been relocated from the proposed dam sites, for example, felt they were betrayed by the Bureau, and vocally expressed their anger against the Basic Plan. They had barely overcome the psychological hardship of submitting their precious land for the benefit of the public at large. There also was the issue of compensatory payments already being made by the Bureau to those having to give up their properties and homeland job opportunities. If the dam construction would not proceed, these compensatory considerations would also be subjected to criticism, leaving them with a lost sense of identity. As another example, the municipal governments that had been counting on the dam to cope with flood and drought risks upon its completion would now have to seek alternative means of coping with such risks. Further, those entities already having made installment payments for expected benefits of dam construction want to have the payments returned. The other side of the coin, of course, was the issue of penalty payments to the Bureau from those expressing a desire to now withdraw from the originally agreed plan of decades ago of having the dams constructed with a cost sharing scheme.

Outline of *the Yodo River Improvement Plan*

The finalized Yodo River Improvement Plan consists of six goals of river management and the measures to accomplish them. Six goals are as bellows;

(a) *Interaction between people and nature*

The purpose is to establish relationships between people and river in such a way that people would be interested in, be willing to interact with, and be thinking

together about the river. So that, people will be able to take adequate actions at a time of floods, and the downstream riparian and the upstream riparian will be able to increase the understandings each other.

(b) *River environment*
The purpose is, based on an idea that "the sustainable ecosystem is essential for human life and activity," to preserve and restore the habitats for various species, including endangered species and other endemic species, with observing the effects on river ecosystems.

(c) *Flood management and disaster prevention*
The purpose is to promote both structural and non-structural measures to minimize the damages caused by any kind of flood as much as possible. At that time, the measures should be taken in cooperation with the riparian in the whole basin, based on the policy to improve security from flooding in the entire river system, rather than sacrificing one area of a region to protect another.

(d) *Water resources*
The purpose is to promote the efficient water utilization, taking the recent population decline and harmonies with river environment into account, and to prepare for the possible serious drought due to the global climate change.

(e) *Utilization*
The purpose is to ensure the integrated river management and improvement with community development, because Yodo river flows mainly through the urban region

(f) *Maintenance*
The purpose is, taking the aging facilities and the life cycle cost into account, to execute the efficient and effective maintenance and renewal of the decrepit existing facilities systematically.

For the reasons stated above, the part of the Improvement Plan pertaining to construction of dams is expected to remain in a state of flux for some time into the future. What will happen in the future is not clear. The flow of events from the revision of the River Law, however, and the twists and turns taken place along the way between by the Committee, the Bureau and the Prefectural Governors are all indicative of the simmering transformation in the shape of the governance of the Biwa-Yodo Basin. This extraordinary sequence of events may be fore-telling the future of the public sector decision-making in Japan.

6.6 The Challenges Ahead

The management story of the Lake Biwa-Yodo River Basin can be told in many different ways. It is told here as an intricate, but dynamic, history of management challenges involving the upstream Lake Biwa region and the downstream Yodo River region, with factual illustrations of associated policies, programs, and specific actions for water resources development, flood control, and environmental and ecosystem concerns. These factual illustrations are also interpreted by the contributing authors, with views reflecting their professional backgrounds, as well as their interests and beliefs regarding the contested and conflicting issues.

The geotopographical, climatological, hydrological settings of the Biwa-Yodo Basin have fostered the peculiar geography of the region, with its resulting unique demographic, socioeconomic, and political interactions. Historically, the pressures put on to Lake Biwa and its watershed from the downstream water users has been enormous because of the latter's political, economic, and industrial power. The restrictions on the discharge of Lake Biwa flood water, both geophysically and geopolitically, had been causing an insurmountable stress on the relationship between the upstream and the downstream communities, until a series of physical interventions was introduced in the first half of the twentieth century, including construction of a flood control weir at the outlet of Lake Biwa. With additional interventions to expand the role of the weir to accommodate water resources development through LBCDP, the strained relationship between the upstream and downstream entities seemed to have been ameliorated, at least superficially. The Biwa-Yodo system is today providing water, flood, and drought mitigations, as well as environmental and livelihood amenities to the population of over 18 million living in Shiga and the Keihanshin area, totaling some 1,200 km^2.

The Biwa-Yodo Basin is also characterized by the historic timing of key policy interventions. Whether they were construction of monumental water control facilities, development and implementation of instrumental plans and programs, and/or emergence of controversies and conflicts, their timings seem to have helped shape lake basin governance since they relate to the region's social and economic profile. As previously discussed, for example, completion of the Lake Biwa Canal in late nineteenth century led to a miraculous recovery of Kyoto City from its doomed economy related to limited access to water sources. The installation of Nango Weir in early twentieth century also resulted in a dramatic reduction in the Lake Biwa water level and in the flooding frequency, allowing Shiga Prefecture to pursue greater economic opportunities in succeeding decades. LBCDP, a massive, national-scale public investment project at the helm of Japanese economic growth, has also brought caused a dramatic change in the management profile of water resources and flood control, accompanied by the emergence of new economic geography within the Biwa-Yodo Basin, and in the entire Keihanshin Region. Thereafter, people and

industries began to migrate from the densely packed downstream region to the more spacious upstream region around Lake Biwa.

The fundamental dynamics of contrasting water management needs, however, remain much the same between the upstream Lake Biwa region and the downstream Yodo River region. The former historically being as a resource provider, while the latter serving historically as a resource consumer. The underlying intricacy of this fundamental linkage dynamics resurfaced as a dictating factor in the evolving process of policy development for the post-LBCDP water and environmental management, in relation to implementation of the Lake Biwa Comprehensive Conservation Plan (LBCCP), and specifically its second phase over the time span of 2011 through 2020, as well as the recently completed, and controversial, Yodo River Improvement Plan (YRIP). LBCCP is a plan being developed and implemented by Shiga Prefecture and therefore touches little on the issues facing the entire Biwa-Yodo Basin, while YRIP is a plan being developed as a river management plan, rather than a river basin management plan, to be implemented as a trans-prefectural plan, legally to be dictated by the national government.

The overriding issue in the former is whether or not it will be possible for LBCCP to play a catalytic role in accelerating the lake's ecosystem integrity when the national government and the downstream governments and people consider that they have already fulfilled what they were obliged to do for the lake over the past decades. On the other hand, the overriding issue for the latter is if, and how, the Shiga Prefecture together with the downstream governments may be able to develop a regional institutional framework for resolving the contentious issues imbedded in the YRIP. Among the emerging frameworks is a regionally autonomous governance structure for the Biwa-Yodo Basin, with the national government probably playing much less prominent role in having "the last say" as having historically been the case since late nineteenth century.

Topic 21 Lake Biwa Canals

Masayoshi Maehata

There are two adjacent old canals at the south end of Lake Biwa. These are the first and second route of Lake Biwa Canal, which were built approximately 100 years ago in the Meiji period to supply water to Kyoto (*Topic 27*). As it is called "the water of life for Kyoto citizens," the water flowing here at a rate of 20 m^3 every second has been a precious source of drinking water for those living in Kyoto. While the planning and supervision of significant civil engineering works were all entrusted to foreign engineers during this period, this project was entirely accomplished by Japanese engineers, which was a memorable achievement at that time. It was a large-scaled governmental project comparable to the recent Lake Biwa Comprehensive Development Project, which was carried out from 1972 until 1996 at a cost of 1,500 billion yen (Oda 1987). A construction plan for a canal connecting Lake Biwa to Kyoto seems to have existed as early as 1800 during the Edo period, for which a pictorial diagram remains as the evidence (Tanabe 1920). The main reason for the planning of Lake Biwa Canal in the Meiji period was to restore the declining industries in the city. Kyoto had flourished for over 1,000 years from the time the capital of Japan was established there by Emperor Kanmu. However, the capital was moved to Tokyo in 1869 during the Meiji Restoration. Thereafter, Kyoto suffered a rapid decrease in population and industrial activities. Prior to the construction of the canals, water shortages in the city often affected the irrigation of agricultural fields and the operation of water mills. It also caused serious difficulty for the people to obtain water for drinking and fire-fighting in winter when wells were dried up (Tanabe 1920).

During the construction of the First Canal, a water-power station (Keage Water Power Plant) was built at the same time, which was a technology invented in the United States. This was the earliest commercial waterpower plant in Japan, which began operating in 1891, being a major achievement in the industrial history of Japan. The Second Canal was built with the intent to address the increasing demand for electricity, and also to settle problems of both the quality and quantity of drinking water for Kyoto citizens. The outline for these two canals is provided below. The objectives of the First Canal include: to supply water for drinking, operation of water mills, generation of electric power, fire-fighting, irrigation, and transportation of goods by boats, Rate of water flow: 8.35 m^3/s, Length: about 11.0 km, Number of tunnels: 6 (the longest one is 2,436 m), Year of completion: 1890. The objectives of the Second Canal include: To supply water for drinking and generation of electric power, Rate of water flow: 15.3 m^3/s, Length: about 7.4 km, Number of tunnels: 1 (the entire line is composed of a tunnel), Year of completion: 1912

M. Maehata (✉)
Lake Biwa Museum, 1091 Oroshimo-cho, Kusatsu,
Shiga 525-0001, Japan
e-mail: maehata@lbm.go.jp

Fig. 27
Lake Biwa Canals.

References

Akiyama M (2001) Kougyouken heno Henbo wo Togeta Kokoku [Industrial development in Shiga Prefecture]. In Shitte Imasuka Kono Mizuumi wo, Biwako wo Kataru 50 Sho [Do You know about this Lake?: Fifty Chapters talking about Lake Biwa], the Lake Biwa Encyclopedia Editing Committee (ed), Sunrise Syuppan, Hikone, Japan: 189–194 (in Japanese with English abstract)

Biwako Chisui-kai [Association on Flood management of Lake Biwa] (1968) Biwako Chisui Enkakushi [History of Flood Management of Lake Biwa]

Biwako River Office, Kinki Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism (1985) Chisui no Rekishi wo Tazunete [Visit to a history of Flood Management]

Biwako River Office, Kinki Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism, and Lake Biwa Development Department, Japan Water Agency (1993) Oumi yo Towani [Forever Lake Biwa]

Council of Promotion of Lake Biwa Comprehensive Development Project, 1997. Biwako Sougou Kaihatsu no Jigyo 25 nen no Ayumi [25 year-History of Lake Biwa Comprehensive Development Project]

Kinda A, Ishikawa Y (eds.) (2006) Nihon no Chishi 8: Kinkiken [Regional Geography of Japan 8: Kinki District]. Asakura Syoten, Tokyo, Japan

Lake Biwa Studies Group (ed) (2003) Biwako Ryuuiki wo Yomu, Jo & Ge. [A Guide to the Watershed of Lake Biwa, volume one, volume two]. Sunrise Syuppan, Hikone, Japan

Ministry of Land, Infrastructure, Transport and Tourism (1997) The River Law

Ministry of Land, Infrastructure, Transport and Tourism (2007) Yodo River Fundamental Management Policy

Ministry of Land, Infrastructure, Transport and Tourism (2009) Yodo River Improvement Plan

Nakamura M (1995) Lake Biwa: have sustainable development objectives been met?: Lakes Reservoirs Res Manag 1:3–29

Nakamura M (2002) Lake Biwa watershed transformation and the changed water environments. Verh Int Verein Limnol 28:1–15

Oda N (1987) Biwa-ko Sosui-shi: Meiji no dai-project [History of the Lake Biwa Canals: big project in Meiji Period], Sun Bright Syuppan, Kyoto, 288pp

Tanabe S (1920) Biwa-ko Sosui-shi [History of the Lake Biwa Canals], Maruzen, Tokyo, 348pp

Tsuji G (ed) (1994) Henbou suru Sangyo Kuhkan. [Changing Industrial Space]. Sekaishisousya, Kyoto, Japan