# 6 Evolving Issues Toward Improvement of the Lake Biwa–Yodo River Basin Governance

*Masahisa Nakamura, Keiko Wada, Kentaro Taki, and Naoko Hirayama*

**Abstract** This chapter presents the historically evolved basin governance challenges facing the Lake Biwa–Yodo River Basin, specifically focusing on (1) the basin-wide water quality improvement achieved and the remaining challenges, with particular focus on the reduction of nonpoint source pollution; (2) a newly introduced program on Integrated Flood Risk Management and its potential basin-wide adoption; and (3) the historically evolved people–community–government relationships in the Shiga Prefecture. For the above purposes, an overview of the Basin with respect to its geography, geohydrology, and socio-demography is first presented. It also attempts to address the historic transformations of land–water linkage structures and the resulting appearance or disappearance of lentic (static, impounded) and lotic (moving, flowing) flow regimes. In the concluding section, the earlier sections will be reflected within on the concept of the "Ecosystem Service Framework" as a tying thread theme for addressing the future basin governance challenges.

**Keywords** Basin governance • Nonpoint source pollution • Flood risk management • Participation • Ecosystem services

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## Introduction

In this chapter, "basin governance" is described for a basin system with a given set of spatial (basin and its interaction linkages), temporal (past, present, and future to work toward sustainability), and perceptional (who are involved in what way and how) spheres, as continuous interactions of rules, institutions, and processes with the basin society exercise powers and responsibilities to make and implement decisions on the basin resources. The governance of basin resources involves societal decisions, a decision-making system, and implementation of decisions to deal with congestion, competition, and conflicts in their use. The concept of "basin governance" is important for sustainable resource use, because the basin management is neither a project nor a program. It is a governance challenge that evolves over time.

An overview of the spatial sphere of Lake Biwa–Yodo River Basin (hereafter referred to also as "Biwa–Yodo Basin" where convenient) is given in section "The Biwa–Yodo Basin in brief" in terms of geographical, demographical, and socioeconomic implications. An overview of the temporal sphere of the Biwa–Yodo Basin Section is given in section "Historic transformations of the Biwa–Yodo Basin" in terms of the land–water linkage structure with historical transformational features about its flow regime with natural as well as anthropogenic forces. The perceptional sphere is formed collectively by the communities within and outside of the basin, gaining over historical time the technological and managerial capacities to interact with the nature, i.e., aquatic ecosystem and environment in particular, which are also spatially and temporarily transforming.

With the above in mind, section "Evolving governance in managing point and nonpoint source pollution" presents the past trend of water quality, particularly with regard to the increasing proportion of nonpoint source pollution as contrasted to point source pollution, with associated governance challenges, focusing on the work of the Lake Biwa–Yodo River Water Quality Preservation Organization (BYQ), an organization playing the role of a trans-basin knowledge hub on water quality. Section "Evolving Basin governance for Integrated Flood Risk Management" presents the prospective adoption across the basin of an Integrated Flood Risk Management


H. Kawanabe et al. (eds.), *Lake Biwa: Interactions between Nature and People*, https://doi.org/10.1007/978-3-030-16969-5_6

(IFRM) based on the site-specific probability assessment, with associated governance challenges. The presentation will be based on the study of the Shiga Prefectural Government on the site-specific flooding probabilities for developing the area-wide hazard risk maps for the Lake Biwa region, to be replicated in other Yodo River Basin prefectures via the Union of Kansai Governments (UKG). Section "Evolving Basin governance of participation: Communities and citizens" presents the historical context of paddy water governance under extreme conditions, the historically pervaded conflicts and contentions in the management of the Lake Biwa–Yodo River Basin, and the pursuits toward meeting the current and future challenges facing Lake Biwa environmental and ecosystem concerns by participatory governance. The presentation here is based mainly on the studies undertaken in relation to the Shiga Prefecture's citizen and community participation programs on environmental and ecosystem concerns about Lake Biwa.

Lastly, section "Basin governance improvement for ecosystem restoration" will conclude this chapter by focusing on the concept of "Ecosystem Service Framework" as a tying thread while taking note also of the concept of the concept of "Principle of Subsidiarity" as a crosscutting concept. Collectively they shed some light to the perceptional feature of the Biwa–Yodo Basin governance that has evolved over time to meet the challenges facing the Basin today and in the future.

The development of sections "The Biwa–Yodo Basin in brief", "Historic transformations of the Biwa–Yodo Basin", and "Basin governance improvement for ecosystem restoration" is mainly coordinated by Nakamura, with all, section "Evolving governance in managing point and nonpoint source pollution" mainly contributed by Wada, section "Evolving Basin governance for Integrated Flood Risk Management" mainly contributed by Taki, and section "Evolving Basin governance of participation: Communities and citizens" mainly contributed by Hirayama and Nakamura.

## The Biwa–Yodo Basin in Brief

The Lake Biwa Basin system with its tributary rivers and their watershed lands constitutes a sub-basin system of the entire Lake Biwa–Yodo River Basin system with the remaining tributary rivers and their watershed lands, connected to the Osaka Bay system through the discharging Yodo River. Management of the former (Biwa–Yodo Basin) is an inclusive part of management of the latter (Biwa–Yodo–Osaka Bay Basin), and some aspects of the above inclusive relationship have been presented earlier (Nakamura et al. 2012), and other basic information is available from various sources, e.g., from the Shiga Prefecture (Shiga Prefectural Government 2014).

The Lake Biwa–Yodo River Basin covers 8240 km$^2$, including that of Lake Biwa of 3848 m$^2$, with a channel length extending 75.1 km. The Basin encompasses the western part of the Mie Prefecture, the southern half of Kyoto Prefecture, the northern half of Osaka, the southwest of Hyogo, and the northwest of the Nara Prefecture in addition to the Shiga Prefecture within which lies Lake Biwa itself. The configurational feature of the Basin is such that Lake Biwa lies in the uppermost part, and the semi-closed Osaka Bay portion of the Seto Inland Sea lies in the lowermost part, sandwiching the mainstream Yodo River and its tributaries in the middle. The three tributaries of Yodo River are the Uji River connecting to Lake Biwa in the north, the Katsura River dendritically spanning toward the west, and the Kizu River spanning toward the east. The mainstream stem part of the Yodo River is only a short stretch of some 20 km or so, from the confluent point of the three rivers to the river mouth at the Osaka Bay. The outflowing river from Lake Biwa down toward the Yodo River is called the Seta River within the Shiga Prefecture but is also called the Uji River within the Kyoto Prefecture before it joins the mainstream stem part of the Yodo River. In terms of basin land area, the Uji River and Lake Biwa sub-basins constitute approximately half of the total, and the other half is contributed by the Kizu, the Katsura, and the Yodo River sub-basins toward the Osaka Bay river mouth. The flow contribution to the Yodo River of the Uji, Kizu, and Katsura Rivers are, respectively, 64%, 18%, and 17% (see *Fig. 1*). The approximate annual average flow, high flow, and low flow are, respectively, 180 m$^3$/s, 230 m$^3$/s, and 120 m$^3$/s.

Lake Biwa is Japan's largest freshwater lake and one of the world's leading ancient lakes, tectonically formed more than 4 million years ago. It lies within the Ohmi Basin surrounded by the Ibuki and Suzuka mountain ranges in the east with their elevations ranging in the order of 1200–1300 m and by the Hira and Hiei mountain ranges in the west with their elevations in the order from 800 to 1200 m. In the south, there are the Shigaraki and Tanakami mountains with their elevations ranging in elevation from about 600 to 700 m. The Kohoku mountains in the north divide the Lake Biwa region and the Japan Sea coastal region feature by the city of Tsuruga. The lake measures 63.5 km in a north–south direction and is divided into two sub-basins at the constriction point approximately 16 km from the southern end. 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. The water surface elevation is 85 m above sea level, and the deepest point is 104 m. The mean depth of Southern Lake is about 4 m, and that of North Basin is about 40 m. Its catchment area is 4.7 times the area of the lake itself, and its boundary more or less coincides with that of the prefecture, constituting 96% of prefectural land.

In terms of the Shiga Prefecture land area of 4017 km$^2$, forestland accounts for approximately 51%, agricultural land covers approximately 13%, and the rest is occupied by lake water surface together with rivers and artificial channels (20%), housing (7%), roads (4%), and others (6%). Relatively large extents of cultivated land lies in the area surrounding Lake Biwa and in the upstream region, while housing, commercial, and industrial lands are located in the downstream region. Since the Lake Biwa watershed

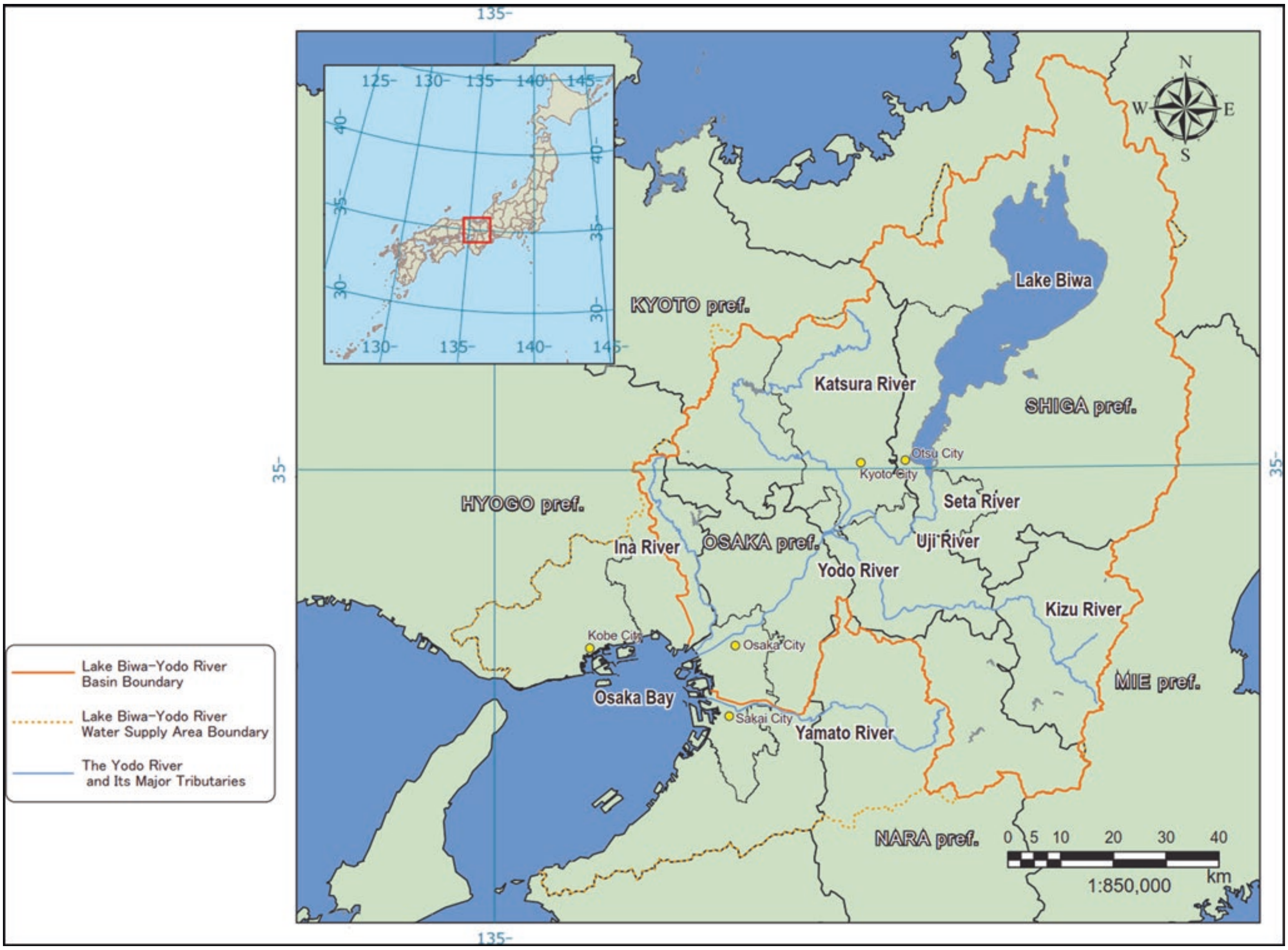



**Fig. 1**
**Jurisdictional boundaries of the Biwa–Yodo–Osaka Bay region**

area occupies 93% of the Shiga Prefecture jurisdictional area, the policies and programs implemented across the prefectural land directly or indirectly reflect on the lake's water quality. It is reported that the agricultural lands have been reduced by 27%, roads increased by 69%, and residential areas increased by 10% in 45 years since the early 1970s. The trend in land use in the Shiga Prefecture continues reflect a decline in forests and agricultural lands and an increase in impervious land surfaces covered by roads, residential areas, and commercial districts. The proportion of residential land has significantly increased from some 12.5% in 1975 to 21.3% in 2010 (see *Fig. 2*).

Some 460 rivers and streams flow into the lake, although only the Seta River flows out of the lake. In addition, the two canals constructed in 1890 and 1912, respectively, transport lake water to the city of Kyoto. Apart from municipal water supplies, the Lake Biwa water also serves for paddy irrigation and hydropower generation in the downstream Seta River. In addition, the fishery and navigational values have historically fostered a sense of special attachment to the lake for the Shiga residents.

The Biwa–Yodo–Osaka Bay hydrological system is the lifeline of the metropolitan regions of Kyoto, Osaka, and Kobe. The natural setting of this region differs widely between the north, which faces the Sea of Japan, and the south, which faces the Pacific Ocean. The weather is generally much warmer and drier in the south than in the north. The mountain ranges around Lake Biwa and the tributaries of the Yodo River are generally covered with dense forest that function as a natural reservoir as well as a gigantic filter producing high-quality raw water to replenish Lake Biwa and the Yodo River. There are, however, some 20 or so dams (including irrigation dams) in the watershed for the integrated management of water resources to compensate for fluctuations in precipitation.

The Biwa–Yodo–Osaka Bay Basin has a temperate climate, with marked variations among seasons and, especially in winter, between north and south. The mean annual atmospheric temperature in the lowland part of the watershed ranges from 14.8 °C in Otsu, 16 °C in Kyoto, and 17 °C in Osaka. The mean temperature in January is 1–3 °C, while that in August is 24–27 °C. As in most of Honshu, the main island of Japan, its weather is dominated by the Sea of Japan

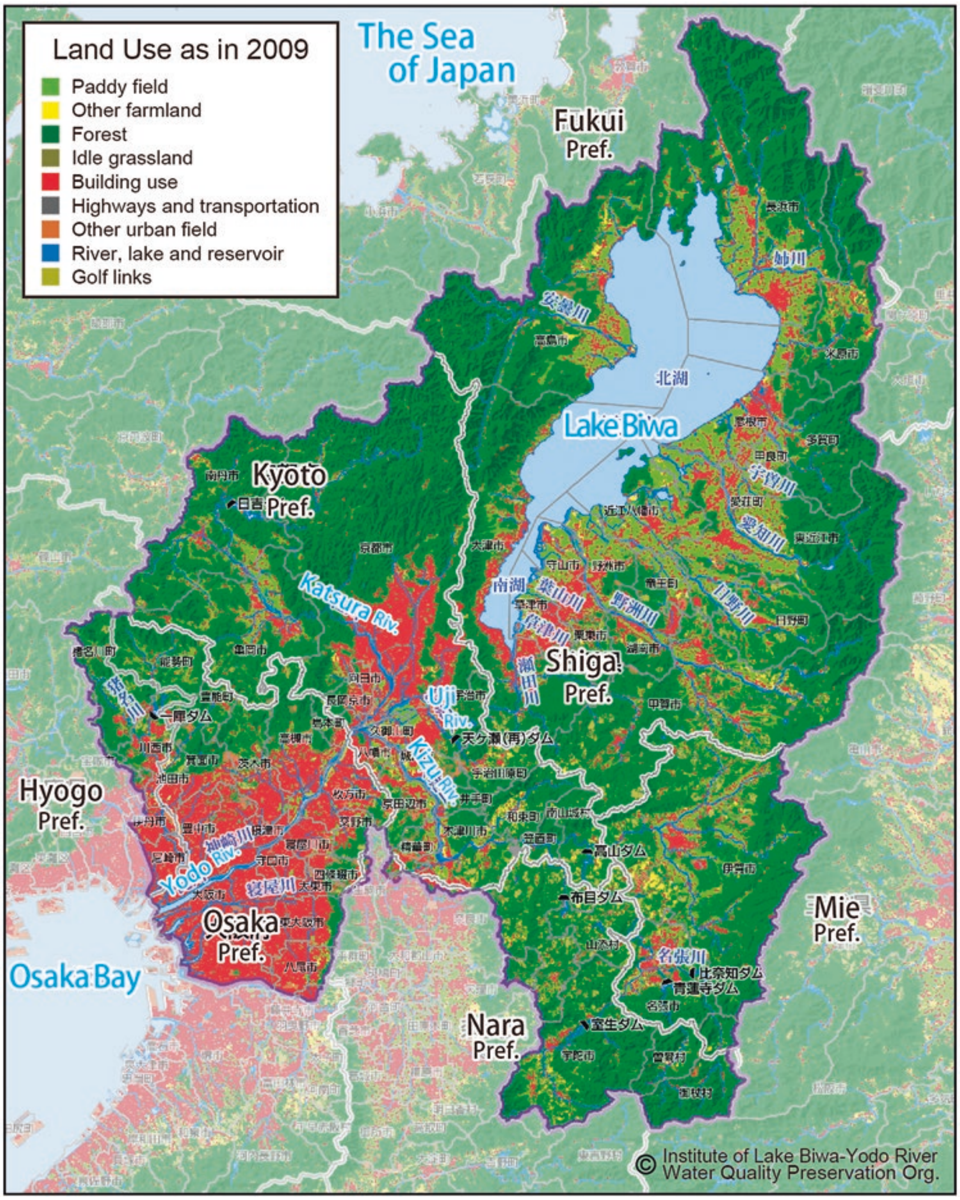



**Fig. 2** Land use classifications in the Biwa–Yodo–Osaka Bay Basin as in 2009 (BYQ 2017). GIS Data Source: The National Land Numerical Information Service, Japan

and the vast Asian Continent to the north and northwest and by the northern Pacific to the south and southeast. In the winter (November through March), the cold air mass from Siberia dominates, sweeping across the Sea of Japan and bringing much snow to the region north of Lake Biwa, while the southern areas remain relatively warm and dry. In spring and autumn, there are periodic rain spells caused by the movement of low (cyclones) and high pressure (anticyclones) from the East China Sea. In early summer from early June to mid-July, a stationary front dominates and gives this region a continuous rain called baiu (plum rain) and tsuyu (consistent rain). In August and September, a tropical south easterly maritime air mass from the Pacific prevails over Japan, giving it warm weather with periodic thunderstorms. From early September through late October, the Lake Biwa region is at risk of experiencing occasional typhoons that can cause floods around lakeshore.

The annual precipitation in the Lake Biwa region is high, varying from about 1600 mm around the southern lake up to 3000 mm in the northern mountains, some of which tower over 1000 m. The north receives significantly more precipitation in the winter in the form of snows brought from the Japan Sea by northwest monsoons that weaken as they move southward. The snow cover in the northern mountains can be several meters deep. Summer precipitation is more concentrated in the mountains whose height ranges in the hundreds of meters. The year-to-year variations in precipitation in the Lake Biwa area are large. The maximum annual precipitation in modern times during the last century was 3096 mm in 1896, three times the minimum of 1101 mm recorded in 1939. The recorded variations during the "baiu" period has been considerably greater, with a 13 times difference between maximum and minimum. There has been a notable trend of decreasing precipitation from the early 1960s through the mid-1990s, but not since then. The mean temperature rise over the past 100 years was approximately 0.78 °C, while the rate of increase in temperature over the same period was 1.84 °C in terms of the yearly lowest temperature in Hikone (Shiga Prefectural Government 2016).

In terms of population (see *Fig. 3*), the cities of Otsu and Kyoto and the surrounding municipalities form the Kyoto metropolitan region which has a combined population of 2.68 million. The Osaka metropolitan region, including Osaka and some ten or so neighboring cities, including those along the coastal industrial belt zone toward Sakai in the south, boasts a population of approximately 12 million. The city of Kobe, together with the surrounding municipalities lying along the Seto Inland Sea coastal region toward west, forms the Kobe metropolitan region with a population of some 2.5 million. Although the population in the main cities like Kyoto and Osaka is declining, those in the surrounding municipalities are increasing, making the combined total number more or less the same over the past decades. The population in the Kyoto–Osaka–Kobe metropolitan regions (hereafter referred to as the Keihanshin Region) constitute close to 10% of the total population in Japan.

## Historic Transformations of the Biwa–Yodo Basin

This section consists of three subsections to tie together the previously discussed historic transformations. The first subsection (section "Transformation of the land–water linkage structure") introduces the historic transformation of the land–water linkage structure. The second subsection (section "Transformation of the flow regimes") discusses the implications of flow regime changes to the Basin. The third subsection (section "Technological and managerial implications") discusses the ecosystem transformation in the Basin.

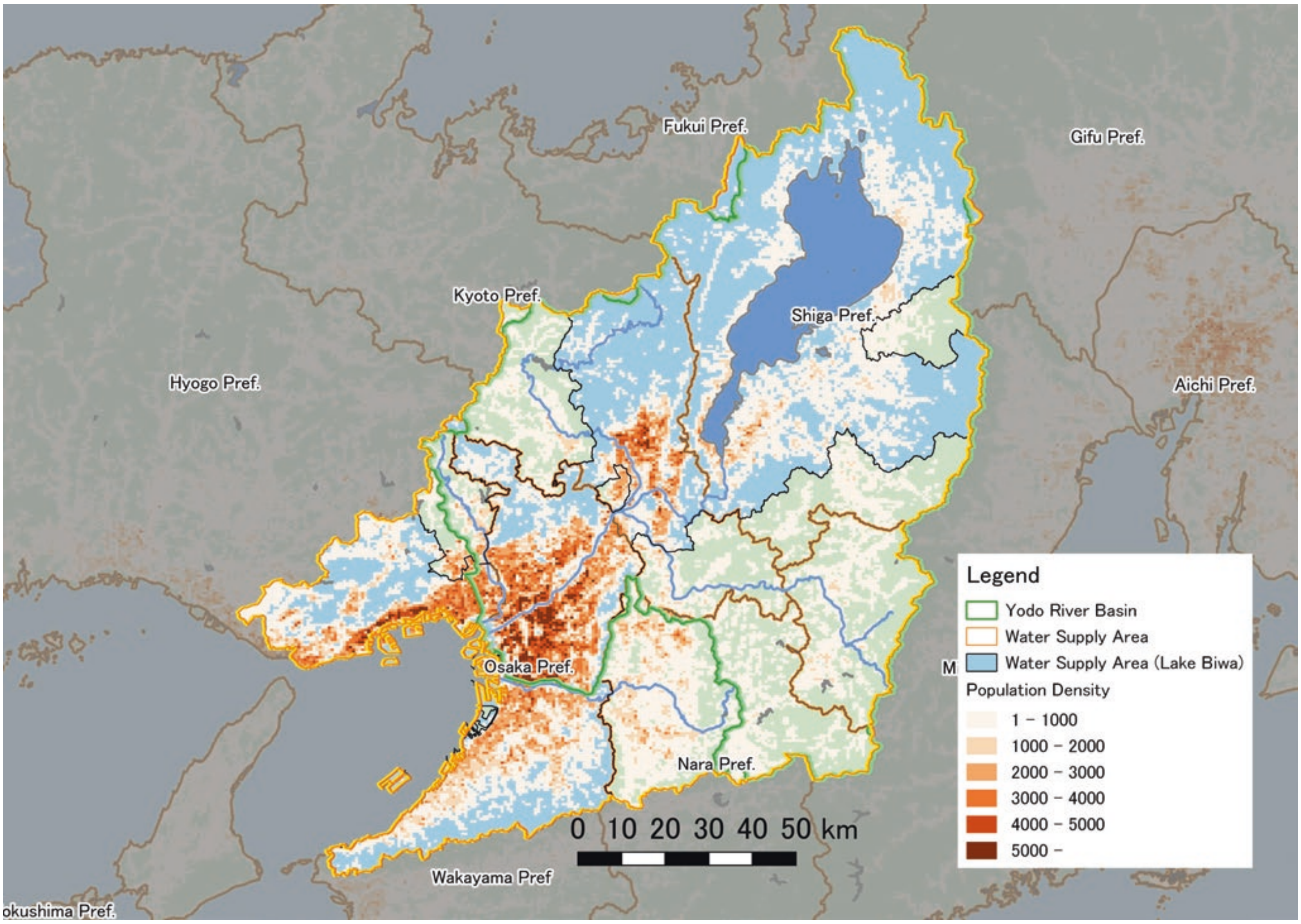



**Fig. 3**

**The Biwa–Yodo–Osaka Bay Basin, population distribution, GIS data source: The National Land Numerical Information Service, Japan**

## Transformation of the Land–Water Linkage Structure

The land–water linkage structure of the Biwa–Yodo Basin has been transformed in a number of different ways over the course of basin history. Geo-historically, for example, the sea level during Japan's Jomon Period (6500–5000 years ago) was a few meters higher, and the Osaka Bay coastline was also much further inland than it is today. As the sea level gradually receded over the next millennia, the inflowing rivers into the Osaka Bay began forming the alluvial plains. The inflowing freshwater began to replace the seawater in the embayment formations, creating a freshwater lake. The alluvial formation persisted, and by the latter part of the Jomon Period (from about the thirteenth century BC to about the fourth century BC) through the Yayoi Period (from about the tenth century BC to about the third century AD), the current Osaka City area began to appear as marshland formations separated by milliards of meandering water courses. Subsequently, the marshlands began to be increasingly drained by the settlers, gradually transforming them to dryer lands more suitable for larger-scale human settlements surrounded by paddy fields that were connected by navigational routes and constructed irrigation ponds, collectively contributing to the emergence of various commodity trade transactions. Even the two oldest written documents of Japan's history, Kojiki (written during 711–712) and Nihon Shoki (completed in 720), refer to the development of flood control and paddy irrigation facilities as early as the Nintoku Emperor Era around 320 AD. In more general terms, because of the limitation of inhabitable and cultivatable land space in the mountainous Japanese archipelago, land development for paddy agriculture had to be rigorously pursued throughout history. In the western part of Japan, development of the available land for paddy agriculture was more or less completed by the mid-medieval time of around the fifteenth century, leaving only a limited land space for development thereafter. On the other hand, conversion of wetlands and wastelands to paddy agricultural lands was rigorously pursued even toward the northeastern part of Honshu Island, particularly during the Edo Era (1603–1868). It is reported that the estimated national population during the middle to the latter period of Edo Era was some 30 million, or one quarter of what is today, being consistently supported with rice as a staple food.

In the riparian regions along the Yodo River, the water course modifications and channel improvement works were important responsibilities of the feudal loads. For example, Hideyoshi Toyotomi (1537–1598), the first Shogun to unite the nation (1586), dedicated himself to improve the navigational and flood control structures in and around Osaka Castle as well as along the Yodo River and its tributaries. The trend continued throughout the following centuries to include, for example, Zuiken Kawamura, a civil engineer assigned by the shogunate to improve the hydraulics of the downstream Yodo River by excavating an island blocking the flow, launched the project in 1684 and completed it in 1687. Similarly, the construction of a floodway leading to the Osaka Bay from the Yamato River, with a distance of 14.5 km, was completed in 1704, changing sparing the Kawachi plain (the current Osaka region) from being a to be flood-prone land to an arable land for paddy and cotton agriculture. More recently, Lake Ogura (Ogura-ike), originally existing as part of the Uji River system at the confluence point of the Uji, Katsura, and Kizu rivers to form the main stem of the Yodo River, was embanked and partially isolated from the Uji River during the above Hideyoshi Period for the construction of Fushimi Castle. As an aside, the lake was totally cut off in 1906 as part of the Uji River Improvement project, later to be completely drained to be subjected to a large-scale paddy land development project undertaken as recently as the 1933–1941 period. A detailed historic account of the Yodo River Basin with respect to flood control, water resource development, and environmental and ecosystem concerns is given in Nakamura et al. (2012). Various accounts of the management intervention history of the Yodo River are also provided in the popular literature (e.g., Yodogawa gaidobukku henshuiinkai 2007; Fujioka 1983; Nishino 2009) (see *Fig. 4* for a schematic image of the geo-historical transformations of the Osaka Bay configuration).

The pursuit for urban water metabolism also involved some land–water transformations, particularly in relation to the construction of sewerage systems in the current city of Osaka, or the Yodo River Delta formation where much of the land was originally interspersed with expansive wetlands. The earliest kind of household drainage systems in Japan are found in the remains of human settlements of the Yayoi Period. By the Nara Period (710–794), the archeological sites of Heijo-kyo, the oldest capitol of Japan in the current city of Nara, located some distance toward the south of Osaka, a well-laid-out sewer drainage network is found in its archeological sites. More recently, the castle town of Osaka was historically in need of sewerage to prevent the spread of waterborne diseases. A stone culvert system called the Taiko Sewerage constructed in the Azuchi–Momoyama Period (1573–1603) was found still intact today in the previous castle town area surrounding the Osaka Castle, where rich merchants and higher-class solders used to reside. The historical extension of the above stories are the modern day Osaka sewerage and stormwater drainage systems. The city launched construction of a combined sewer system (a sewerage system to collect and treat the wastewater under the dry weather condition but to collect and discharge it directly to the Osaka Bay together with the collected urban stormwater under wet weather conditions when the combined flow exceeded a certain limit) in 1894 after major cholera outbreak incidents. Upgrading of the extensively developed Osaka sewerage system continued, providing the city with one of the most extensively developed sewerage systems in Japan as early as the 1970s. The system progressively improved, including the completion of an extensive underground sewage network, as well as stormwater retention and discharge

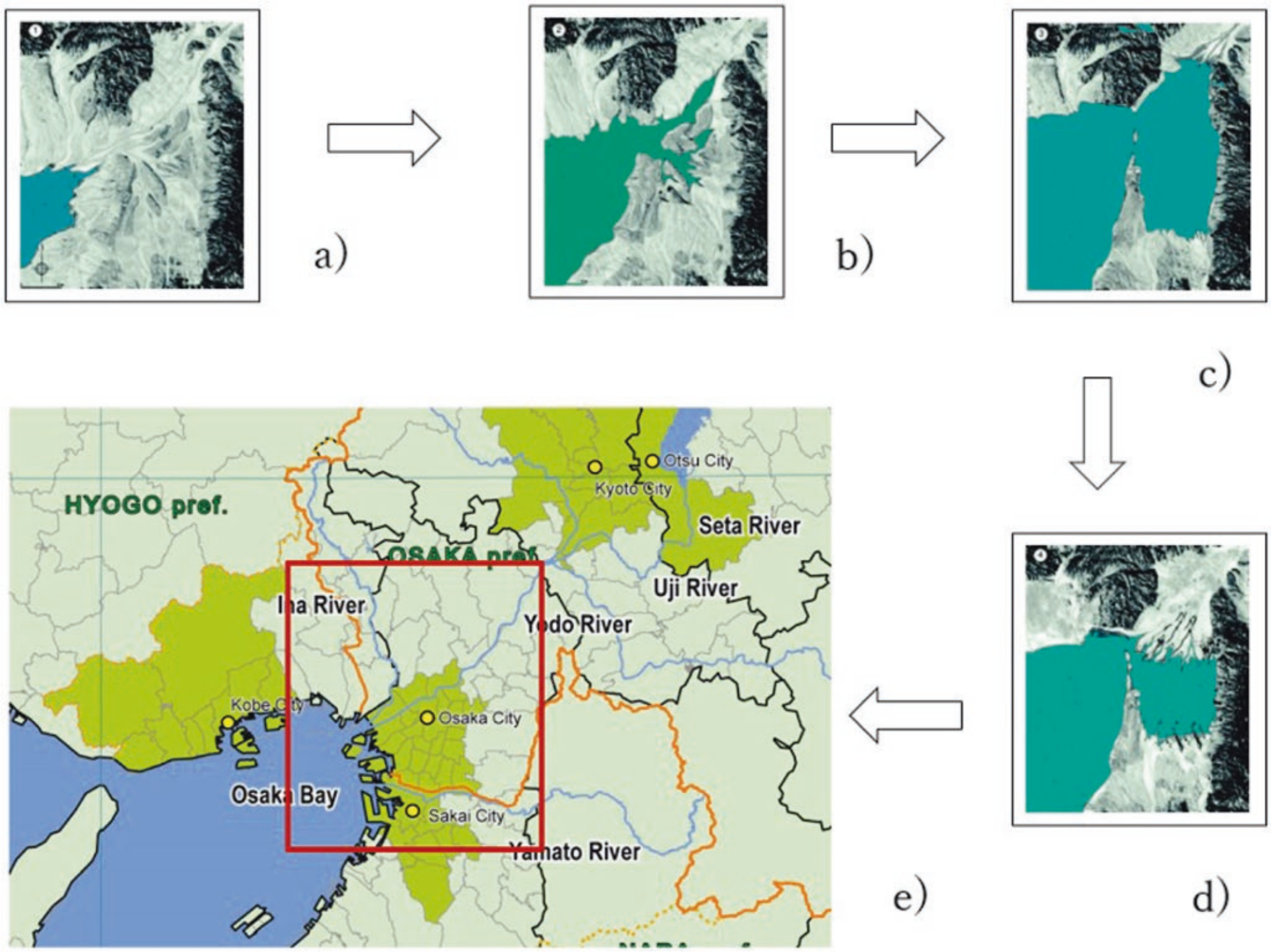



**Fig. 4**
**Geo-historical transformations of the Osaka Bay Configuration: a) up to some 9400 years ago, b) up to some 8000 years ago, c) up to some 5500 years ago, d) up to some 4500 years ago, and e) as of today (Ransetu no Sayama Sa-an, no date)**

systems. In the meantime, the municipal water supply system in Osaka also was developed in about the same time period. The first modern water supply system was constructed in 1895, also for combatting outbreaks of waterborne diseases. This water supply system was soon expanded to serve for the rapidly developing surrounding municipalities and also to meet the growing industrial water demand as well.

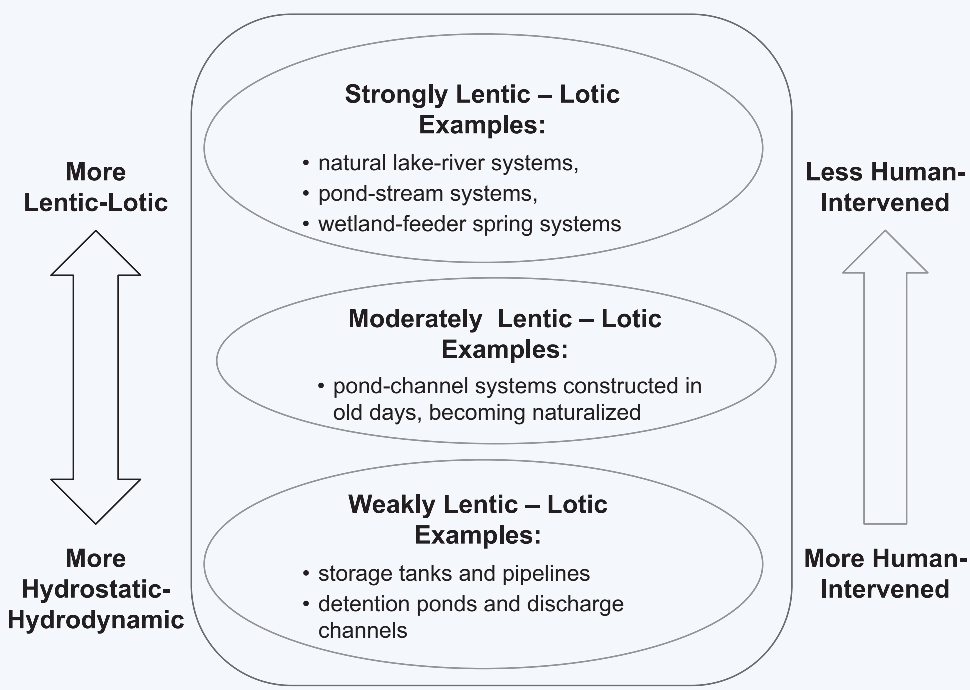
## Transformation of the Flow Regimes

The transformation from the lentic–lotic flow regime to a hydrostatic–hydrodynamic regime (see *Box 1*) can take place in many different shapes and forms of artificial interventions over the course of its history. For example, the geohydrological alteration of the Osaka Bay Delta region, being much more toward the inland direction, with the receding sea water level creating a deep embayment formation that was subsequently transformed to Kawachi Lake, illustrates a transformation of one form of lentic–lotic flow regime to another, without any human interventions. During the late Jomon and early Yayoi periods, the former Lake Ogura was an important component of the Lake Biwa–Yodo River lentic–lotic flow regime, together with many other natural lake- and pond-like formations of various sizes, some temporary and others semipermanent. In the meantime, the paddy farmers construct drainage channels and canals for paddy irrigation purposes, resulting in many other hydrostatic–hydrodynamic systems. Typical structures existed in the Yamato, Kawachi, and Settsu plains, where water was drained out via manually constructed canals, transforming wetlands to dry fields suitable for paddy agriculture. The human settlements were developed on higher grounds in the form of mounds surrounded by deep moat formations, later named “Wajyu” systems. With an increased population and food production need, the conversion of wetlands to dry fields continued through the medieval Edo Period (between 1603 and 1868,

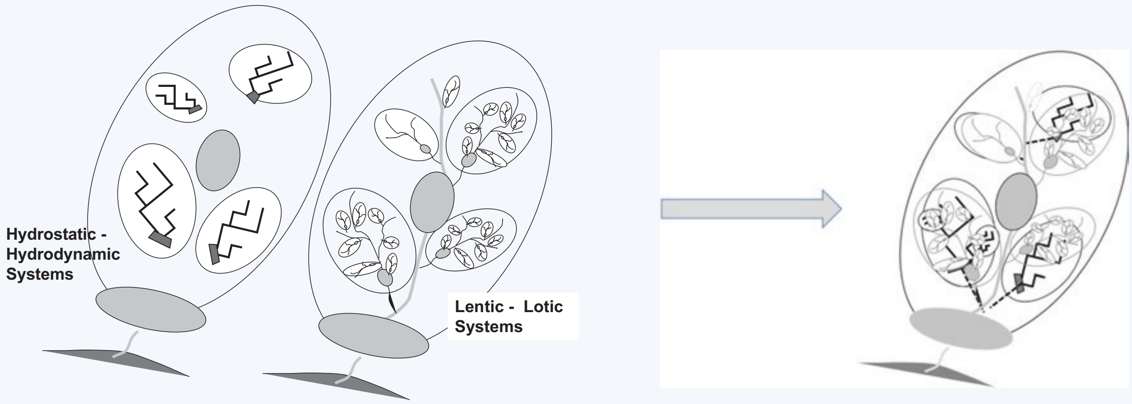
## Box 1 The Flow Regime Transformations: Lentic–Lotic vs. Hydrostatic–Hydrodynamic

Lakes and reservoirs are broadly considered as "standing" or "static" water systems, or, using a hydrologic term, they are designated "hydrostatic" systems. In contrast, "moving" waters, such as rivers, can be regarded as "hydrodynamic" systems. In general, the terms hydrostatic and hydrodynamic are also more commonly associated with human ingenuity to control and utilize the physical properties of water through application of technologies. Similar expressions exist in the ecology literature as well. The descriptive terms are "lentic" and "lotic" systems. The meaning of "lentic" is basically the same as for hydrostatic, and the meaning of "lotic" is the same as for hydrodynamic. However, the lentic and lotic expressions have the additional connotation of their imbedded ecological functions. That is, the term "lentic" also connotes the ecological properties unique to a standing body of water, while the term "lotic" also connotes the ecological properties unique to a moving water system. In other words, the terms lentic and lotic imply the geo-historically formed ecosystem significance associated with standing and moving waters, even to connote the anthropogenic state of water with evolutional and historic memories of human–nature interactions. Thus, the basin water systems as they exist naturally, such as lake–river systems, pond–stream systems, and wetland–spring systems are lentic–lotic systems because of their historically fostered ecosystem functions. Even if the basin water systems have been modified by human interventions, the greater the time that has passed after such interventions that allow more time for "naturalization" to occur, the greater are their lentic–lotic implications. On the other hand, a water supply storage tank of treated water, with inflowing and outflowing conveyance pipelines, constructed with artificially manufactured materials, such as steels and concretes, would be regarded only as hydrostatic–hydrodynamic systems. Those water systems constructed by man when such technologies and materials were not available may have acquired lentic–lotic properties through many decades and centuries of naturalization.

The transformation of basin flow regime, i.e., from the "more lentic–lotic state" to "more hydrostatic–hydrodynamic state," occurs as a result of historical human interventions to alter the land–water linkage structure that has occurred because of the basin population and their intervention capability and capacity, as shown in Box *Fig. 1a*. In essence, the dynamics of basin water are founded on the natural hydrological phenomena (forming the basis of natural water circulation system) and the artificially instituted hydrological mechanisms (forming the basis of artificially created water metabolism) and are sup-




**Box Fig. 1a**
**Lentic–lotic basin systems in the hydrostatic–hydrodynamic context**




**Box Fig. 1b**

**A basin with overlapping lentic–lotic and hydrostatic–hydrodynamic flow regime**

ported by the overall framework of their management or the basin governance. Over some thousands of years of human interventions, the scale and magnitude of human interventions have dramatically increased with the acquired technological and managerial skills, particularly in the last few centuries. Many lake–river embayment basins today exhibit a configuration feature consisting of a complex combination of lentic–lotic and hydrostatic–hydrodynamic flow regimes, in an often multiply nested manner, as shown in Box *Fig. 1b*.

for 265 years)until the mid-twentieth century. The extent of conversions was constrained by the configurational feature of the Biwa–Yodo Basin terrain. After most of the easily conversional land was transformed to arable land, the increased food production depended more on an increased productivity per unit land space and an increasing variety of crops other than paddy rice.

*Figure 5a* is a map of wetland areas identified to have existed in early Meiji Period (mid-nineteenth century), and *Fig. 5b* is a map of what is called the wetland potential calculated using a GIS computational tool (SAGA GIS 2018) that supposedly simulates the geo-historically existed lowland areas. The two closely resemble each other. *Figure 6* is a map of the depressions artificially created by using GIS (the size of depressed land formations is exaggerated for ease of visible identification). The distribution of thin lines represents tributaries of the main rivers, while that of dots are the depressions where water would have easily been impounded. As it turned out, the Biwa–Yodo Basin and the surrounding region are known for numerous irrigation ponds having been constructed over the course of history and exist to the present time. They are another form of lentic waters interlinked with lotic waters, i.e., the hand-dug canals and dendritically spanning tributary rivers.

## Technological and Managerial Implications

The transformation of a basin flow regime from the "more lentic–lotic state" to a "more hydrostatic–hydrodynamic state" takes place as a result of historical human interventions. Broadly speaking, it often involves some thousands of years of human interventions during which the scale and the magnitude of human interventions have dramatically increased, particularly in the last few centuries with the acquired technological and managerial skills. The concept of "water management," therefore, has also evolved to encompass "water control" in the late nineteenth century after a series of government interventions and then "water metabolism" of the urbanizing regions, particularly in the latter half of the twentieth century in multiple subbasins of the Biwa–Yodo Basin. Here the term "management" of a basin is quite an encompassing concept in that it pertains to management of such constituent mattes as water, soil, sediments, etc., management of the bounded land space, or the physical expanse of such constituent basin areas as urban area, forest area, agricultural area, etc., and it further pertains to various resource values such as water (quantity and quality), the state of their existence (surface and subsurface flows and their transient behaviors), as well as the activities taking place within the spatial existence of land and the associated productive func-

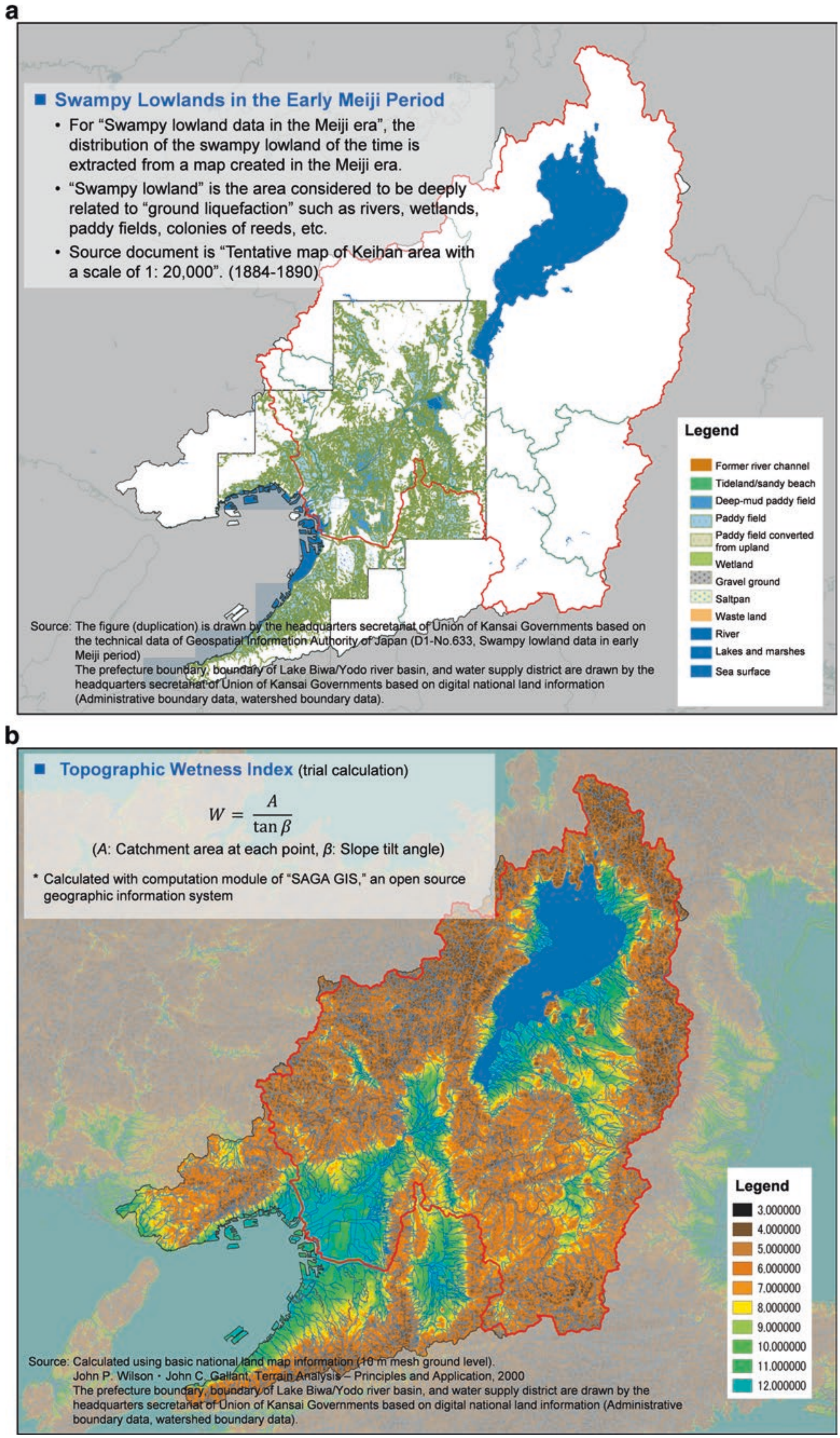



**Fig. 5**

**Actual wetland in the mid-nineteenth century (a), calculated wetland potential (b), and river inundation hazard area (c)**

c

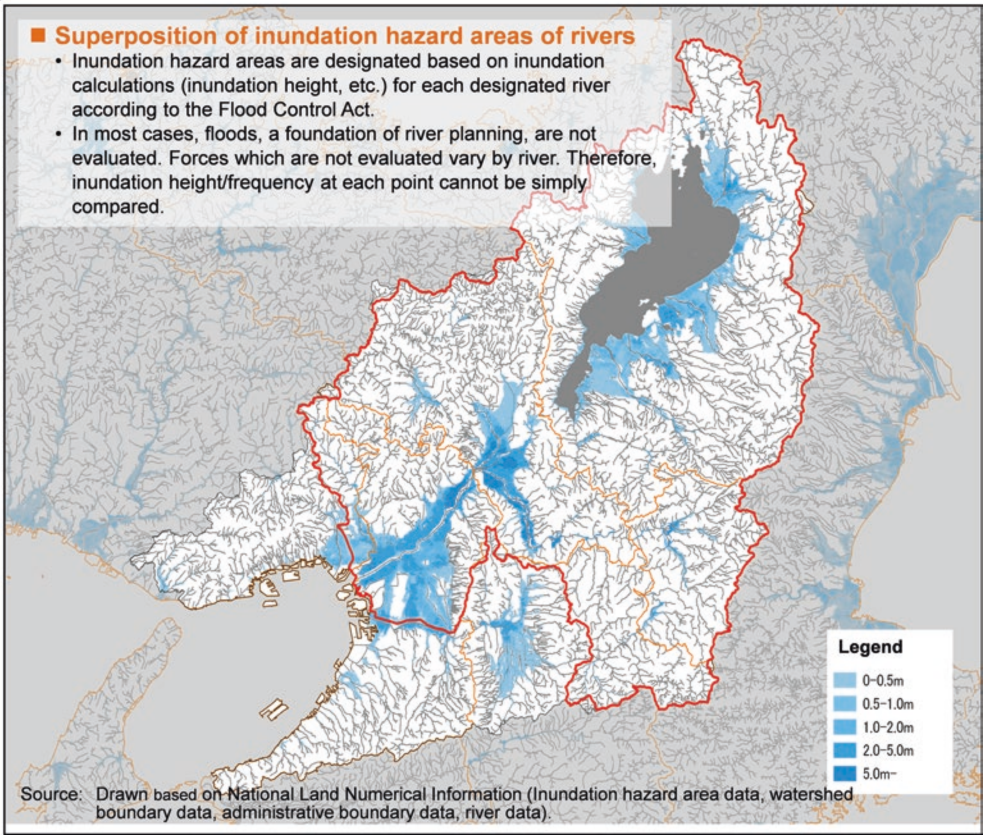



**Fig. 5**
**(continued)**

tions such as urban and industrial activities. In addition, water management also entails accommodation as much as possible for specific ecosystem characteristics of the basin terrain, from the uppermost reaches of dendritically shaped feeder river systems and their surrounding forestlands that provide for their retention capacity, among others, all the way down to the delta formations at the river mouths and the tidal estuaries that possess the geo-historically formed physical, chemical, and biological properties and functions.

Among "water management" elements is "control of flowing water" such as flood control to reduce inundation and structural destruction and damages and drought control to reduce shortages of water for household, urban, industrial, and agricultural uses. The reduction of flooding risks may be achieved by structural intervention measures such as construction of dams and levees and by nonstructural measures such as preparation in advance of the risk aversion, risk avoidance, and other means and procedures for preparatory and precautionary actions. The reduction of water shortage risks may be achieved by structural intervention measures such as construction of reservoirs and rainwater holding facilities and by nonstructural measures such as preparation in advance for implementing water-saving practices. These water control policies and programs generally fall under the jurisdiction of water resources management and river management agencies.

The concept of water metabolism has emerged to describe the material balance and transformation within the systems humans have developed and their support mechanisms. For example, in the case of urban water metabolism, the quality of water suitable for drinking is produced through water treatment processes that provide for physicochemical and biological water quality transformation processes such as mixing, flocculation, filtration, adsorption, and settling. The transformed quality water will be provided to the consumers through the distribution system by taking advantage of water's transportability by gravity. If the quality of raw water is sufficiently good, the cost of water quality transformation would be lower than otherwise. The similar situation applies to waters used for industries and for agriculture or irrigation, the quantity of which is generally much greater in most cases. Because the intake, transport, and distribution systems, respectively, of drinking, agricultural, and industrial purpose waters are generally independently constructed, their collection and disposal systems (i.e., sewerage, effluent discharge, and irrigation return flows) exist independently.

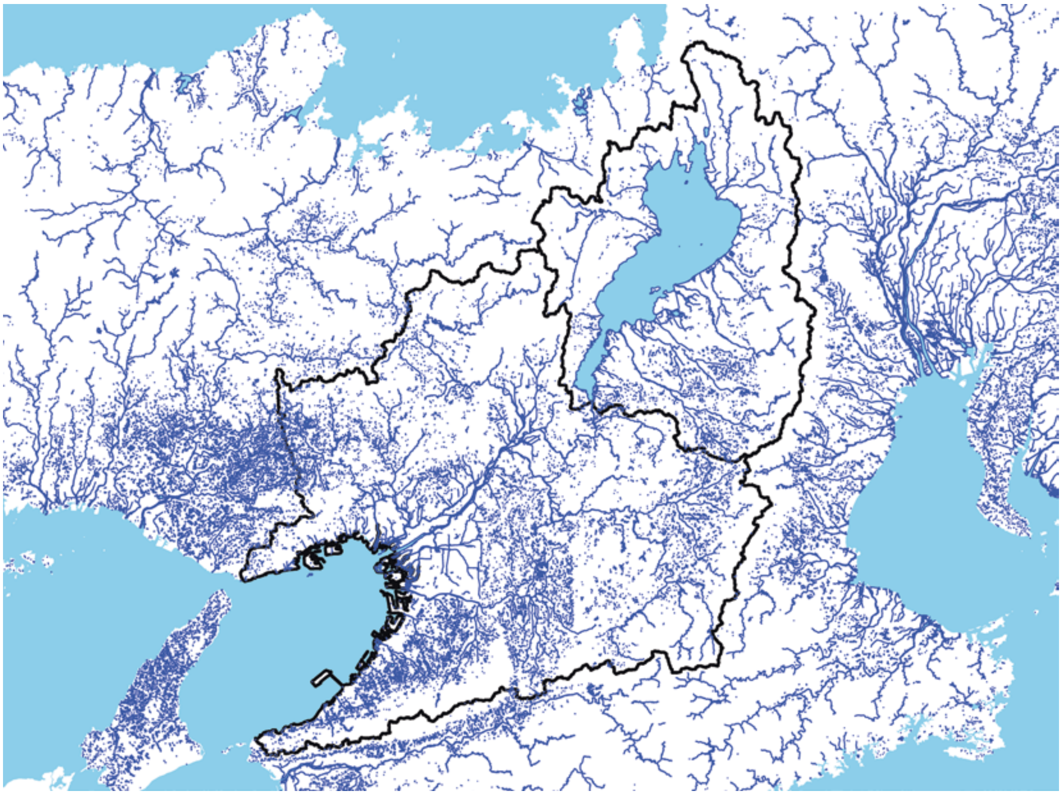


**Fig. 6**
**Image of the original Lake Biwa–Yodo River lentic–lotic systems (credit: Thomas Ballatore, Lake Basin Network)**

Depending on the size of such systems determined on the basis of human convenience, these artificially created systems of water metabolism may straddle more than one basin, resulting in artificial inter-basin water transfers.

In essence, the dynamics of basin water are founded on the natural hydrological phenomena (forming the basis of natural water circulation system) and the artificially instituted hydrological mechanisms (forming the basis of artificially created water metabolism), and have become complexly intertwined with multiple frameworks of their management, or the basin governance. With regard to flood control, the countermeasures have been gradually improved over the past several decades, although there are many pending issues of concern such as the increasing frequency of extreme weather events. With regard to the water metabolism infrastructures such as water supply and sewerage facilities, the population provided with piped water exceeds 17 million or nearly all of the population within the Basin, and the sewerage coverage is quite high in the densely populated areas within the Basin (*Fig. 7*), although the facility renewal needs have emerged as a growing concern. As a whole, therefore, the lentic–lotic and hydrostatic–hydrodynamic balance within the Biwa–Yodo Basin has shifted significantly toward the latter, highlighting the need to address the ecosystem sustainability of the Basin system.

## Aquatic Ecosystem Features and Their Transformations

There is a number of reasons that aquatic ecosystem are adversely affected. For example, according to Nishino (2009, p 41–48), the threat factors to native fish species in the Lake Biwa–Yodo River system include introduction of carnivorous alien species of fish, channelization and other river improvement works, water pollution, agricultural land improvement works, water level control for flood control and drought management, lakeshore levee construction, a decline in the number of host bivalve shellfish, and overfishing, where each threatened fish species is found to have been subjected to more than one factor. Among the above factors, channelization and other river improvement works, agricultural land improvement works, and lakeshore levee construction are physical alterations of fish habitats or, in relation to the expressions used in this chapter, transformation from a lentic–lotic flow regime to a hydrostatic–hydrodynamic flow regime. These physical alterations, together with water pollution and water level controls, are man-induced (non-biological) factors, while alien species of fish and decline in bivalve shellfish are biological factors. Of the 42 threatened fish examined, 35 of them are ascribed to the threats category of physical alteration of fish habitats (Nishino

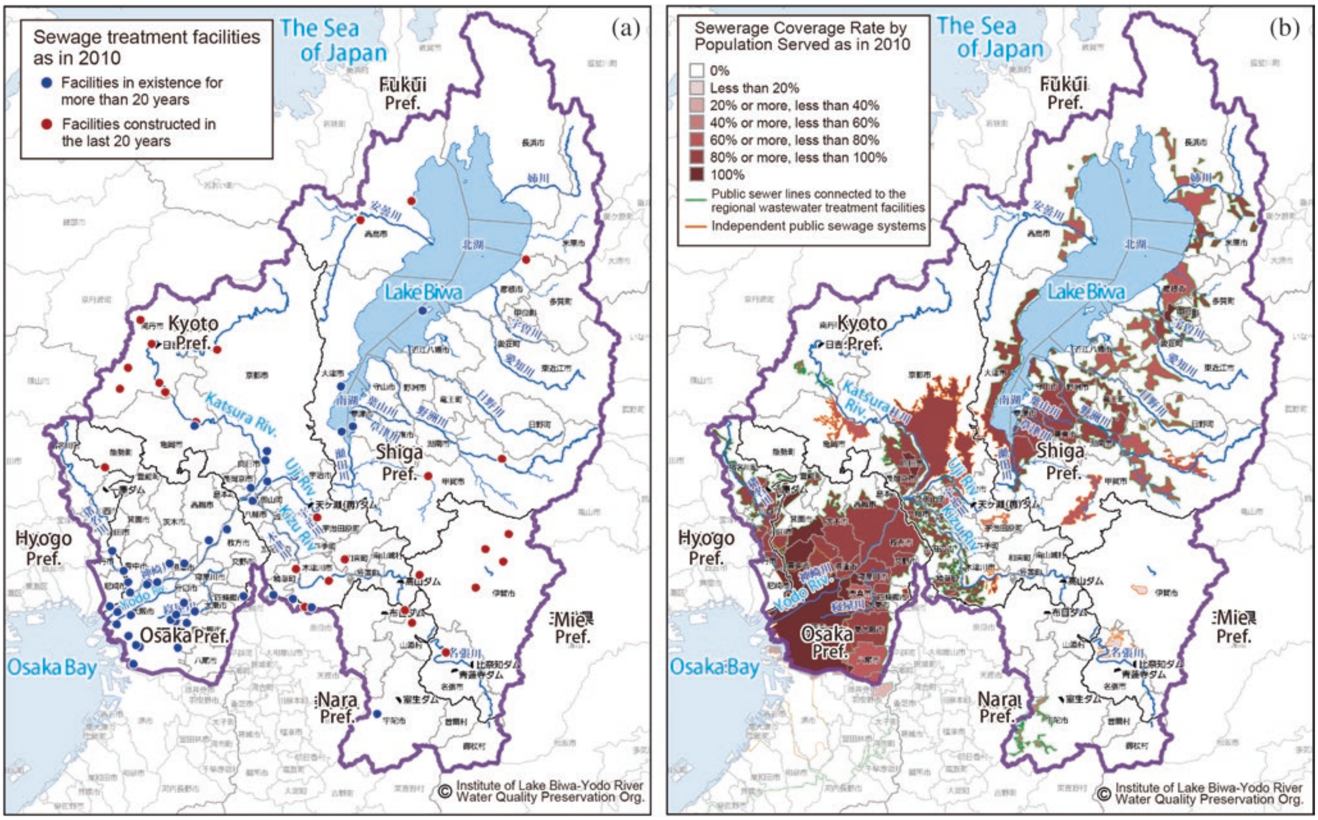



**Fig. 7**

**(a) Sewage treatment facilities in 2010, (b) Sewerage coverage rate by population served (%) in 2010 (BYQ 2017)**

2009, p 42). More specifically, Lake Biwa has undergone rather dramatic changes of concern with respect to the aquatic ecosystem features attributable to land–water transformations and to the human–nature interaction features implicitly ascribable to the flow regime transformation as follows:

The aquatic ecosystem features include:

- Disappearance of attached lakes, i.e., the reduction in fish diversity is attributable in part to the landfilling of satellite lakes attached to Lake Biwa. Recent studies on satellite lakes have proven to have amplifying effects on biodiversity.
- Artificially constructed shorelines, i.e., the dominance of only a few carnivorous species capable of surviving in the artificially constructed shorelines is found to be contributing greatly to the diminishment of fish species diversity.
- Levee cum ring road, i.e., the shoreline along the lakeshore has been extensively transformed to levee cum ring roads that have been found to suppress the growth of wetland species of plants.

The human–nature interaction features include:

- Traditional water culture lifestyles, i.e., some of the rural communities are favorably located to maintain the traditional water culture, such as using the spring water for non-polluting household purposes and the discharge of its wastewater free of contamination (keeping the lentic–lotic water environment).
- Discharge of paddy irrigation return flow, i.e., the paddy farmers, now provided with irrigation water from large-scale lake water irrigation by pumping (a hydrostatic–hydrodynamic system), are also being guided to reduce the amount of contaminated return flows being discharged into the lake, possibly by recirculation and reduction of water use. The traditional low-impact cascading irrigation systems (lentic–lotic system) are now experimentally tested for its advantage, i.e., to appeal for the environmentally conscious consumers.
- Man-made rivers, i.e., the ayu fish (*Plecoglossus altivelis*) fisheries are using the man-made rivers with pumped water mimicking the natural river flows for the fish to spawn on the artificial spawning ground (a simulated lotic–lentic regime using a hydrostatic–hydrodynamic technology). Such artificial rivers were created as the newly introduced operation rule of the Setagawa Weir being operated for flood control and drought management which defy the naturally fluctuating lake water level, leading to drying up of natural spawning grounds during the spawning season.

In all, the bountifulness of Lake Biwa ecosystem has been significantly compromised by the transformations of linkage structure and of flow regime.

The bountifulness of ecosystems in the Yodo River portion has also been declining during the course of flow regime transformation from lentic–lotic to hydrostatic–hydrodynamic in nature, except that the lotic/hydrodynamic features, typically exhibited by the water systems of flowing nature such as rivers and channels, are much more dictating than the lentic/hydrostatic features typically exhibited by the water systems of impounded forms such as lakes and reservoirs.

Rivers have morphological features and associated ecosystem functions as reflected in (1) domains of flowing water, (2) interactions among water media interfaces, and (3) transient and transitional features of the landscape. As for item (1), there are three domains, i.e., surface flow domain, subsurface flow domain, and geosphere domain such as wetted perimeters and embankment formations. As for item (2), a milieu of intricate interactions is taking place in the hydrosphere (water), geosphere (soil), and their interface environments. As for item (3), the topography (e.g., soil types and elevations) and hydrography (e.g., depth, velocity, surface area, and water quality) change gradually and continuously toward the downstream direction, as well as toward the shoreline direction, to form the landscape features. The morphological features and associated ecosystem functions change over multiple temporal and spatial scales in response to the water quantity and water level fluctuations, as typically represented by the recurrence cycles, e.g., on the order of years, scores of years, and centuries. The recurrence of seasonal changes less than 1 year in duration, such as occasional small-scale flooding and rainy and dry seasons, is the driver for perpetuation of annual landscape features (Osaka kougyo daigaku yodogawa kankyo kyouiku sentah (2008).

The physical alteration impacts to the aquatic ecosystem in the Yodo River, therefore, should be considered to be under much greater stress than that Lake Biwa, not only because of the dramatic transformation of the flow regime from more lentic–lotic than hydrostatic–hydrodynamic but also because of the near-total disconnect of river flows due to the installation of various in-stream flow control structures for flood control, drought management, and navigation purposes. For example, the mainstream Yodo River and Lake Biwa was virtually disconnected from downstream upward by the installation of the Nango Weir in 1905 and the Amagase Dam in 1970. Such downstream–upstream disconnects have virtually prevented the upstream migration from the Yodo river mouth connected to Osaka Bay of such species as *Oncorhynchus masou masou*, *Plecoglossus altivelis*, *Anguilla japonica*, and *Eriocheir japonica*, known locally as "Satsukimasu," "Umiayu," "Unagi," and "Mokudugani." On the other hand, Nishino (2009, p 28) also notes that because of the upstream–downstream disconnect, of the 61 indigenous species of fauna (mostly shellfish and fish), only 21 species are recorded as being identified in the aquatic environments downstream of Lake Biwa, despite the fact that the species are being constantly supplied through the Seta River and Lake Biwa Canal. It is inferred that the species may reach downstream, but they simply cannot multiply due to the lack of suitable food and environment for a lasting habitat.

As a showcase movement for aquatic ecosystem restoration, a fish species identified as *Acheilognathus longipinnis*, commonly known as *Itasenpara*, has been drawing much attention. The fish was thought to have become extinct in the Lake Biwa water by the mid-1940s and in the Yodo River water by the early 1960s. However, it was reidentified in 1971 by a group of high school students studying the river at one of the water pools in the midstream Yodo River and later at a few dozen other locations along the river. The fish then acquired the natural monument status in Japan in 1974, and ever since it has become a symbol of the Yodo River ecosystem restoration, with many groups of citizens and scientists volunteering to protect their habitats. The habitat spots identified were actually called the "Wando (fluvial lagoon)," being constructed as part of the river improvement work starting in 1878, headed by a Dutch Engineer. These "Wando" structures are sided with partitioning stone piers protruding out toward the deep to create a deeper channel within the river course even during drier periods with little water. However, the role of these "Wando" structures was thought to have been already fulfilled in developing the new river improvement plan of 1971. The plan was to increase the throughput of the Yodo River flow by large-scale dredging of the river bottom together with installation of a flow control structure at Kema, only several kilometers from the river mouth entering Osaka Bay. The "Wando" structures got gradually phased out over the course of time, except for a couple of dozen of them having survived, still to forming water pools here and there. Those "Wando" remains found their own purpose of different kinds, i.e., for aquatic ecosystem restoration of *Itasenpara*.

## Evolving Governance in Managing Point and Nonpoint Source Pollution

This section consists of three subsections. The first subsection deals with the Lake Biwa–Yodo River water quality trends over the past 20 years, as expressed in GIS map displays, with reference to the point source–nonpoint source relationship. During the period, there was land use changes with associated flow regime transformation from more lentic–lotic to more hydrostatic–hydrodynamic, contributing to the trend toward increasing nonpoint source pollution (section "Basin water quality: Shifting emphasis from point source to nonpoint sources"). The second subsection presents an overview of the road drainage nonpoint source pollution, one of the most challenging nonpoint pollution issues yet to be addressed adequately (section ""Road drainage": An overlooked issue"). The last subsection deals with key governance challenges facing the Lake Biwa–Yodo River nonpoint source pollution issues in whole and the need for conceptual realignment needed about the future courses of action in dealing with the challenge (section "Beyond the conventional approach").

## Basin Water Quality: Shifting Emphasis from Point Source to Nonpoint Sources

The water pollution loads entering into lakes and rivers originate either from specifically identifiable discharge points or from not-so-easily identifiable discharge points. Typical point sources of pollution include municipal wastewater treatment plants, industrial wastewater treatment plants, stocking and disposal facilities of livestock manure and aquaculture wastes, as well as the discharge outlets of combined sewer overflows. Typical rural nonpoint pollutants include excess fertilizers, pesticides and other agricultural chemicals from such sources as paddy fields, croplands and forestlands. Typical urban nonpoint pollutants include atmospheric depositions, chemical and biological contaminants as well as debris particles on the paved surfaces, rooftops, roads and highways in the urban areas. The quantities of nonpoint sources of pollution discharged to the receiving waterbodies depends much on the intensity and frequency of precipitation.

The overall state of water quality in the Biwa–Yodo Basin attributable to point sources of pollution has been significantly improved over the past decades, thanks to the increased coverage of wastewater treatment systems by area and population served. The state of sewerage service coverage by population served (in percent) in 2010 of the Biwa–Yodo Basin is shown in *Fig. 7*, which may be compared with *Fig. 3* (population distribution), indicating that most of the Lake Biwa population centers and the downstream Kyoto and Osaka metropolitan areas are already well served by their respective sewerage systems. The major wastewater treatment plants located around Lake Biwa are provided with tertiary treatment process for phosphorus and nitrogen removal. The stringent implementation of regulatory measures, advancement of monitoring techniques, and research and applied study capabilities at the government institutions and universities also contributed to the development of control policies and programs for point and nonpoint source pollution.

The GIS graphics shown in *Figs. 8* and *9* are the changes in biochemical oxygen demand (BOD) and chemical oxygen demand (COD, measured using potassium permanganate as an oxidizing agent, or $COD_{Mn}$, hereafter referred to simply as COD) over the 20-year period between 1990 and 2009 for the whole Biwa–Yodo Basin. The areas with little or no improvement in river water quality (red and orange) correspond to the area provided with insufficient sewerage coverage, as shown in *Fig. 7*. Overall, significant improvement has been achieved with respect to BOD, but less with respect to COD.

While the reduction in the river COD concentration is attributable to increased sewerage coverage, the increase in the COD concentration is due to the increasing inflow of wastewater from areas where the sewerage systems were still inadequate to take care of the rapidly increasing population and industrial activities. The poor improvement of lake water COD concentration is due mainly to the growing quantity of COD generated in-lake, well as by the growing inflow of land-based COD materials contained in the river water.

*Figure 10a–d* illustrates four pairwise comparisons of the potential nonpoint pollution magnitudes computed using the values for the GIS 500-m grid size data (computed as the combined mean of 25 100-m grid size data), *Fig 10a* as illustrated in *Table 1* based on the values provided by the Japan Sewage Works Association (2009) and Nishizawa and Tachi (2009), and *Fig 10b–d* using the unit pollution load for the respective land use categories of the COD, TN, and TP shown in *Table 2*, based on the values provided by Shiga Prefecture and Kyoto Prefecture Background Document for the Preparation of Fifth Lake Biwa Water Quality Conservation Plan (2006 through 2010).

The following are interpretations of GIS figures, *Fig. 10a–d*, for the assessed parameters of the runoff coefficient, COD, TN, and TP.

A pair of GIS images is shown for each of the above four parameters, i.e., the status assessment for 2009 shown on the left side and the status assessment for the incremental change during the period between 1991 and 2009 shown on the right side. The interpretation of the left side image (i.e., the 2009 status assessment) should be straightforward. The grid color represents the assessed magnitudes of the runoff coefficient and of the pollution load discharge values of COD, TN, and TP in 2009, based on the assumed values shown in *Tables 1* and *2*. The interpretation of the right side image (i.e., the status assessment for the incremental change during the period between 1991 and 2009) will require knowledge regarding land use changes during the period. The figure indicates a significant reduction in domestic and industrial loads attributable to the extensive coverage of sewerage system for the reduction of respective point source loads, with the resulting decrease in the sewerage effluent load after their treatment. On the other hand, there are increases in urban nonpoint source loads, despite the fact agricultural loads have been reduced. The increased rainwater load is attributable in part to climate change impacts during the period. The increased urban nonpoint source load is attributable both to the slow progress in urban nonpoint source control and to the change in land use from agricultural land to urban land for which the unit pollution load is higher for the latter. The following are specific observations for each of the eight cases:

<Runoff coefficient for 2009, *Fig. 10a*)-left>

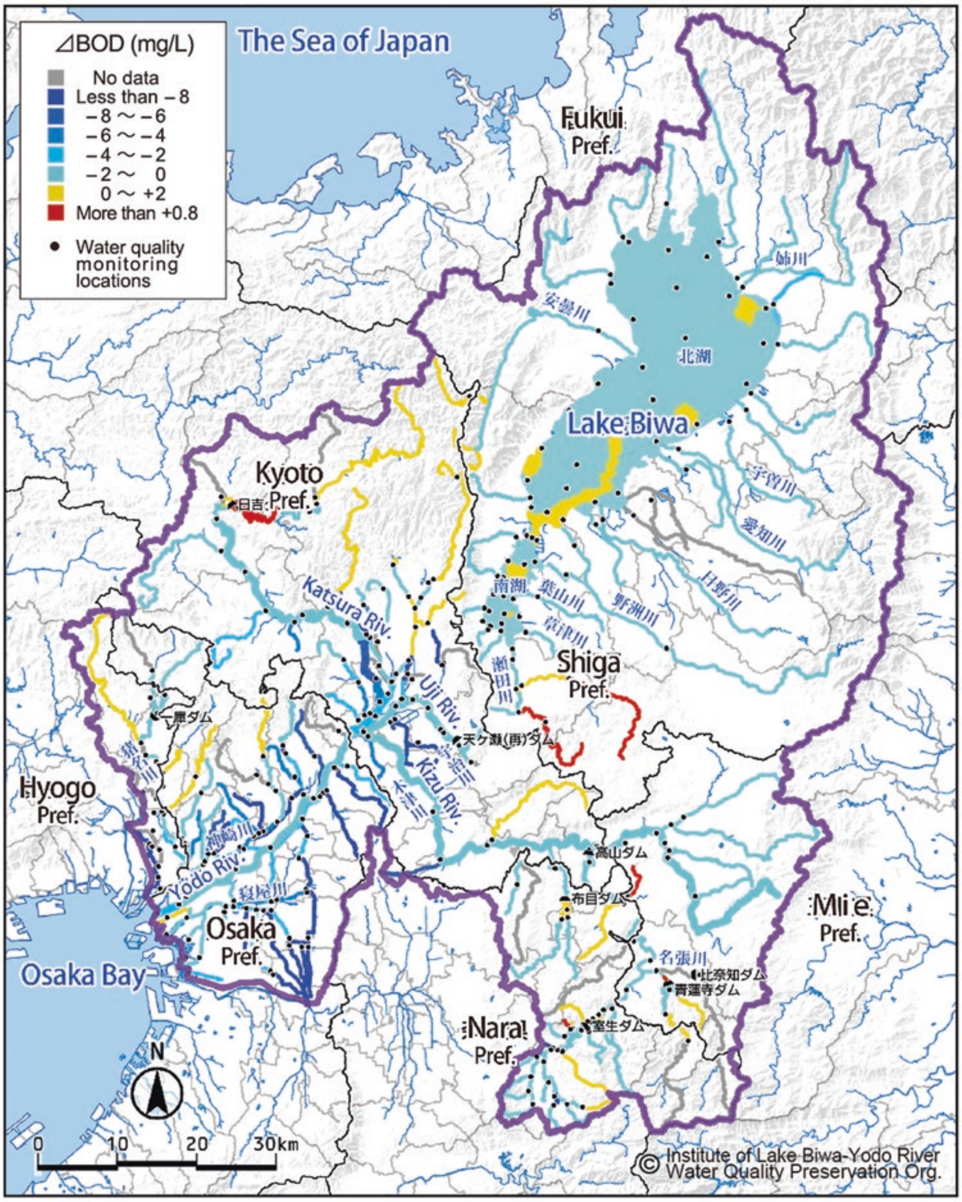



**Fig. 8**

**Improvement in BOD values between 1990 and 2009 (the 1990 and 2009 values are the mean values of 1988, 1989, and 1990 and the mean values of 2007, 2008, and 2009, respectively). (BYQ 2017)**

- The intensity is high in the urban areas (reddish, 0.8–1.0), particularly in the highly populated municipal areas on both sides of the downstream Yodo River region. It is also high in the highly populated urban centers in the eastern plain part of Lake Biwa watershed, although they are immediately surrounded by the agricultural areas exhibiting slightly lower coefficient values (green/yellow, 0.4–0.7). The intensity is generally quite low for the forestland (blue).

<Runoff coefficient, differential increment during the 1991–2009 period, *Fig. 10a*)-right>

- The reddish grids on both sides of the downstream Yodo River region, in the upstream Kizu River (toward the eastern watershed boundary), and on the eastern side of the South Basin of Lake Biwa correspond to the areas where land use has changed from suburban agricultural land to housing or to other urban built-environment land, resulting in increased runoff coefficient values. The reddish grids scattered into the forestland areas are locations where forest clearing took place for land development purposes.

<COD pollution load potential for 2009, *Fig. 10b*)-left>

- The values are quite high (mostly reddish, more than 140 g/ha/day) in the urban areas on both sides of the midstream Yodo River and in the entire metropolitan Osaka region downstream of the river. The values are also quite high in the eastern plain part of the South Basin of Lake Biwa.

<COD pollution load potential, differential increment during the 1991–2009 period, *Fig. 10b*)-right>

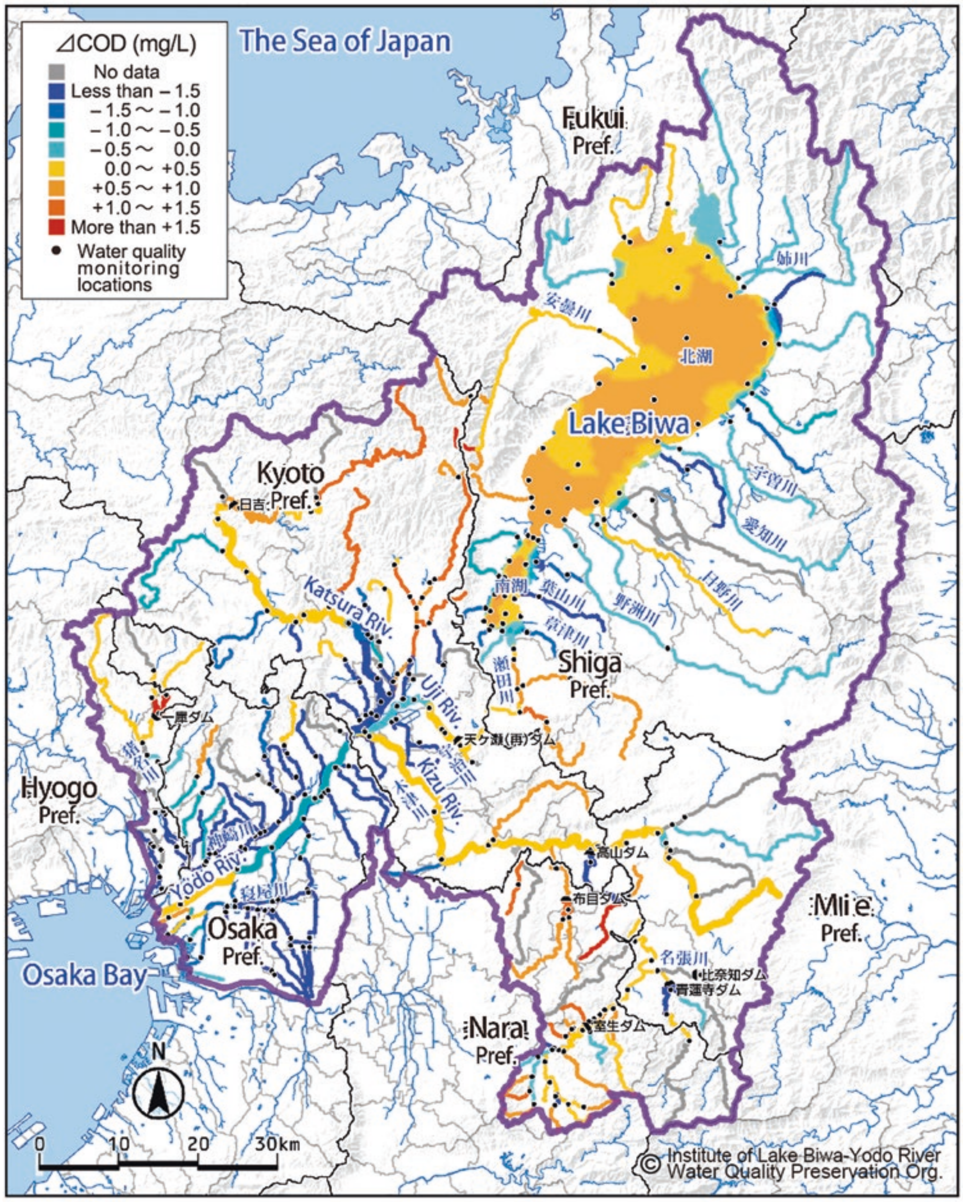



**Fig. 9**
**Improvement in COD values between 1990 and 2009 (the 1990 and 2009 values are the mean values of 1988, 1989, and 1990 and the mean values of 2007, 2008, and 2009, respectively). (BYQ 2017)**

- In general, there are close overlaps between the reddish grid clusters in *Fig. 10a*)-right and those in this figure, meaning the regions with increasing trends in runoff coefficients tend to match closely to the regions with increasing trends in COD pollution load potential.
- The reddish grids in the Lake Biwa watershed area and in the Yodo River region represent the areas where paddy land parcels were converted to suburban housing land parcels, and the suburban sprawl land parcels interspersed with patches of agricultural land were converted to the densely urbanized land parcels, etc.
- One of the major reasons for the decreased COD in the upper Kizu River region (toward the eastern watershed boundary) is because a significant number of farmer population have given up paddy agriculture, leaving much of their paddy land to become idle grassland and golf links. Similar reasoning applied to the agricultural areas in the mountainous region exhibiting similar decreasing trends in COD over the 20-year period.
- The land use changes from paddy land to urban and suburban lands increase the COD load, but not significantly (from 118 to 144), while those from forestland and idle grassland to urban and suburban lands increase the COD load quite significantly (from 46.2 to 144). These two "increasing" factors contribute to the overall reddish appearance of grid clusters, compared to TN and TP cases discussed below.
- The blue grid clusters spread across the upstream land bordering the watershed boundaries because many paddy land parcels have been converted to croplands, reducing the COD load to half (from 118 to 62).

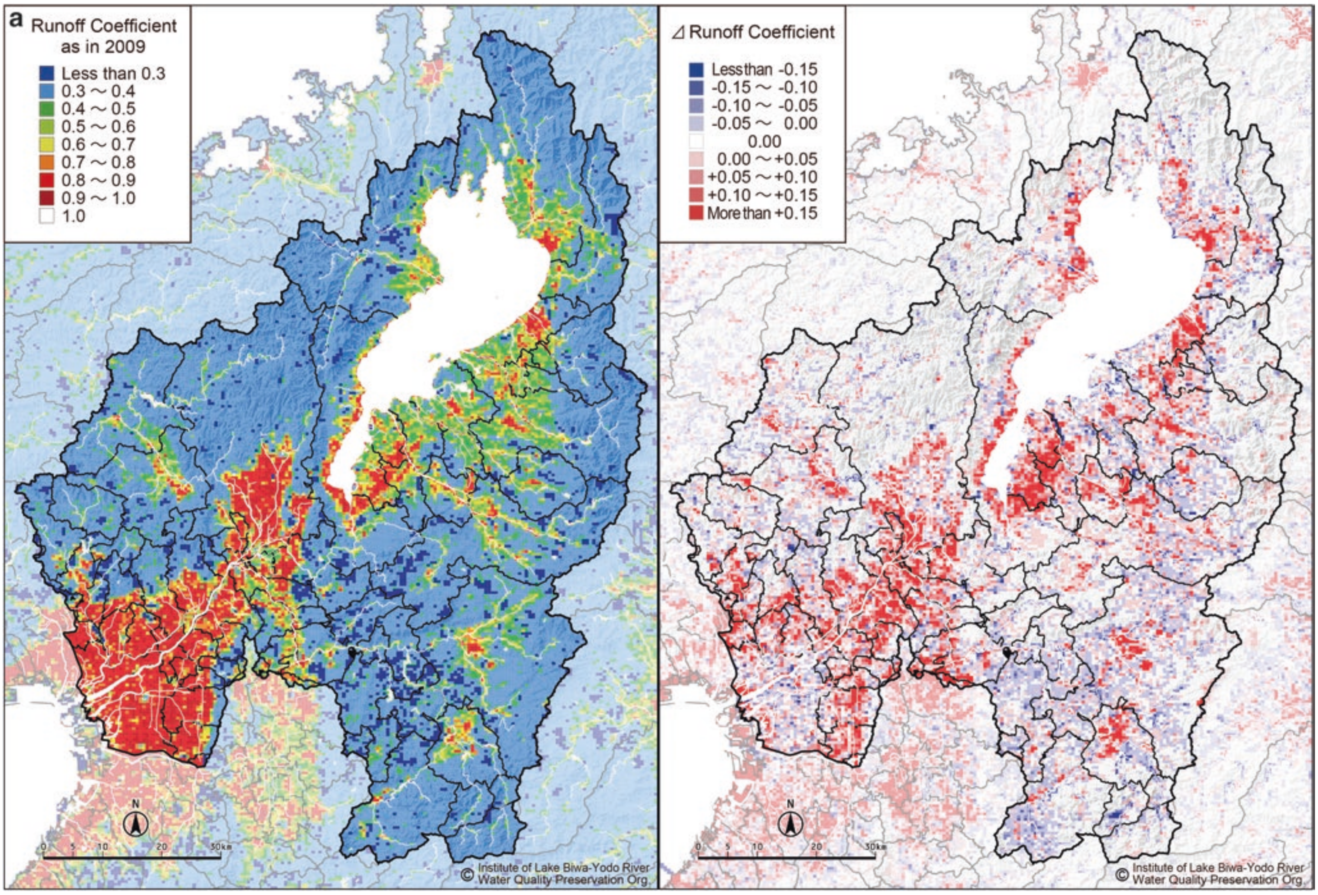



**Fig. 10a**

**(a): Runoff coefficient values for 2009 (left), and the difference between the 1991 values and the 2009 values at the respectively corresponding locations (right). (b), (c) and (d): The COD, TN and TP pollution load distributions each for 2009 (left), and the difference between the 1991 values and the 2009 values at the respectively corresponding locations (right).**
**The GIS displays were developed using the data obtained from the National Land Numerical Information Service, Japan**

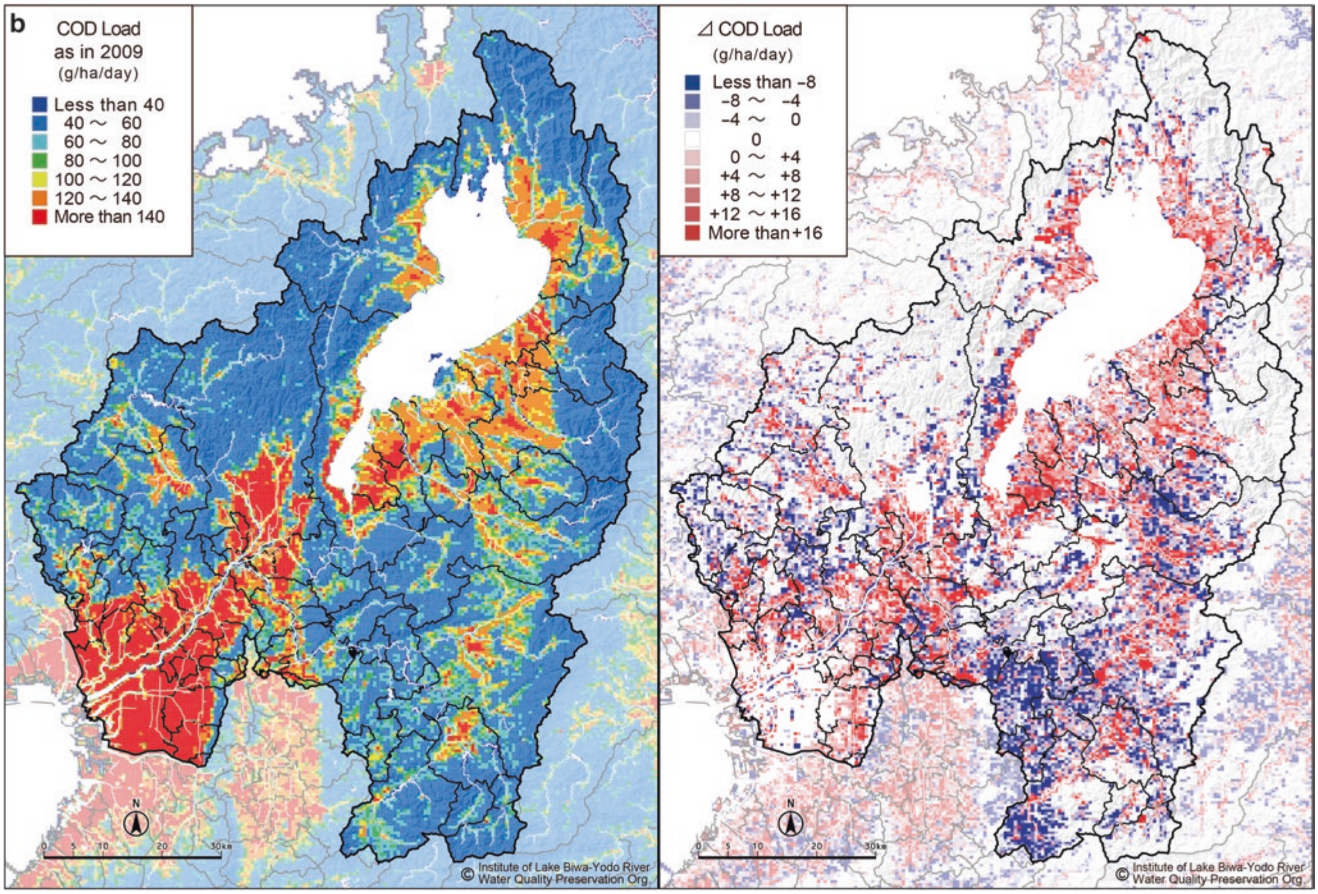



**Fig. 10b**
**(continued)**

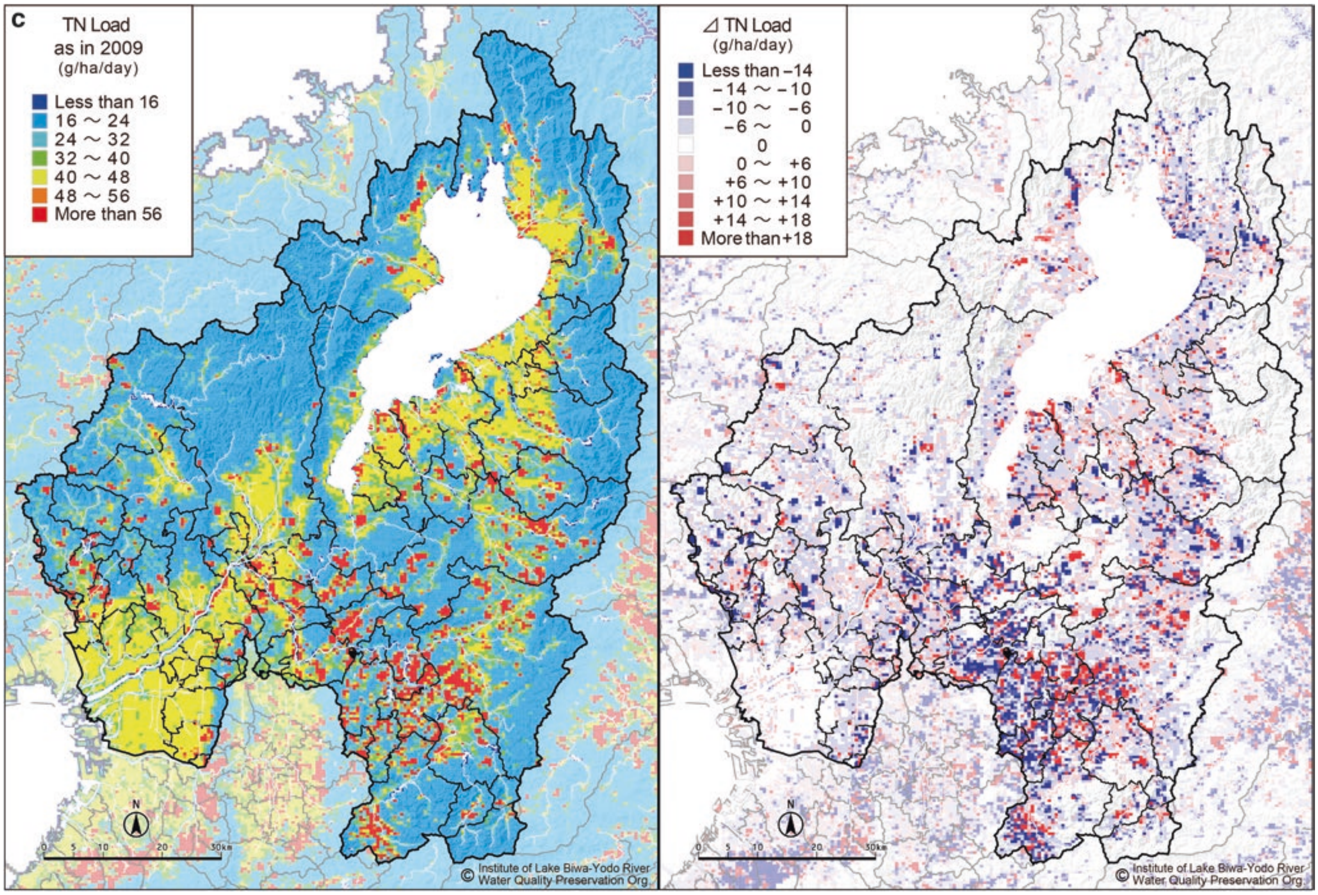



**Fig. 10c**
**(continued)**

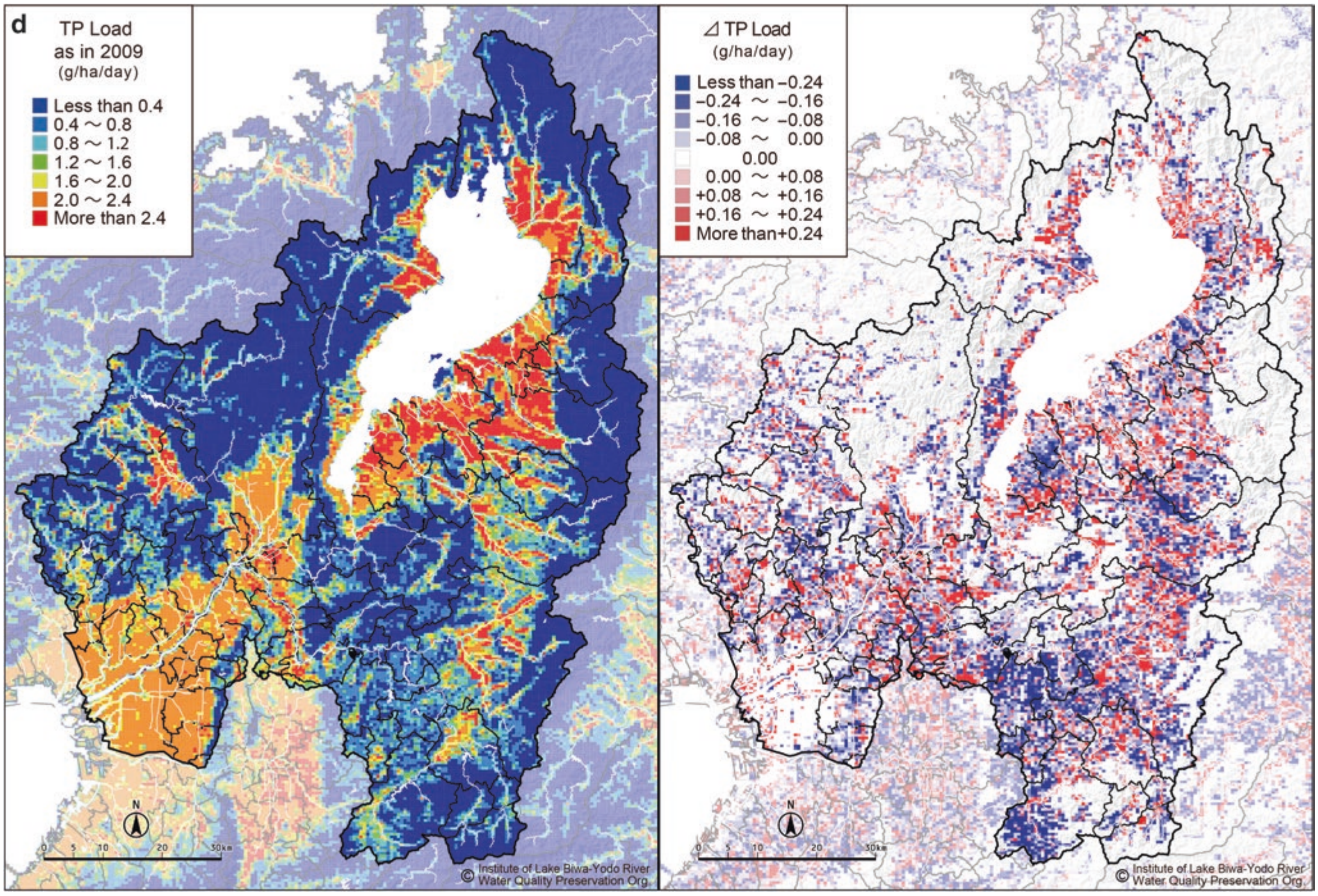



**Fig. 10d**
**(continued)**

**Table 1**
**Runoff coefficient values for respective land use categories**

| Land use types | Runoff coefficient value |
|---|---|
| Paddy field | 0.4 |
| Other farmlands | 0.2 |
| Forest | 0.3 |
| Idle grassland | 0.2 |
| Building use | 0.9 |
| Highways and transportation | 0.85 |
| Other urban field | 0.2 |
| Rivers, lakes, and reservoir | 1.0 |
| Golf links | 0.2 |

Source: The Japan Sewage Works Association (2009) and Nishizawa and Tachi (2009)

**Table 2**

**Unit pollution load values for respective land use categories**

| Land use types | Unit pollution load (g/ha/day) | | |
|---|---|---|---|
| | COD | TN | TP |
| Paddy field | 118.0 | 39.2 | 2.68 |
| Other farmlands | 62.0 | 261.0 | 0.54 |
| Forest | 46.2 | 18.0 | 0.35 |
| Idle grassland | 46.2 | 18.0 | 0.35 |
| Building use | 144.0 | 38.6 | 2.00 |
| Highways and transportation | 144.0 | 38.6 | 2.00 |
| Other urban fields | 144.0 | 38.6 | 2.00 |
| Rivers, lakes, and reservoirs | – | – | – |
| Golf links | 62.0 | 261.0 | 0.54 |

Source: Background Document for the Preparation of Fifth Lake Biwa Water Quality Conservation Plan (Shiga Prefecture and Kyoto Prefecture 2006 through 2010)

<TN pollution load potential for 2009, *Fig. 10c*)-left>

- The values (orange and red colors) are particularly high in the tea plantations and golf links (261 g/ha/day) in the deep suburban and hill areas.
- The yellow, orange, and red grids near the urban areas correspond mostly to vegetable and other croplands.

<TN pollution load potential, differential increment during the 1991–2009 period, *Fig. 10c*)-right>

- The land use changes from paddy land to urban and suburban lands does not greatly affect the TN load (from 39.2 to 38.6), although those from forestland and idle grassland to urban and suburban lands affect TN load somewhat significantly (from 18.0 to 38.6).
- There are many bluish grid clusters appearing in the entire Lake Biwa–Yodo River over the 20-year period, indicating areas with conspicuously cumulative TN reductions over the 20-year period in areas where paddy land parcels were converted to housing land parcels.
- As discussed with respect to COD, a significant number of the farmer population have given up paddy agriculture, leaving much of their paddy land to become idle grassland, resulting in a significant number of bluish grid clusters implying a significant TN decrease over the 20-year period.

<TP pollution load potential for 2009, *Fig. 10d*)-left>

- The distribution of red grids corresponds to the paddy agricultural land in the Lake Biwa watershed and in the upstream of Katsura River toward the southwestern mountain region. The brownish grids on both sides of downstream Yodo River region correspond to the highly populated urban areas on both sides of Yodo River, where the value of runoff coefficient is highest because of a high density of roads (0.85) and an extensively built-up environment (0.90).

<TP pollution load potential, differential increment during the 1991–2009 period, *Fig. 10d*)-right>

- The land use changes from paddy land to urban and suburban lands reduce the TP load somewhat significantly (from 2.68 to 2.00). The bluish grid clusters in the urban and suburban areas in the Lake Biwa watershed close to the lake shore attest to this fact.
- The land use changes from forestland and idle grassland to urban and suburban lands increase the TP load quite significantly (from 0.35 to 2.00), as indicated by the reddish color. Such lands are scattered around in the upstream region in the southeastern part as well as northwestern and northeastern coastal regions of the Lake Biwa and in the midstream suburban regions of Yodo River.
- As shown in *Table 2*, the TP and TN profile are similar. In other words, there are areas with decreased TP due in part to the paddy land converted to housing land and also due to the increase in idle grassland and golf links resulting from abandonment of paddy agriculture in certain higher altitude regions. On the other hand, the TN would increase by the transformation of cropland to housing land and to idle grassland, as shown by the distribution of grid clusters with reddish color.

## "Road Drainage": An Overlooked Issue

Among the most challenging nonpoint pollution issues is that of "road drainage," consisting of gaseous and particulate exhausts and fuels, worn and torn tire debris of various sizes, asphalt and concrete chips and powders, shredded plastic parts and torn metal pieces, roadside vegetation litters, etc. They contain hazardous inorganic and organic chemicals, including polycyclic aromatic hydrocarbons (PAHs), as well as eutrophication-causing nutrients such as nitrogen oxides and phosphorus. These noxious substances get accumulated in dry weather and washed off at times of storm events (e.g., Wada et al. 2006, 2011, 2015).

Some initial studies to estimate their magnitudes for the Lake Biwa watershed have been undertaken (Wada and Fujii 2007, 2010). The studies focused on the "first flush" (the initial wash-off of the accumulated pollutants on the road surface at a rain event after a period of dry weather) of the Lake Biwa Basin road drainage. The precipitation measurements for an interval of 10 min with a scale range of 0.5 mm recorded at the Omihachiman District Meteorological Observatory was obtained from the Japan Meteorological Agency (2000). Data for all dry weather periods and all rainfall amounts were substituted into the model, and the pollutant loads were calculated as average values for 10 years for the 1998–2007 period. A summary of the study findings are as follows:

- The pollutant loads of road drainage in the Lake Biwa watershed were 29.9, 3.50, and 0.18 kg/(km$^2$·d) for COD, TN, and TP, respectively.
- These values are used as unit loads for estimating the respective pollutant loads. The unit loads are expressed as mass per area per time, typically kg/(km$^2$·d). The unit loads of road drainage in the Lake Biwa Water Quality Protection Program (LBWQPP, Shiga & Kyoto Prefectures 2007) were 14.4, 3.86, and 0.20 kg/(km$^2$·d) for COD, TN, and TP, respectively.
- The COD value obtained in this study was twice as much as that of the LBWQPP, and the values of TN and TP were almost the same as those of the LBWQPP (*Fig. 9*). These values were multiplied by the total area of roadways in the watershed (98.8 km$^2$) obtained from the Roadways Traffic Census (Ministry of Land, Infrastructure, Transport and Tourism and Shiga Prefecture 2002), and the road drainage amounts in the Lake Biwa watershed were determined to be 2950 COD kg/d, 350 TN kg/d, and 18 TP kg/d, respectively.
- This estimated COD load was equivalent to 7.7% of the total COD inflowing load to Lake Biwa in 2005 (38,400 COD kg/day). Considering the extremely hazardous nature of the first flush road drainage discharged directly to the water courses, the need for effective control measures is imminent.

The foremost of many possible reasons for the challenges facing road drainage is that there are so many factors affecting it, but none being significantly prominent. Thus, it is difficult to develop a viable institutional framework to deal with this issue unlike the cases with other sources of nonpoint pollution. As for the managerial complexities, the parties to be held responsible could include the road authorities, road transport industry, individual drivers, automobile and tire manufacturers, etc., although their individual and collective responsibilities have not yet been clearly delineated, partly because the legal and policy frameworks have not yet been established. While implementation of a totally dedicated policy to reduce the road drainage pollution may face complicated legal, institutional, and administrative challenges, the reduction may be achievable by taking advantage of the purification capacity of natural and constructed wetlands available for meeting other objectives such as flood risk reduction, environmental amenity enhancement, and aesthetic improvement.

## Beyond the Conventional Approach

As discussed in the previous two subsections, sections "Basin water quality: Shifting emphasis from point source to nonpoint sources" and ""Road drainage": An overlooked issue", the quantity of nonpoint sources of pollution to be reduced in the Biwa–Yodo Basin is still far from satisfactory. Some of the major difficulties associated with introducing effective control measures for nonpoint source pollution include:

- The spatial extent of nonpoint source pollution is generally far too expansive for the introduction of cost-efficient measures.
- It is generally infeasible to direct appropriate sets of management policy, institutional framework, as well as the financing scheme, for prevention, control, and treatment of all types of nonpoint source pollution from numerous individual source types.
- Development of legal and regulatory frameworks for nonpoint source control generally requires considerations for balancing the competing policy objectives. For example, effective control of agricultural nonpoint source pollution represents a subtle balance between agricultural and environmental policy objectives, which may bring about half-hearted and ineffective implementation results.
- In general, the management programs of nonpoint source pollution encompass multiple policies and programs belonging to different sector agencies, and their collective implementation may be hampered by the ambiguity in legal delineations and by the incompatibilities of technical and managerial practices.
- Introduction of countermeasures would generally require installation of extensive and expensive physical facilities that are far beyond the responsibility and capability of a particular sector. For example, the control of forestland nonpoint source pollution, e.g., dissolved and suspended pollutants being washed off together with soil particles at times of storm events, may require installation of extensive facilities far beyond the forest sector's financial capability.
- The physical, chemical, and biological response characteristics of nonpoint source pollution are spatially nonuniform and temporary irregular, making it quite challenging to

make precise and accurate assessment for the development of effective programs.

- The land–water interactions, including those related to subsurface water flows, are too complex to make accurate measurements.
- The recent changes in climatic conditions are affecting their temporal and spatial behaviors beyond the prediction based on the past historical records.

Further, together with their special features of integrating nature, long retention time, and complex response dynamics, the nonpoint source pollution problems will continue to linger for such enclosed bodies of water as lakes, wetlands, and coastal embayment formations.

In the meantime, there are some promising developments both in Japan and in other countries. In the case of Japan, the only legislation that specifically provides a legal framework for managing nonpoint source pollution is the Law Concerning the Special Measures for the Prevention of Lake Water Quality, enacted in 1984 and amended in 2005. The law stipulates that "The areas which require some measures to treat contaminated effluent water from the farmlands and urban areas are designated as 'target areas' for the treatment of effluent water, and the actions plans should be formulated and promoted. The peripheral areas of lakes and marshes which requires special protection for preserving the water quality is designated as environmental preservation areas around the lakes, and the notification is obliged in taking some plants from these areas" (WEPA 2018). The number of cases pertaining to this amended stipulation is increasing over time. As expected, many of the projects and programs implemented under the above legal provisions do not necessarily pertain exclusively to the management of nonpoint source pollution. For example, many of them are implemented as part of the policy to reduce urban flooding risks. Similarly, many agricultural nonpoint source control projects and programs are actually for promotion of environmentally friendly agriculture aiming to reduce the use of unnecessary amounts of fertilizers and pesticides. Specifically, there are Ministry of Agriculture policy provisions that pertain to promotion of environmentally friendly agricultural practices, as well as promotion of agricultural products for healthy food habits, discouraging the release of harmful agricultural chemicals beyond the level considered appropriate.

Similar ideas have also been promoted elsewhere. In the case of the USA and Europe, in addition to the use of the such contemporary approaches as retention pond, wetland, soil conservation, and infiltration beds, collectively called Best Management Practices (BMPs), there is a growing interest and emphasis on the use of SUDS (sustainable urban drainage systems) (e.g., USEPA 2007) and LID (low-impact development) (e.g., Schueler 1987; CIRIA 2015; Prince George's County Department of Environmental Resources 1999). SUDS alternatives intend to meet both the technical requirements of runoff discharge and the quality requirements such as public amenity and ecosystem functions, and LID alternatives focus on integration of nature as part of land use planning (e.g., USEPA 2000). Together with the Green Infrastructure concept (e.g., green buffers, rooftop greeneries, application of ecosystem service concept), the application of SUDS and LID is drawing growing interest as a means of pursuing multiple policy objectives, including the reduction of nonpoint source pollution, rather than ways that bring about incidentally acquired results that happen to be more than the reduction of nonpoint source pollution. There are many factors associated with successfully devising SUDS and LID approaches, including those hydro-geometric features as geography, topography, hydrography, and hydrology that have evolved over the course of development history of land and water systems, as discussed in sections "The Biwa–Yodo Basin in brief" and "Historic transformations of the Biwa–Yodo Basin". Regardless, they entail many disciplinary and sectoral fields for the governance of "basin metabolism" with flexible institution, progressive policies and programs, hybrid of technologies to fulfill multiple policy objectives, and the duly designed applied studies involving not only natural science fields but also social science fields, all to be broadly supported by sustainable funding.

In *Fig. 11*, the principle author of this section, Wada, proposes a schematic representation of the holistic framework of mutually interlinked policies interfacing with the subject of nonpoint source pollution control and management. Each individual thematic fields has direct, as well as indirect, implications regarding nonpoint source issues, and therefore, their individual pursuits for meeting own objectives will naturally accompany policies, plans, and programs interfacing with nonpoint source issues, likely to bring forth multilayered contributions to the governance of nonpoint source pollution issues. It is also important to point out that the range of governance challenges pertaining to nonpoint source issues of hybrid nature as shown in *Fig. 11* entails the concept of a participatory environmental governance approach, to be discussed in section "Evolving Basin governance of participation: Communities and citizens", and the concept of ecosystem services to be discussed in section "Basin governance improvement for ecosystem restoration".

## Evolving Basin Governance for Integrated Flood Risk Management

This section deals with the Shiga Prefecture's efforts on the basin flood management policy and the efforts by the Union of Kansai Governments, to realize what is called Integrated Flood Risk Management (IFRM). First, a historic account of the Japanese river management policy with respect to flood control is briefly described (section "Government responsibilities in flood control and management"). In the case of the Lake Biwa–Yodo River Basin, a number of compounded historical issues culminated in the Shiga Prefectural Government (SPG) taking an exceptional step to expand the scope of flood control from one focusing exclusively on the traditional structural approach to one that

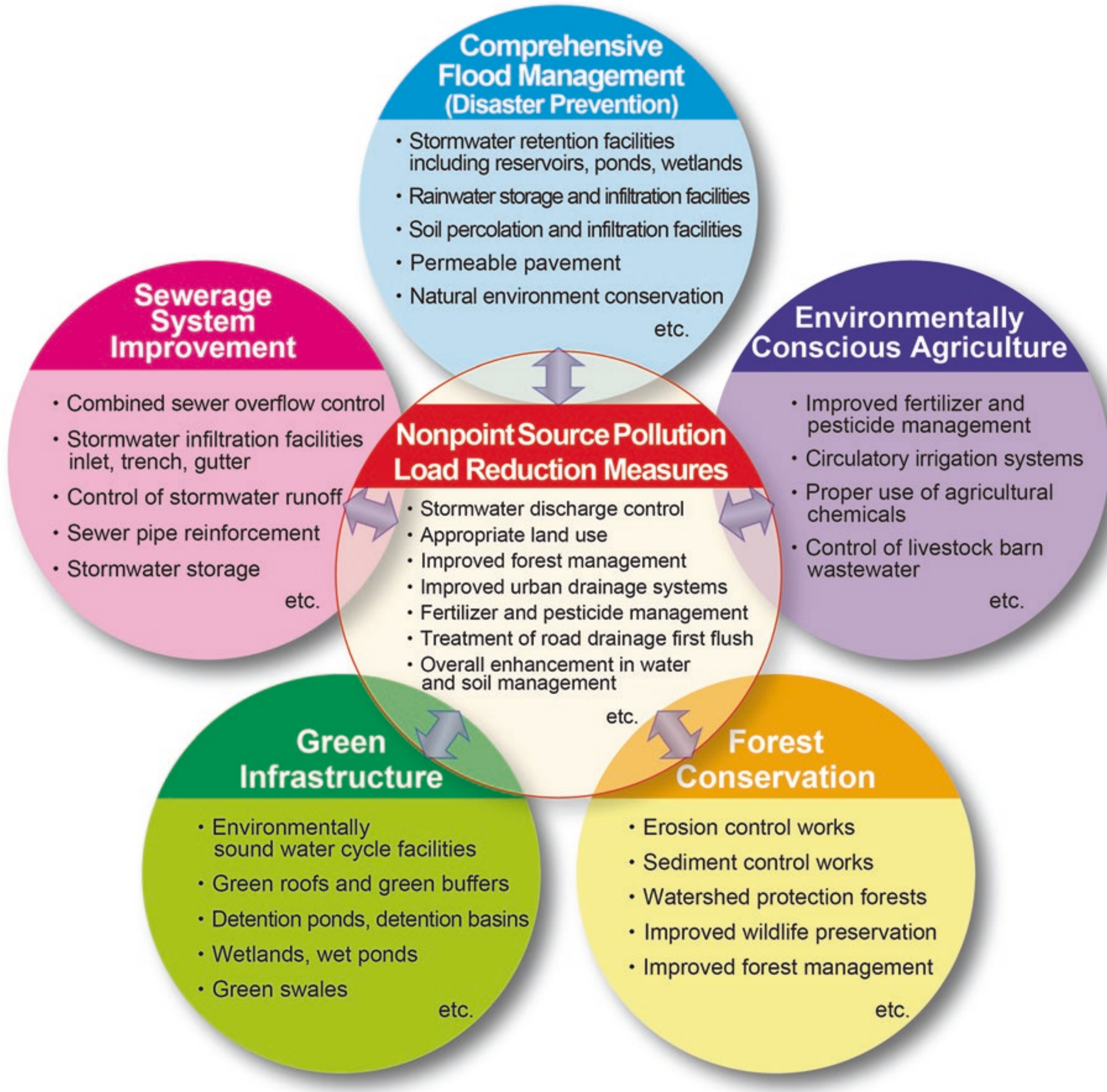



**Fig. 11**
**Multi-policy solution approaches for nonpoint source issues, a conceptual framework (prepared by K. Wada)**

integrates the risk-based floodplain management (section "From flood control to flood risk management: A Shiga Prefecture initiative") A section responsible for floodplain management in SPG took the lead and brought this exceptional attempt to successful initial steps for institutionalization. The Union of Kansai Governments (hereafter referred to as UKG), a regional legal government entity established in 2010 for dealing with hitherto unattended cross-jurisdictional basin management issues in the Basin region, is now attempting to adopt the scheme and also intending to expand the scope of this framework to environmental management and ecosystem restoration issues (section "The Kansai Initiatives in Integrated Rivers/Lake Basin Management").

## Government Responsibilities in Flood Control and Management

The responsible ministry in Japan for flood control and management is the Ministry of Land, Infrastructure, Transport and Tourism (MLITT). MLITT pursues its responsibilities under the River Law (being enacted and promulgated in 1896 as old River Law and then being replaced with the present River Law promulgated in 1964 and amended in 1997), and, under this Law, the Japanese rivers are classified into three categories. The first-class rivers are those rivers designated by Ministry of Construction (the current MLITT) as water systems especially important from the view of land conservation and/or national economy. The second-class rivers are those which do not belong-

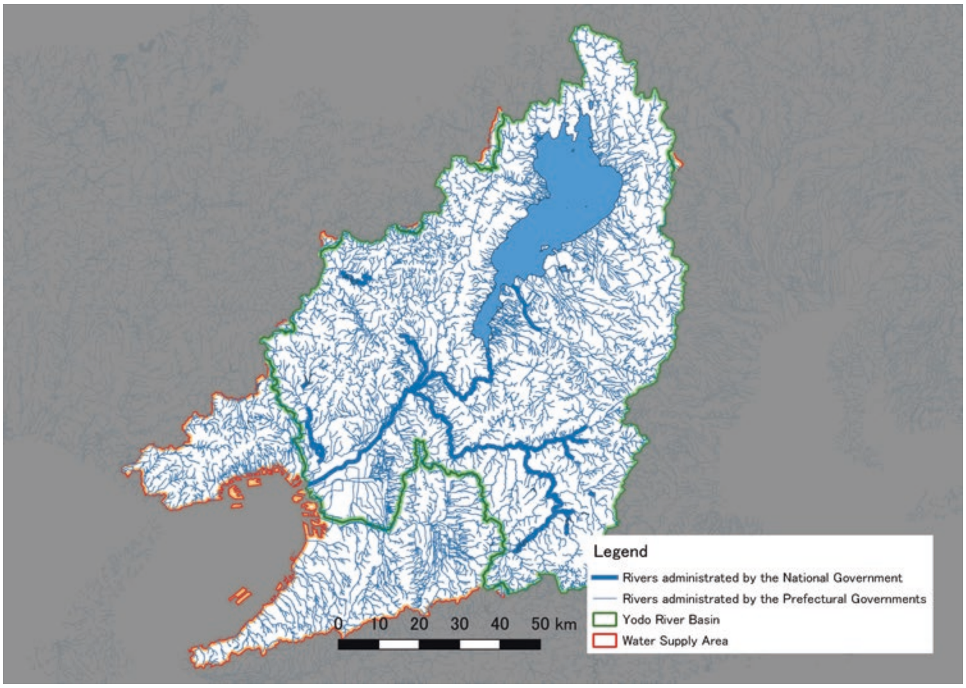



**Fig. 12**
**Administrative classification of rivers in the Lake Biwa–Yodo River Basin, GIS data source: The National Land Numerical Information Service, Japan**

ing to the first-class river systems but are designated as important by the prefectural governors. The rivers that do not belong to the first- and second-class rivers may be designated as important by the municipal mayors, being classified as locally designated rivers. The number of first-class rivers is 109 in Japan, of which the Yodo River system is also one, basically being administered by MLITT. In the Yodo River system, the downstream part of the Seta River Weir is under direct control of the MLITT, but Lake Biwa and the inflowing rivers are basically managed by the Governor of Shiga Prefecture. *Fig. 12* shows the division of the direct and designated section of the Yodo river system.

Within the flood protection plan of the Yodo river system, the target level of river improvement is determined according to the relative importance. Against the downstream part, where there are concentrations of assets that would potentially be adversely affected, the protection level for the middle upstream and the tributaries command lower levels of flood protection. This relationship is strictly observed even in the interim stages of implementing the river improvement plan. If improvement of the middle upstream and branch precedes, the downstream region will suffer from frequent flooding. The flooding risk is simply passed to the downstream region, which is not humanely tolerable. This is why the implementation level of flood protection in the downstream section is considered a high priority. It will be possible to implement flood protection in the middle upstream part and in the tributaries only after the protection plan is implemented for the downstream part to accept floods originating from the middle upstream part and the tributaries. Based on these principles, the allocation of the river improvement project budget is determined, balancing those for 109 water systems and for the upstream–downstream tributaries.

Shown in *Table 3* is the history of the modern flood control policy in Japan (Hori et al. 2008).

**Table 3**
**History of modern flood control policies in Japan**

| | |
|---|---|
| The 1st stage | Control the largest record flood of the subject river without any overflow by channel improvement and by construction of levees and reservoirs |
| The 2nd stage | Control the design floods by channel improvement and by construction of levees and reservoirs without any overflow. A given probable flood such as decade–year flood is considered as the design flood of the river. The flood level is defined for each river by using such indicators as basin size, population, and floodplain properties |
| The 3rd stage | Consider the measures to reduce discharge into rivers from the catchment area as one alternative, in addition to the measures to control the flood water in rivers |
| The 4th stage | Consider the overflow, caused by excessive floods, from the rivers, and take into account not only the basin–river system but also the floodplain in preparation for possible property damages |

In considering the recent trends in climate change and the decreasing population in Japan, Hori et al. (2008) recommend that the flood control policy stage be advanced to the fourth stage in *Table 3*.

## From Flood Control to Flood Risk Management: A Shiga Prefecture Initiative

The Lake Biwa–Yodo River Basin has had a long history of upstream–downstream conflicts with regard to the control of the Lake Biwa water level (Nakamura et al. 2012). While the upstream–downstream conflict seemed to have been mostly resolved after completion of Lake Biwa Comprehensive Development Project (hereafter referred to as LBCDP, the name has subsequently been changed to Lake Biwa Comprehensive Preservation and Improvement Project. or LBCPIP, also dubbed as Mother Lake 21), the specific plans and programs transpiring out of the LBCDP framework over the next decades were yet to be developed at the time of its completion. The specifics of the necessary plans and programs to follow through the LBCDP outcome had to be developed and implemented over the following decades. In particular, those to be included in the Yodo River Basin Management Plan with deep involvement of the Yodo River Basin Committee (referred to as Committee) established by the Yodo River Basin Management Bureau of MLITT were of critical importance. During the period of heated interactions between the Bureau and the Committee, many contentious issues resurfaced, not so much as the upstream–downstream conflict but more as mixtures of contentious relationships between the central government and the prefectural governments, between the soft alternative proponents (citizens, NGOs, progressive academicians including ecologically conscious natural scientists and social scientists, etc.) and the hard alternative proponents (conservative academicians including dam-proponent experts in water security and flood management disciplines), and even between the expert viewpoints and the lay citizen viewpoints, including those of vocal local politicians. These contentious issues could be regarded as having reflected the rather unsettling sociopolitical climate at the time in the whole Japan, with serious economic slowdown and the breakdown of traditional top-down hierarchical relationship between the national government ministries and the prefectural government. In a nutshell, the first decade after the completion of LBCDP was also a politically turbulent decade, shifting the political balance from centralization to decentralization.

In the midst of such turbulent years of post-LBCDP developments, one of the Committee members (Ms. Yukiko Kada) won the 2007 gubernatorial election for the Shiga Prefecture, running on a political plat form for decentralization of Lake Biwa–Yodo River management. Among a series of political initiatives, she took the political leadership for SPG to explore the viability of the fourth stage policy in *Table 2* above, for the reasons that the "structural" flood control approach will no longer be a viable option for the Prefecture in view of the budgetary constraints, depopulation, and climate change and in view that the Shiga residents have fallen into the trap of false security provided by structural interventions. After a few years of heated political exchange within the prefecture, further complicated by the strong sectionalism and bureaucratic behaviors of the SPG officials and the then-prevailing public sentiment that flood control ought to fall within the responsibility of government professionals rather than themselves, the integrated flood management policy involving the development of a new land use regulation was promulgated for the first time in 2011 in Japan by SPG.

The disaster risk management approach adopted was intended to reduce not only hazard but also exposure and vulnerability. The approach adopted by the Prefecture is consistent with the concept of Ecosystem-based Disaster Risk Reduction (Eco-DRR) and the Green Infrastructure, gaining much attention globally today.

The following is a brief explanation of what is called the Integrated Flood Risk Management (IFRM) approach developed by SPG.

(1) The Adding-Up Strategy

In 2006, SPG established a new office "Floodplain Management Office" and located it alongside the River and Port Division, as an addition to the Division whose responsibility traditionally was to control floods within the river channels, an orthodox concept for dealing flood incidents as stipulated in the River Law. Having been professionally so attuned to the traditional disciplinary approach, it was difficult for the Division staff members to assume more than their historical mission to control a particular flood within the river channel. The new office was tasked to undertake an additional aspect beyond the traditional flood control approach, i.e., to develop an approach for dealing with those flood incidents having greater return periods than the design period. The floods with such magnitudes would overflow the river channel perimeters and inundate the riparian lands or floodplains, and their management will have to be met by the floodplain management plans to be newly conceptualized, rather than by the plans resorting to the traditional structural approach of flood control. This "adding-up approach" taken by the then Shiga governor turned out to have successfully realigned the policy direction of such a very conservative government organization with strong bureaucratic culture as those being responsible for flood control, the issue domain involving human lives (Kada et al. 2010).

(2) Floodplain Management Basic Policy

The Floodplain Management Basic Policy (2012) describes the concept of the risk-based regulation for the land use and building in the floodplain.

(a) Flood Risk Indicator: Methodology for Evaluating Flood Risk

To conduct the in-floodplain countermeasures, the risk distribution should be estimated as a basic information. For the river administration, the performance index is the discharge capacity expressed in the annual probability of exceedance (*Fig. 13*).

SPG developed a numerical model to calculate flood risk (Taki et al. 2013). The calculation procedure is shown in *Fig. 14*. A drainage basin model was introduced to predict rainfall runoff, channel flows, and overtopping or breach flow processes. The drainage basin was divided into three zones (*Fig. 15*), i.e., zone 1 is a mountain area; zone 2 is a river reach with a drainage basin; and zone 3 is the main reach with a floodplain. The channel flow was evaluated both in zones 2 and 3 by means of 1-D governing

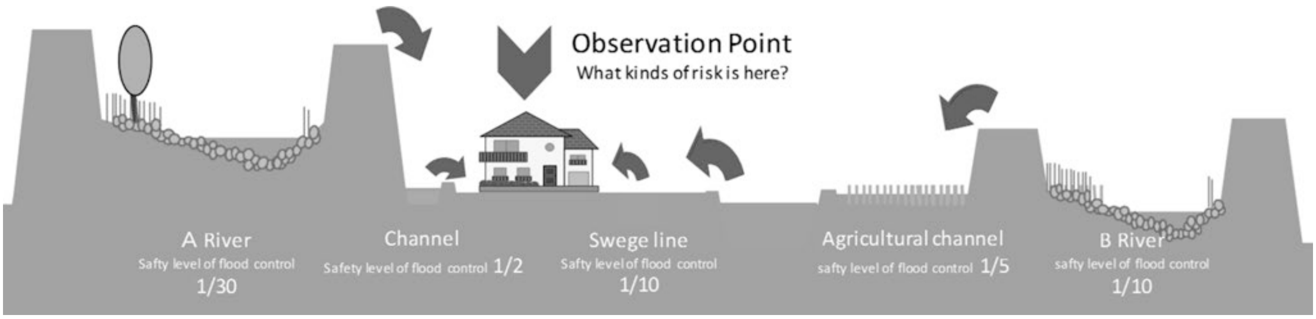



**Fig. 13**
**Flood flow from various sources – facility safety vs. on-site risk**

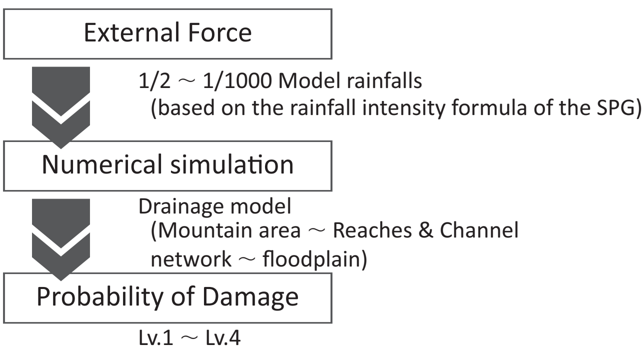



**Fig. 14**
**Calculation of flow**

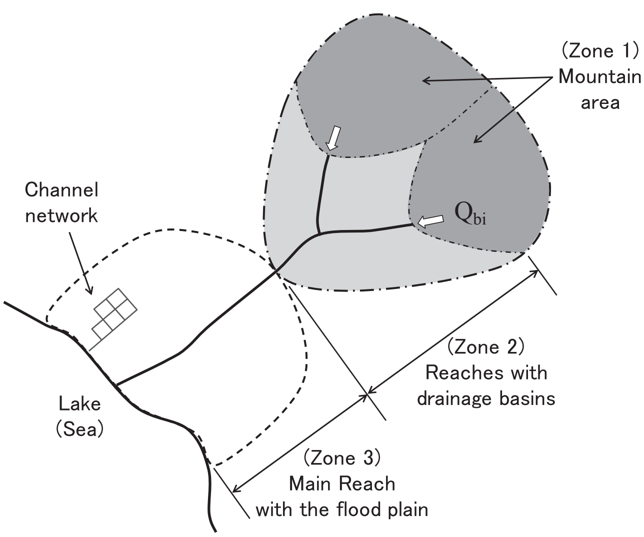



**Fig. 15**
**Schematic of drainage basin**

equations. In the floodplain of zone 3 and in the drainage area of zone 2, a depth-integrated 2-D governing equations were employed to predict flow depth, flow velocity, and fluid forces.

By computing the rainfall runoff and inundation process, the flood hazard risk of each mesh point will be specified in terms of a matrix element. SPG formulated the risk matrix as shown in *Fig. 16* from the space-time distribution of the various return period floods. The rows of the matrix correspond to the occurrence probabilities of various floods based on eight rainfall sizes. The columns indicate flood damage levels from 1 to 5. The risk matrix provides flood hazard risk maps reflected by flood risk at all mesh points in a floodplain. The flood hazard risk maps based on various rainfall events give useful information for promoting suitable land use.

The magnitude of damage can be classified into five levels: level 1 ($h \leq 0.1$ m) indicates no damage; level 2 ($0.1 \leq h \leq 0.5$ m) indicates damage from inundation below the ground floor of a building; level 3 ($0.5 \leq h < 3.0$ m) indicates severe damage from inundation above the ground floor; level 4 ($3.0 \leq h$) indicates fully submerged; and level 5 ($2.5\text{m}^3/\text{s}^2 \leq u^2h$) indicates completely destroyed. The probability of occurrence of each flood event was evaluated by means of its return period, namely, 2, 10, 30, 50, 100, 200, 500, and 1000 years, where $h$ is depth (m) of the inundation and $u$ is velocity (m/s). The term $u^2h$ means the "fluid force."

(b) Risk-Based Land Use and Building Regulation

The land use regulation is applied for Area A, based on the risk matrix (*Fig. 16*), where the expected damage frequency is determined, for example, as 0.5 m and over inundation for a 10-year flood. The zone is prohibited from inclusion in the urbanized promotion area stipulated by the City Planning Law. Moreover, building regulation is applied for the Area B on the risk matrix (*Fig. 16*), where severe damage frequency is expected, for example, as 3.0 m and over deep inundation for a 200-year flood. The Shiga governor designates the Area B as the

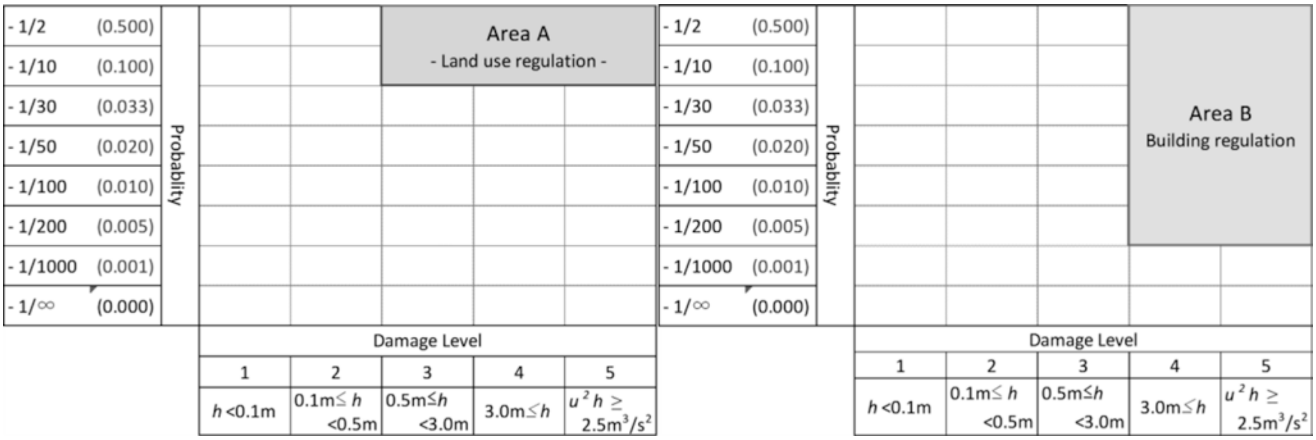



**Fig. 16**
**Land use/building regulation area in the risk matrix**

Flood Risk Reduction Priority Area. In cases where houses and/or apartments are already located therein, the resident's agreement must be acquired as a binding condition. In the area where the expected flood level exceeds the stipulated flood level, the new buildings must have a room for evacuation.

Area A ( $h \geq 0.5$ m by 10-year flood ) – Frequent damage

No one can expand the urbanization promotion area without elevating land over the flood level.

Area B ( $h \geq 3.0$ m or $u^2 h$ by 200-year flood ) – Severe damage

No one can build houses without a shelter over the flood level at least.

In Shiga, the wetlands will be protected by such a risk-based land use and building regulation. In fact, we firstly tried to evaluate the ecosystem value for wetland protection, instead of the flood risk evaluation (*Fig. 17*). Despite a few years of effort, unfortunately, we were unable to find any legal basis in Japan to set restrictions on private properties, based on the assessed ecosystem service values.

## The Kansai Initiatives in Integrated Rivers/Lake Basin Management

(1) Union of Kansai Governments

SPG formulated the basic policies for IFRM in 2012. Then a new regulation was enacted in 2014 to ensure its effectiveness. The regulation gave SPG a forceful tool to conserve wetlands in Shiga. Wetlands provide for rich ecosystems and also serve for reducing flooding risks by storing the flood water and moderating the downstream water level rise. Therefore, such a risk-based approach for flood management is an effective approach to conserve wetlands, making this SPG approach an exemplary case of Eco-DRR, which also constitutes an important component program within the Comprehensive Flood Management (disaster prevention) cell of the illustration entitled "multi-policy solution approaches for nonpoint source issues" shown in *Fig. 11*. In the meantime, the above approach began to be more and more accepted through the prefectural political process, and even by MLITT, which itself was facing a shortage of national project funds and was inclined to shift toward a nonstructural approach. At the same time, the IFRM model was considered to be one of the key policy measures to adopt for the entire Lake Biwa–Yodo River Basin within the Union of the Kasai Local Government (UKLG) that came into being in 2010, with seven prefectures in the Kansai region as its members.

UKLG was born as the first wide-area (trans-prefectural) union of local governments in Japan. Its role is to focus on the common aspirations of the member prefectures to provide the necessary trans-prefectural local services to the population across the Kansai region, making best use of common institutional and administrative approaches. As it turned out, in finally developing the Union concept, very extensive studies were carried out by the preparatory office on the already existing overseas cases of unions of local governments as well as that of national governments, including the European Union established in 1993.

In accordance with the legal provisions, UKLG can enact legislation in pursuit for noncontentious common objectives, such as provision of public services as mentioned above, and enhancement of environmental and ecosystem improvement and disaster prevention and management, the key subject areas of integrated management of Lake Biwa–Yodo River Basin. The Union initially set seven areas for region-wide administrative action, i.e., disaster preparedness, promotion of tourism and culture, industrial promotion, healthcare services, environmental conservation, staff training, and certification examinations

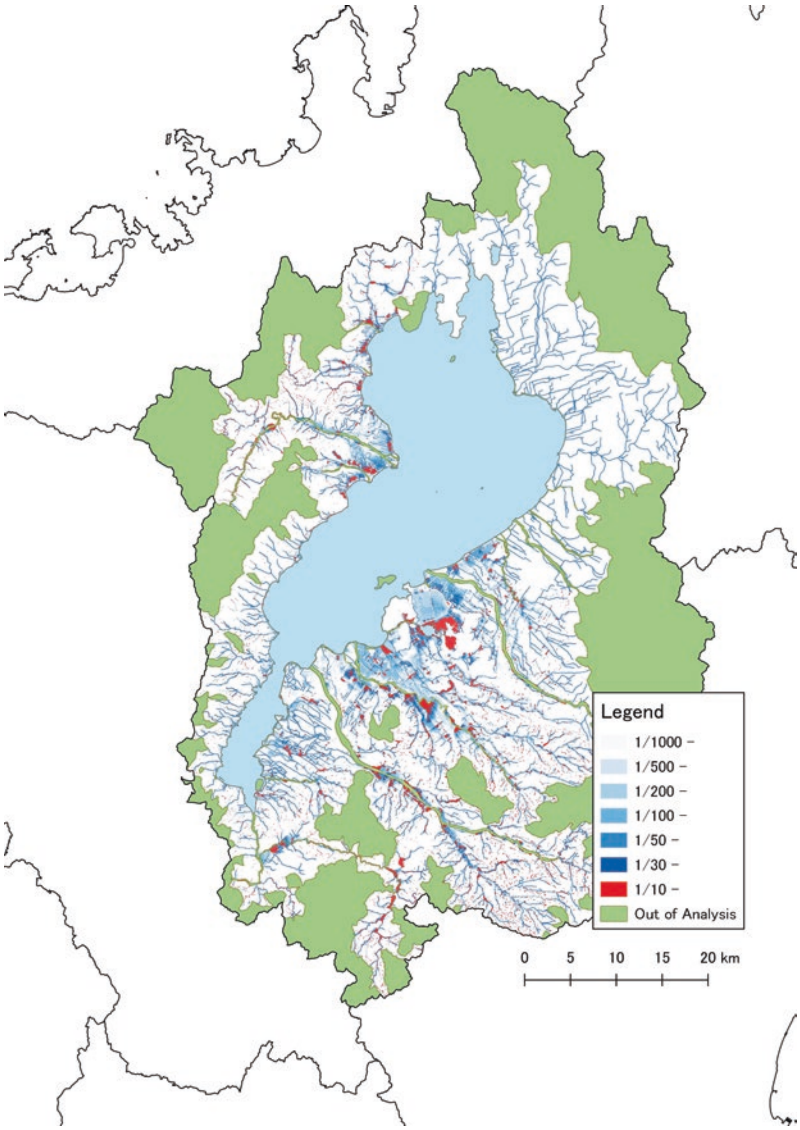



**Fig. 17**
**Annual probability of flooding above floor level (level 3, H≥0.5 m) [red-colored area corresponds to area A in the risk matrix], Base map GIS data source: The National Land Numerical Information Service, Japan**

**Table 4**
**Members of the Union of Kansai Governments**

| | | |
|---|---|---|
| Established | December 1, 2010 | |
| Member | Prefecture | Shiga, Kyoto, Osaka, Hyogo, Nara, Wakayama, Tokushima, Tottori |
| | Major city (ordinance-designated) | Kyoto, Osaka, Sakai, Kobe |
| President | Toshizo Ido (Governor of Hyogo Prefecture) | |

and licensing. As of today, eight prefectures and four major cities participate in UKLG as identified in *Table 4*.

After a range of projects were implemented with success, UKLG initiated a new project, i.e., the implementation of the above Integrated Lake–River Basin Management System adopted by SPG for the Lake Biwa Basin to be promoted in the whole of Lake Biwa–Yodo River Basin, as presented below in (2).

(2) The Lake Biwa–Yodo River Basin Management Committee

UKLG launched in 2014 an expert group on Lake Biwa–Yodo River Basin called the Lake Biwa–Yodo River Basin Management Committee (BY-BMC). BY-BMC's assigned tasks were two, i.e., one to review and formulate a conceptual framework for the governance of Lake Biwa–Yodo River from a basin-wide perspective and another to undertake a feasibility study of the "Integrated Lake–River Basin Management" implementation scheme. BY-BMC consists of representatives from academic institutions in the Kansai region, with professional background on river engineering, water environment, ecology, risk management, sociology, and water policy. Through 2 years of intensive discussion, BY-BMC submitted a report to the Governor of Hyogo Prefecture who is also the UKLG President, proposing a practical approach to resolve such emerging issues facing the basin society as increased flood/drought risks, ecosystem deterioration under global climate changes, and population declines in the region.

(3) The Lake Biwa–Yodo River Basin Challenges Identified as Priority Issues for Study by UKLG

BY-BMC also pointed out eight subject areas listed below as being the major challenges faced by UKLG, as follows:

1. Promotion of Integrated Flood Management and River Improvement
2. Dissolution of multiplicity of water supply systems improving financial and service performances
3. Conservation of groundwater
4. Rehabilitation of aging water infrastructure
5. Restoration and improvement of overall ecosystem service of UKLG region
6. Promotion of comprehensive sediment management of Yodo River Basin
7. Strengthening of the regional water crisis management
8. Restoration of locally specific water culture and enhancement of the upstream–downstream relationship for mutual benefit

The issues included in the above list have somehow either been difficult for or left out of the traditional government sectors working in the compartmentalized government structure. They are also the kind of issues lost in the maze of compounded responsibilities or are being considered as fringe issues. The improvement of basin governance, with enhancement of individual efforts and collaboration and cooperation among diversified actors, is becoming extremely important. UKLG proposed that BY-BMC continue to guide the studies to be undertaken by technical subgroups to be formed for the list of issues on a priority basis.

## Enhancement of Risk Management Through Basin Governance Improvement

As referred to Subsection "Historic transformations of the Biwa–Yodo Basin" and the earlier subsections in section "Evolving Basin governance for Integrated Flood Risk Management", management of a lake–river–bay system such as the Lake Biwa–Yodo River–Osaka Bay Basin has evolved through thousands of years of human–nature interactions cumulated as historical experience in dealing with floods, water resource acquisition and discharge, as well as environmental and ecosystem services. As a result, it is quite unlikely that there could suddenly be dramatic modifications/alterations of the historically acquired management approach. Taki et al. (2010) made a proposition in reference to the real-world applications of the concept of IFRM by SPG that "it is most appropriate to consider that the already existing river improvement plans and programs (the range of obligatory responsibilities in river management) be firmly set as given and unchanged, and to only add a separate, additional and new dimension of policy objective (e.g., floodplain management in the case of flood control) that can fulfill the necessary increment." In other words, to realize integrated management of a river–lake basin, it makes much more sense for the concerned stakeholder organizations to collaborate, rather than to be institutionally united, in order for them to jointly identify possible areas and approaches for collaboration on subjects of emerging importance. In other words, it makes more sense to aim at enhancing the overall governance of the collaborating members without being too preoccupied about the individual member's exclusive mandates and the delineated areas of responsibility. Such approaches will facilitate a better chance for consensus building. Noting that, even within the same river basin, it is easy for the sub-basin communities to exert their own concerns (perceptions) to be far too different from others, depending on where they are located, i.e., upstream/downstream, left bank/right bank, or what standpoints they take on issues of concern, e.g., development vs. conservation; the basin society has to strive to share a common vision (future image) to be able to overcome the differences for achieving the common goal. Such efforts are indispensable, regardless of how the government organizations undergo changes or how the financial resources are reallocated. *Figure 18* shows a conceptual sketch of a cyclic process for consensus building for reaching a single consented resolution.

In addition, as shown in *Fig. 19*, in one cycle of efforts to solve the problem, each river basin component such as administrative departments, NGOs, private enterprises, local residents, etc. ① confirmed the current situation on a watershed basis, ② recognize issues that are manifesting, ③ set frameworks and policies for collaboration and collaboration, and ④ cooperate and collaborate by related parties. Then return to ① to undertake improvements and initiate the next task. This cycle can proceed simultaneously by the number of tasks, and it is difficult to reach complete voting in one cycle. Rather, it is better to consider moving forward from where you can while constantly repeating this cycle.

To encourage such an upward spiral process effectively, a "stagehand," who can integrate available knowledge and intelligence of society and environment in the basin, should be required. According to the committee report, the "stagehand" takes the five roles according to the step of the spiral-up process, as follows:

A. Accumulate knowledge and intelligence of basin environment and society.
B. Present state analysis and subject extraction.
C. Propose possible resolution or alternatives.
D. Prepare the table for discussion between stakeholders.
E. Compile a sharable vision successively.

The BY-BMC report suggests the administrative organization from UKLG to be more a "stagehand" for the Integrated Lake–River Basin Governance than the actual implementation organi-

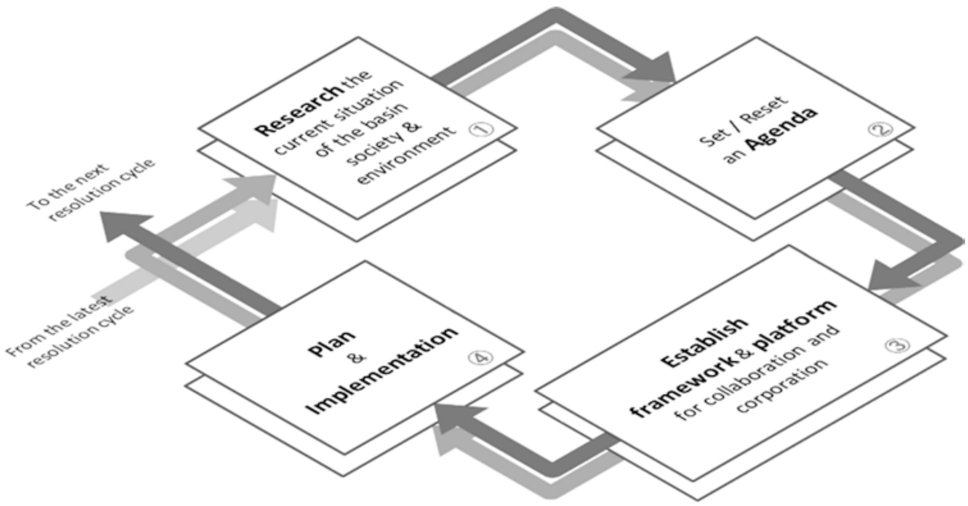



**Fig. 18**
**A cyclic process for a single resolution**

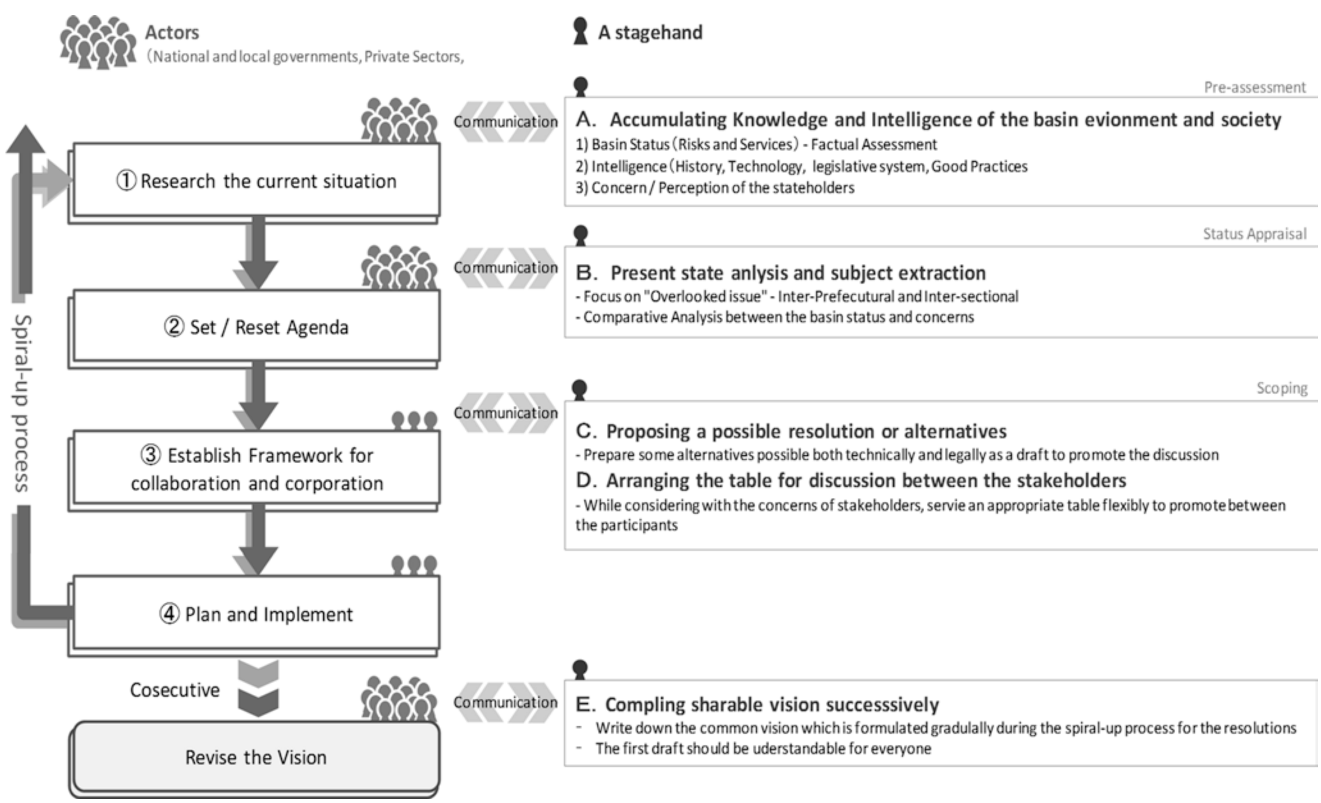



**Fig. 19**
**Governance cycle for the Integrated Lake–River Basin Management in the Lake Biwa–Yodo River Basin**

zation. UKLG was advised to form expert groups to work on some selected topics on a pilot project basis. UKLG should also conduct basin-wide status reading and mapping assessments. The indicators evaluated in the multi-scales give various incentives for action to the basin actors, including individuals, NGOs, private sectors, cities, prefectures, and national governments.

## Evolving Basin Governance of Participation: Communities and Citizens

This section discusses the history of paddy agriculture as related to the Biwa–Yodo Basin governance in Subsection "Historical implications of paddy culture as a basis of Basin governance", the results of survey by the general public in the Shiga Prefecture and downstream region on the value of Lake Biwa in Subsection "Conflicts, contentions, and collaboration: A recent Lake Biwa history", some historical reflections on LBCDP for the Shiga general public in Subsection "Citizen awareness about the value of Lake Biwa: The perceptional gaps", the concept of subsidiarity in lake–river basin management in Subsection "Basin governance and the principle of subsidiarity", and the approach SPG has adopted in the management of Lake Biwa, the so-called the Lake Biwa Model in Subsection "Participatory governance: A Lake Biwa model?".

### Historical Implications of Paddy Culture as a Basis of Basin Governance

The Japanese political, socioeconomic, and cultural institutions have revolved around the Emperor system infused with Shintoism and Buddhism that gradually took shape during the classical period (592–1185) and the feudal period (1185–1603). The infused institution was supported throughout the period by the autonomous and tax-free manors called Shoen estates that were owned and controlled by the Shinto shrines and Buddhist temples, as well as by the Emperor palaces. Toward the middle of feudal period, the Shoen estates themselves grew more and more independent and began to invite the rise of local military clans. In the meantime, during times of severe floods and droughts, widespread famines and catastrophic epidemics exasperated by water use conflicts were not uncommon within and among the Shoen estates. The relocation of the Emperor's palace (the capitol) from Osaka, Nara, Kyoto, and Otsu and back to Kyoto areas during the period between the seventh and ninth centuries is believed to have been caused by these water-related famines, epidemics, and conflicts.

The management of the Shoen estates in the classical period was to entrust the management authority to the village chief controlling his subordinate peasants, which together were overseen by the landlords representing the temples, shrines, and palaces. As time passed, this entrusted power structure of the Shoen estates gradually eroded due to the increasing social disorders and unrests caused by meager crops lobbed, for example, by local clan intruders and outcast peasants. Thus, the Shoen-based social power structure gradually got replaced by the paddy farming village power structure; autonomous self-regulating system, with stringent community rules to deal with crime control; trans-community conflicts; paddy infrastructure development; management and maintenance of irrigation infrastructure; as well as flood control and drought management. These villages were called "Soh-son." The word "Soh" means "all members" and "Son" means "villages."

Nonetheless, the Shoen system underwent further transformation during the Kamakura shogunate (1191–1333, the capitol located in Kamakura), Muromachi Era (1336–1573, the capitol located in Kyoto), and Azuchi-Momoyama Era (1573–1603, the capitol located in Azuchi and Kyoto) still maintaining the important power base for many local lords. The feudal system got firmly established in Tokugawa shogunate (1603–1868, the capitol located in Edo, current Tokyo) with the Daimyos (the loyal local lords) more or less having taken over the Shoen system. During this period, the paddy farming villages were made to submit the yearly harvest of rice as tax to the Daimyos and the Shogun in return for the protection of the villages. The Yodo River region (the current Kyoto and Osaka regions, collectively called Kinai (meaning "close to the capitol," consisting of Yamato, Izumi, Kawachi, Settsu, Yamashiro territories)) and the Lake Biwa region (called Ohmi territory, part of Kigai or "outside of the capitol region) were very much under constant power struggles. Under such circumstances, the paddy farmers were continuously suffering from crop failures caused by occasional floods and droughts, particularly in the more rural Lake Biwa region. The sufferance of paddy farming villagers was doubly strained because they had to pay their annual rice tax or tribute even in years of meager harvests. Also, throughout Lake Biwa and Yodo River regions, particularly in the fifteenth and sixteenth centuries, there were frequent water conflicts between the upstream and downstream villages and occasional revolts against the wealthy merchants working for the local Daimyos. With no financial and technological resources, the villagers were able to undertake only minor river improvement works. In the Ohmi region, the villagers were further discouraged to undertake any improvement works that might increase the discharge from the Seta River to downstream. Such works would increase the flooding risk in the wealthier and more populated downstream Osaka, the thriving commercial center as well as the political and military power center.

In the meantime, in the Ohmi region, it is said that the "Soh-son" culture (the self-regulating management for paddy farming with stringent community rules having gradually superseded the Shoen-based system of external control) somehow persisted more prominently in the absence of strong local loads, thus allowing the individual "Soh-sons" (Noda 2016) to be rather independent. A characteristic of the Ohmi region also was that the paddy agricultural practices were dramatically affected by the lake-level rise (causing flooding along the lake shore and along and around the inflowing river watersheds) and fall (as a consequence of droughts). The village chiefs and other leaders such as Buddhist monks from local temples continually petitioned to the Tokugawa shogunate for large-scale dredging and channel improvement of the Seta River whenever large-scale flooding took place. However, no major intervention was carried out during the Tokugawa shogunate. In addition to the increased flooding risk, such interventions would defy the military strategy to keep the river beds shallow for the Kinai soldiers (defending the shogunate) to be able to walk across the Seta River to quash any uprisings around and beyond the Ohmi region. Thus, the above "Soh-son" culture had to be firmly passed on for generations to deal with various water-related calamities at the village levels, implicitly even to the current time(Noda 1995). The long-time residents in Shiga tend to identify their affiliation more with Ohmi than with Shiga because of their acquired sense of individual roles and responsibilities in times of cultural and religious festivities, all related to the collective responsibilities to carry out the village traditions in firefighting, flood disaster prevention, water and crop management during the rice planting and harvesting seasons, etc.

## Conflicts, Contentions, and Collaboration: A Recent Lake Biwa History

After many centuries of procrastination by the downstream powers represented by the Tokugawa shogunate, in connection with the extraordinary large-scale flooding events of 1885 and 1889, the post-feudal Meiji Government (1868–1912, the capitol located in Tokyo) undertook dredging of the outflowing Seta River from Lake Biwa and installation of a weir at Nango in 1905. The combined discharge capacity increased from 50 to 200 $m^3$/s and later to 400 $m^3$/s with further dredging, successfully reducing the flooding frequency in subsequent years, as described in Subsection "Government responsibilities in flood control and management". On the other hand, the primary purpose of the construction of the Nango Weir was for flood control, not water resource development, and the drought-related conflicts along the inflowing rivers to Lake Biwa continued until as late as 1932. The manually operated wells began to be replaced with electrically operated wells from about the 1920s. Nevertheless, the problems still lingered in both the Lake Biwa watershed and in the downstream Yodo River. In the case of former, there was still frequent fighting over the irrigation water rights among the neighboring villages during droughts. An inter-village water fight broke out along the Inukami River, resulting in ten villager deaths. Some 300 from the police force intervened for 3 days before it ended with a great deal of animosity. This incident led to the local and national government decisions to reform and modernize the paddy irrigation systems in the Shiga Prefecture. The Inukami dam subsequently constructed in 1946 was the first irrigation dam in Japan, while the national irrigation modernization project also began in 1947 along the Yasu River and in its basin. The irrigation modernization projects thereafter contributed to the gradual reduction of agricultural water conflicts in the Shiga Prefecture and consequently reducing the need for the self-governance of paddy villages (Noda 1995).

During the years between the 1900s and the 1960s, the increased water demands in the downstream Osaka area had to be met mainly by an increase in the number of wells. Such an increase resulted in extensive land subsidence due to the groundwater overdraft, causing a serious risk of coastal inundation. The Nango Weir was replaced by the Seta Weir in 1961, increasing the discharge capacity from 400 $m^3$/s to 600 $m^3$/s and also for meeting the growing water demand in Osaka and other downstream population centers along the Yodo River. In the succeeding years, the demand for water in the Greater Osaka area further increased, particularly to provide water for the Osaka Bay industrial belt zone for the development of heavy industries such as ship building, iron and steel mills, allied chemicals, and paper and pulp manufacturing. After several years of contentious disputes between upstream Shiga and downstream Osaka, LBCDP was finally agreed and launched in 1972, with the agreement that some 40 $m^3$/sec of Lake Biwa water would be sent down to the Yodo River during times of severe droughts, that the discharge capacity would be increased to 700 $m^3$/s for flood control downstream, that around-the-lake levees would be constructed for flood control around the lake, and that various environmental conservation measures would be introduced for improving Lake Biwa water quality (Nakamura et al. 2012). The historic upstream–downstream conflict involving the whole of the Shiga Prefecture (the Ohmi region) and the whole of the Yodo River downstream seemed finally to be resolved in completing LBCDP. Unfortunately, things were not that simple.

For one thing, another kind of Lake Biwa conflict emerged soon after the inauguration of LBCDP. This time a group of environmentally conscious citizens and scientists in the Lake Biwa and Yodo River regions sued the federation of national and local governments (i.e., Shiga Prefecture; Osaka Prefecture; Central Government; Water Resources Development Cooperation) in 1976 that implementation of LBCDP by the governments would bring about irreversible environmental and ecosystem degradation for Lake Biwa and would not be beneficial for the Lake Biwa–Yodo River society as a whole. After numerous rounds of hearings and field studies, the court case was closed in 1989 in favor for the defendant body, with the final ruling stating basically that the LBCDP shouldn't be regarded as detrimental to the society, since the potentially accruable LBCDP benefit to society, in terms of the greater quantity of water resources and the reduction of flooding risks and associated damages, far exceeded the environmental and ecological impacts to the lake and its shoreline ecotone zones.

It took 25 years (1972–1997) to complete the LBCDP, after two extensions of duration, from 1982 to 1992 and then from 1992 to 1997. The LBCDP infrastructure development for water resources had already been completed by 1997, despite the fact the above economic decline significantly altered the profile of the region's water resource needs. By then, however, many of the heavy industries in the Osaka coastal industrial belt zone had already moved out of the country or changed their operational practices to save energy which in turn reduced their water uses. Thus, the prediction of water resources development needs that formed the very basis of LBCDP was no longer valid. The above two cases (the historic upstream–downstream conflict on the management of Lake Biwa flood waters for one and the short-lived conflict on the LBCDP impacts on Lake Biwa environment for another) are quite unique contextually, but they also suggest many important lessons learned for other similar lake–river cases elsewhere.

LBCDP has facilitated the necessary economic development and environmental conservation infrastructure in the Lake Biwa watershed region (i.e., the Shiga Prefecture jurisdictional area). It has benefitted the Shiga Prefecture in terms of local economy and environmental amenity enhancement (e.g., lakeside amenities such as ports and harbors, lakeside parks, agricultural land improvement, afforestation, the levee cum ring road around the lake, etc.). The housing amenity improvements, particularly with much larger land parcels served with good water supply and sewerage coverage, have also attracted the migration of people as well as business operations to the Lake Biwa region from the Greater Osaka region. The general public and the media, although having been intensely drawn to the court case deliberations some 10 years before, also took the court decision for granted. Compared to the pre-LBCDP era, the Shiga Prefecture population has increased almost twofold. In other words, the social and demographic structure has been dramatically altered from a pre-LBCDP outdated parochial living by the indigenous residents, to a post-LBCDP suburban lifestyle by the migrant populations enjoying both the newly created economic opportunities and the abundant environmental amenities. The general public therefore was not about to complain about the LBCDP accomplishments in general, i.e., improved economic status and environmental amenity improvement in terms of lakeshore park developments, improved roads, new leisure and recreational facilities, and the like.

LBCDP also included many structural and nonstructural component projects for the improvement of Lake Biwa water quality, including development of four regional wastewater systems encircling the lake. Over the course of the project duration between 1972 and 1997, however, such projects brought about only minor improvements in lake water quality, not to mention improvements in ecosystem health. On the contrary, the LBCDP structural projects for water resource development and flood control, such as construction of around-the-lake levees; excavation of roads for laying sewer pipelines underneath; transformation of the traditional cascading irrigation to the pipeline irrigation; consolidation of smaller, individually owned paddy lands to larger parcels to allow the use of agricultural machineries; transformation of forest and agricultural lands to housing and industrial estates, etc., all contributed to the deterioration of ecosystem integrity. This dramatic change in the profile of the Lake Biwa watershed, now very urbanized and industrialized, also meant the ecosystems which used to provide prolific fish habitats have been lost. During the same period, quite extensive land loss of the paddy wetlands also occurred along the lakeshore.

In addition, there were totally unexpected and unaccounted for incidents about Lake Biwa that took everyone by surprise. They are both related to the lake water level established anew in the LBCDP design for meeting its flood control and drought management objectives.

The first incident pertains to the record drought of 1994, when the lake water level fell down to minus 123 cm, breaking the previous all-time low of minus 103 cm that took place in 1939. The drawdown of the lake water level, exhibiting the extensive dried-up lake bottom, particularly in some parts of the Northern Basin, leading to extensive die-offs of benthic flora and fauna, causing a tremendous foul odor along the shore. In addition, this drawdown may have triggered the sudden explosive growth of certain macrophytes of an exotic nature (e.g., *Elodea nuttallii* and *Egeria densa*) and of indigenous nature (e.g., *Ceratophyllum demersum* and *Hydrilla verticillata*) in the Southern Basin, which persisted over the following decades to the present date.

The second incident pertains to the impacts of new operational rules for the Seta Weir that began in 1992. The agreed operational rule set forth in LBCDP to meet the flood control and drought management needs began to cause a noticeable decline in the natural spawning of the cyprinid fishes. Obviously, the spawned eggs would dry up if the operational rule to raise or lower the weir gates is followed, adversely affecting the Lake Biwa fishery. The above two cases remind us of the views expressed by the plaintiffs in the court litigation case discussed in Subsection "Historical implications of paddy culture as a basis of Basin governance" that the lake would gradually be transformed more and more into an artificial reservoir and would inflict serious long-term consequences in terms of the lake ecosystem deterioration, actually seemed to have been proven generally correct.

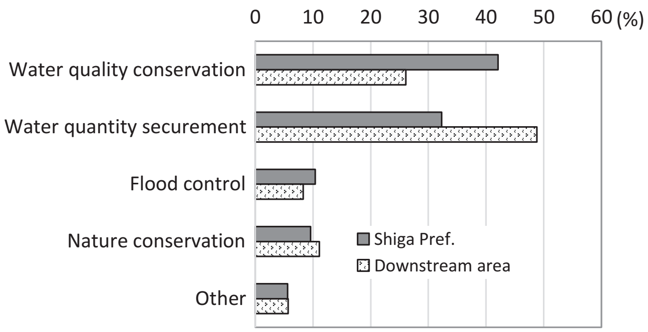



**Fig. 20** The difference in the awareness level between the Shiga Prefecture residents and the downstream Yodo River residents (Noda 1995)

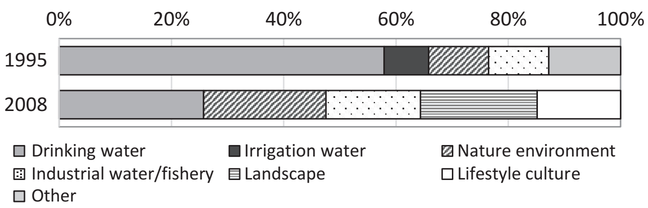



**Fig. 21** The difference in residents' awareness between 1995 and 2008 (Noda 1995; Shiga Prefectural Government 2008)

## Citizen Awareness About the Value of Lake Biwa: The Perceptional Gaps

In the contemporary context of managing a river–lake coastal basin, the term "participation" is associated with such terms as "citizen" and "community." The definition of participation is provided also in relation to the degree of mutual influence, for example, information sharing (one-way communication), consultation (two-way communication), collaboration (shared control over decisions and resources), and empowerment (transfer of control over decisions and resources), in the ascending order of extent (ILEC 2005). Several observations elaborate on the governance challenges facing the Lake Biwa–Yodo River Basin. In the case of the Shiga Prefecture, the residents are quite aware of the importance of Lake Biwa, not only as a source of water but also as a living ecosystem as well as a fishery ground. Although not as contentious an issue as in the past, the gap in the sentiment about the value of Lake Biwa between the Lake Biwa residents and the downstream Yodo River residents is rather significant, as illustrated below in the survey results on the subject.

Q1: How do the awareness levels of citizens and NGO/NPO members in Shiga Prefecture differ from those in the downstream prefectures?

Shown in Fig. 20 is the result of a survey undertaken in 1995 in connection with a record drought of 1994, involving a sample population of 3380 residing in the Lake Biwa–Yodo River Basin that are more than 20 years old. It shows, for example, that regarding the most important issue facing Lake Biwa, a significantly greater number of sample population in the downstream region considered "securing adequate amount of water" as being most important, compared to the fact that a significantly greater number of people in the Shiga Prefecture considered "conservation of lake water quality" as being most important. The preference structure in the downstream region and in the upstream Shiga Prefecture was totally opposite between the two respondent groups (Noda 1995).

Q2; How does the structure of priority concern in the value of Lake Biwa differ between 1995 and 2008?

*Figure 21* shows the result obtained from a questionnaire survey on the Lake Biwa water use categories undertaken in 2008 for a sample population of 3000 (Shiga Prefectural Government 2008), compared against the result obtained from a similar questionnaire survey undertaken in 1995 for a sample population of 2000. As it turned out, while the Shiga residents placed the greatest emphasis in 1995 on the quality of water to be used for drinking, agriculture and industrial activities, the 2008 survey results show much greater emphasis on the quality of water for fisheries, natural environment, and landscape as well as a culturally fulfilling life.

Based on the study conducted on the relationships among the number of years of residency significantly affected "the amount of knowledge about Lake Biwa" and also "affectionateness to the nature and Lake Biwa" and "the magnitude of human ties," with these three factors influencing the assessment of nature, as well as the waterfront environment (Hirayama and Wada 2016). In addition, it was revealed that the environmental enhancement activities promoted by the local citizen associations play an important role in encouraging the newly settled residents to mingle together with the long-term residents, providing opportunities for them to actively participate in the lake environmental-related activities (Hirayama et al. 2012).

## Basin Governance and the Principle of Subsidiarity

The concept of "Principle of Subsidiarity" is defined "as the idea that a central authority should have a subsidiary function, performing only those tasks which cannot be performed effectively at a more immediate or local level" (European Parliament 2012) It originates from the Catholic teaching "that individuals can only develop freely in society when what they can accomplish by their initiative is not given or taken away from them by a higher authority" (Evans and Zimmermann 2014) but became well known since "it was formally enshrined by the Maastricht Treaty" that formed a basis for the establishment of the European Community, later transformed to the European Union. In the inauguration of UKLG presented in Subsection "The Kansai Initiatives in Integrated Rivers/Lake Basin Management", the Principle of Subsidiarity theme of the Maastricht Treaty of 1992 was referred in its preparatory study. The details of that particular study are not available, but a similar study was carried out by National Institute for Research Advancement (NIRA) (n.d.) on the ideal wide-area local government system in a decentralized society (i.e., on the federal system and the "doshusei" regional administrative system in Japan). The study indicated that "These debates (having taken place in Japan thitherto) typically centered on 1) the need to reform the prefectural governments; 2) the structure of the regional administrative system and management of the prefectural system (two-tier vs. three-tier system, etc.); 3) distribution of power between the central and the prefectural governments; 4) the redistribution of tax resources and the improvement of financial efficiency; and 5) local demarcation."

In the meantime, the Principle of Subsidiarity was implicitly included in the presentation of the nonpoint source pollution issues in Subsection "Evolving governance in managing point and nonpoint source pollution" as a crosscutting concept of this chapter. In connection to this subject, Pezaros (2001) writes, "From the point of view of competence, the intervention of the EU in environment is based on the *Subsidiarity Principle*." This phrase implies, to a great extent, reduction of agricultural nonpoint source pollution, particularly from "the over-use of chemical fertilizers (nitrates, phosphates, potassium-based), …." The same light may be shed on the nonpoint source water pollution issues in the Lake Biwa–Yodo River as presented in Subsection "Beyond the conventional approach". For example, the paddy agricultural farmers in the Shiga Prefecture are provided with SPG policy guidelines to reduce the amount of highly contaminated (with fertilizers and paddy soil particles) irrigation return flows back into Lake Biwa. Among the policy guidelines is an ordinance enacted in April 2003 to certify environmentally conscious farming. Under the ordinance, the farm products would be certified if they were produced using 50% or less of the fertilizer amount used by conventional farming (Japan for Sustainability 2005). This unique agro-environmental policy of SPG is a case in point of the Principle of Subsidiarity. Although gradually spreading across Japan, the adopted policy by SPG is still an exception rather than the rule. SPG has the opportunity for two policies to increase their mutual affinity to synchronically contribute to the basin governance enhancement in future.

In addition, the usefulness of promoting IFRM and other pending list of activities described under subsection "The Biwa–Yodo Basin Challenges Identified as Priority Issues for Study by UKLG" falls within the realm of the Principle of Subsidiarity. Stoa (2014), for example, states on the concept of Integrated Water Resources Management (IWRM) that "As a foundational element of IWRM paradigm, the rise to prominence of the Principle of Subsidiarity has paralleled the widespread adoption of IWRM itself." The conceptual definition of IWRM, "a process that promotes coordinated development and management of water, land and related resources, in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital systems …," is inclusive in the concept of IFRM.

In relation to historically fostered "community participation" culture in the Shiga Prefecture, a brief treaty of the medieval "Soh-son" paddy agricultural village system in Japan, and its specific reference to the Ohmi region (current Shiga Prefecture), was presented in Subsection "Historical implications of paddy culture as a basis of Basin governance". The feature of "Soh-son" village governance was that individual "Soh-sons" were pretty much independent in making their own political and administrative decisions while maintaining the mentorship received from their local shogunate clan representing the region. The two sides were, in effect, playing complementary roles in the overall governance of the region, functioning similar to the way the Principle of Subsidiarity is portrayed above. In the meantime, the subject of "community participation" is also related to the above Maastricht Treaty and the subsequent Aarhus Convention (i.e., the United Nations Economic Commission for Europe (UNECE) Convention on

Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters) adopted in 1998. There is an ongoing movement among the citizen groups considering the Japanese Government's position on "citizen participation" in environmental issues still being inadequate and that the Japanese Government formally become a signatory of the Aarhus Convention to make sure the citizens will be legally empowered to have access to a much broader range of information on the contentious issues. It has not yet taken place.

## Participatory Governance: A Lake Biwa Model?

Coincidental to the timing of LBCDP completion in 1997, major revisions were made on the River Law of 1964, the very law that provided the major policy guidelines for various water resources and flood control infrastructures during the previous decades. The Revised River Law of 1997 stipulates two new ideologies, the first being to "improve and conserve river environment" and the second being to "take into account the opinion of local residents" in developing and implementing the river management plans. Specifically, the law requires stakeholder involvement not only during the planning stage but also during the stage of operation and maintenance of constructed facilities. The promulgation of this 1997 Law, together with a series of other environment-related laws promulgated in the 1980s and 1990s, signifies the dawn of the era of environmental and ecosystem concerns with involvement of the public in managing rivers and their basins, a turning point from the era of large-scale infrastructure development that was widely pursued in the 1970s and 1980s, often accompanied by strong contentious sentiments among the environmental concerns.

In the meantime, focusing on the environmental and ecosystem concerns not adequately addressed within LBCDP, SPG was able to launch a post-LBCDP plan of its own in 2000 called the "Lake Biwa Comprehensive Preservation and Improvement Project (LBCPIP), " dubbed as Mother Lake 21 Plan (ML21 Plan), being assisted by six national government ministerial and sub-ministerial agencies. In the introductory part of the plan, it states the need for post-LBCDP needs as "…, during the last phase of the LBCDP, SPG began to consider how to ensure the comprehensive conservation of the lake for future generations. …." Further, it states on the intent on the preparation of the plan as "The ultimate solution to these problems lies in the revival of an environmental culture …. The solutions must begin with changes in the behavior of citizens of the prefecture and the business sector …." Being a vision plan rather than a project implementation plan, the time horizon of the ML21 Plan was set at 2050 with review timings set initially for 2010 and 2020. Further, it states the roles to be played by the beneficiaries of the Plan as "The citizens, private-sector members, local government officials and various other members in the community should cooperate with each other to promote watershed conservation. Specifically, it is important for them to learn and understand each other regarding their, respectively, unique situations and the associated issues in the upper, middle, and lower reaches of the river basin, by forming a partnership with each other, fostering profound understanding and a sense of shared values about Lake Biwa, that will lead to the evolving process of proactive engagements among themselves." As part of the planning elements of the ML21 Plan, the measures of achievement were set to be improvements in (1) the overall quality of Lake Biwa water with the aim to attain specific water quality target levels; (2) the infiltration and retention capacities of watershed soils, with the aim to identify and set aside such lands; (3) the natural environment and landscape ecology, with the aim to acquire the network hubs for the purpose; and (4) the development of a river basin association each major river basins. These achievements were to be measured both in terms of quantitatively measurable outputs (such as water quality) and qualitative outcomes (such as landscape ecology).

After 10 years of implementation of the ML21 Plan, however, an expert panel reviewing the first phase of ML21 (1999–2009) concluded in essence that a whole range of new issues surfaced needing due attention for all four target objectives. It also concluded as for item (1) above that the achievement target of pollution load reduction was gradually approaching, but the ambient standards of water quality had not been fulfilled, and, as for items (2), (3), and (4) above, little had been achieved or the achievements have been quite unsatisfactory. In addition, the panel pointed out the planning objective to be added in the second phase of ML21 (2010–2019) as being (a) significant change in lifestyles; (b) prioritization of projects to be undertaken; (c) increased number of trans-sectoral activities; and (d) more proactive dissemination of visual image information for easy communication with lay citizens. The panel also concluded that a platform called the "Lake Biwa Environmental Citizen Forum (ML21 Forum)" needed to be established, and its outputs should be integrated into the formal governmental process (Shiga Prefectural Government 2011a).

In retrospect, the ML21 Plan turned out to closely reflect the two new ideologies having been stipulated in the Revised River Law of 1997, i.e., first to "improve and conserve river environment" and second to "take into account the opinion of local residents" in developing and implementing the river management plans. In particular, the philosophy through ML21 that its Forum outputs be integrated into the formal government process implies that ML21 is now seeking what may be regarded, in the absence of any useful term to explain, as "participatory governance". The term, "participatory governance" is considered as a "variant or subset of governance theory that puts emphasis on democratic engagement, in particular through deliberative practices", and as seeking "to deepen citizen participation in the governmental process by examining the assumptions and practices of the traditional view that generally hinder the realization of a genuine participatory democracy." (Fisher 2012). In addition, the "Soh-son" culture discussed in Subsection "Historical implications of paddy culture as a basis of Basin governance" in connection with the presumed trait gained through history of the "community self-governance" in the Ohmi region may be appropriately reminded in this context.

## Basin Governance Improvement for Ecosystem Restoration

### Legal Frameworks for Water Cycle and Ecosystem Restorations

In the meantime, two important legislative initiatives have been introduced in Japan over the past years, one pertaining to achievement of a healthy water cycle (Japanese Government 2014) and another pertaining to restoration of the Lake Biwa ecosystem (Japanese Government 2015). The title of first one is "Basic Law on the Water Cycle" and of the second is "Lake Biwa Conservation and Restoration Act."

Under the water cycle law, the national government is to establish a Water Circulation Basic Plan, recognizing that proper water circulation is of crucial importance to environment, people, and industrial activities and that water is valuable national property. Also, in cooperation with the national government, local governments are required to take measures to improve the water retention and recharge capacity by, for example, properly managing forests and croplands, among many others. The law requires that, to be eligible for facilitation of provisions by the national government, the basin community needs to develop a basin water cycle plan, wherein the plan sets forth (1) clarification of the present and future water cycle challenges; (2) the ideal situation or vision to fulfill; (3) specific objectives for meeting water cycle maintenance and/or restoration; (4) specific means to meet the objectives; and (5) indicators for describing the state of the water cycle today and for describing the progress. As it turned out, SPG proposed that Lake Biwa be considered a designated basin under this law and was granted this status, among a score or so of lake–river basins in other regions in the country.

The new Lake Biwa law basically facilitates the ML21 (which is only a prefectural plan) in such a way that the national government provides the necessary resources, on the condition that SPG meet certain basic requirements for such measures as (1) prevention of water pollution and improvement of water quality; (2) improvement of the water recharge capacity of forestlands and croplands; (3) restoration of ecosystem integrity by means of (3a) conservation and restoration of coastal natural environment, (3b) prevention of ecosystem damages by alien species of fauna and flora, (3c) prevention of ecosystem damages by Great Cormorant (*Phalacrocorax carbo*), and (3d) removal of macrophytes and other water weeds; (4) improvement and preservation of landscapes; (5) promotion of agricultural and fishery industries, tourism, transportation, and other means to promote industrial development, by means of (5a) promotion of ecologically friendly agriculture and development of such industrial activities, (5b) appropriate conservation and management of fishery resources, and (5c) promotion of tourism and transportation; and (6) promotion of education on these subjects. The basin conditions the law stipulates are (1) that SPG and Shiga residents endeavor to gain broad recognition and support from the Japanese people in general on the importance of Lake Biwa and the need for its restoration in view of the seriously challenged situation with regard to its ecosystem; (2) that SPG and Shiga residents endeavor to conserve the lake environments and to pursue diverse and prolific industrial activities while also making sure to balance the two; and (3) to make sure to transcend the value of Lake Biwa to future generations. Since these are among the key components of the ML21 Plan, it is expected that SPG and the prefectural residents will be in much better position to fulfill the long-term aspiration of the ML21 Plan.

Although these new developments are encouraging and useful, the pursuit for sustainable governance of the Lake Biwa and Yodo River Basin will have to be addressed in much broader perspectives, to which the Ecosystem Service Framework to be discussed in the next section may give some useful clues.

### Ecosystem Service Framework

The concept of ecosystem service (ES) became well known in connection with Millennium Ecosystem Assessment (MEA) conducted under the auspices of the United Nations during the period between 2001 and 2005. It was coordinated by the United Nations Environment Program (UNEP) and was governed by a multi-stakeholder board consisting of a large number of scientist and nonscientist members, with its objective being to "assess the consequences of ecosystem change for human well-being and to establish the scientific basis for actions needed to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being." The project outputs were summarily reported in the publication *Ecosystems and Human Well-being – Synthesis: A Report of the Millennium Ecosystem Assessment* (Read et al. 2005).

The report defines the ES component services as consisting of:

1. *Resources Provision Services (PS)* referring to the products people obtain from ecosystems, including food, wood and fiber (e.g., jute, cotton, hemp, silk, and wool), fuel (dung and other biological materials serving as sources of energy), genetic resources (biochemicals), ornamental resources, and freshwater (for human consumption and for generating electric energy).
2. *Regulating Services (RS)* referring to the benefits people obtain from the regulation of ecosystem processes, including water regulation, erosion regulation, water purification and waste treatment, disease regulation, pest regulation, pollination, and natural hazard regulation.
3. *Cultural Services (CS)* referring to the nonmaterial benefits people obtain from ecosystems, including spiritual and religious values, knowledge systems (traditional and formal), educational values, aesthetic values, social relations, sense of place, cultural heritage values, and recreation and ecotourism.
4. *Supporting Services (SS)* referring to the services necessary for the production of all other ecosystem services, including heat energy, soil formation, nutrient cycling, photosynthesis and primary production, and water cycling. Because water is required for other life to exist, it could also be included as part of the supporting service.

The report then elaborates the relationship between these ES component services and human well-being, including the basic material needs for a good life, health, good social relations, security, and freedom of choice and action.

As for Lake Biwa, a study was undertaken in 2010 to apply a methodology for ES assessment called the Economics of Ecosystem and Biodiversity, otherwise known as TEEB (Ministry of Land Infrastructure, Transport and Tourism 2011). In addition, a special committee appointed by the Shiga Prefecture Governor undertook a study in 2011, submitting a report entitled "Proposal: Toward the Emergent Next Steps in the Management of Lake Biwa and Yodo River Basin" (Shiga Prefectural Government 2011b) which used the ES Framework as a core concept. This report, although prepared for SPG, suggested the use of ES Framework for dealing with the emerging challenges facing the Lake Biwa–Yodo River Basin, particularly the upstream–downstream collaboration for achieving sound water circulation in the Basin. The report later served as a useful input for the BY-BMC for possible application to the whole of the Biwa–Yodo Basin, as discussed in Subsection "Technological and managerial implications". There is a whole range of other ES application cases reported in Japan, but they mainly focus on biodiversity conservation rather than lake–river basin management.

Globally, a large body of literature has been generated on the application of ES to lake–river basin management over the past decades. For example, Brauman et al. (2014), in their paper entitled "Ecosystem Services and River Basin Management," present a review of the status of its application in the EU region. They state "This framework is inherently anthropocentric, organizing ecological processes by their effects on human beneficiaries and explicitly connecting ecosystem processes to human welfare. The ecosystem services approach facilitates management of a complex system by incorporating important aspects of risk-informed management" and conclude that "Overall, ecosystem services are a useful tool for river basin managers because they provide a coherent context to incorporate stakeholders and complex biophysical processes into a consistent, learning-based management scheme." Brils et al. (2014) in their book entitled *Risk-Informed Management of European River Basins* present summarily many cases of its application. They state "Risk-informed management involves the integrated application of three key-principles: 1) Being well informed; 2) Managing adaptively; and 3) Pursuing a participatory approach. The authors explain and underpin these principles in detail, offer inspiring examples from practice, and connect them to the implementation of the European Water Framework Directive (WFD).

In the meantime, Costanza et al. (2017) state in their paper entitled "Twenty years of ecosystem services: How far have we come and how far do we still need to go?" that traces the history since 1997 of the knowledge generated on the subject of ES in general, natural capital, social capital, human capital, and built capital collectively interact with the ES portion of natural capital. They state "The ecosystems that provide the services are sometimes referred to as 'natural capital,' using the general definition of capital as a stock that yields a flow of services over time. Here the term 'capital' is useful to reconnect the human economy with its ecological dimensions. In order for these benefits to be realized, (1) natural capital (which does not require human activity to build or maintain) must interact with three other form of capital that do require human agency to build and maintain. These include: (2) built or manufactured capital; (3) human capital; and (4) social or cultural capital. These four general types of capital are all required in complex combinations to produce any human benefits. Ecosystem services thus refer to the relative contribution of natural capital to the production of various human benefits, in interactions with the other forms of capital. These services do not simply flow to human wellbeing without these crucial interactions. As a consequence, understanding, modelling, measuring, and managing ecosystem services requires a very transdisciplinary approach." Their view is that "Built capital and human capital (the economy) are embedded in society, which is embedded in the rest of nature. Ecosystem services are the relative contribution of natural capital to human wellbeing, and that they do not flow directly." It is therefore essential to adopt a broad, transdisciplinary perspective to address ecosystem services, as shown in a conceptual sketch, i.e., *Fig. 1* of the above paper. The views expressed by Costanza et al. are quite informative and trigger many useful thoughts, of which the following discussion would hopefully be one.

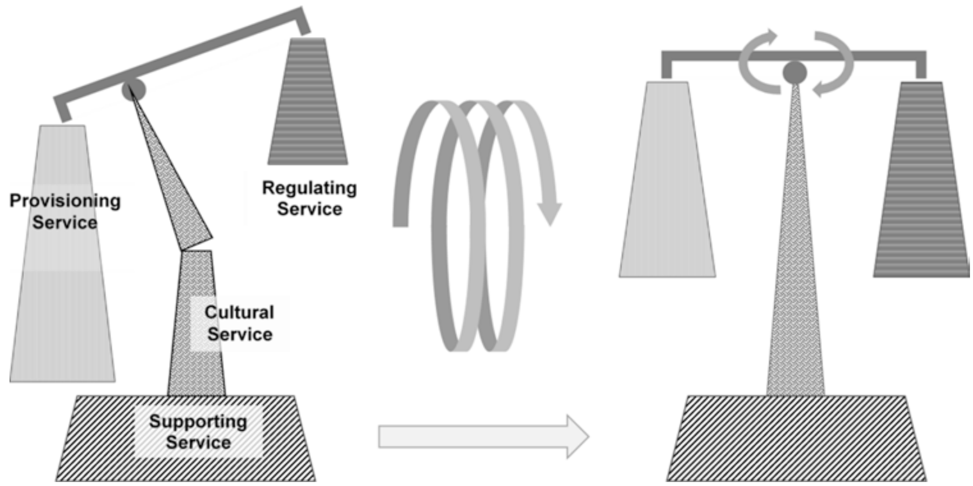



**Fig. 22**
**Conceptual illustration of a cyclic process of ecosystem service restoration**

## Meaning of Regulating Service and Its Relationship with Provisioning, Cultural, and Supporting Services

How is the above ES Framework related to the theme of this chapter, i.e., the evolving issues toward improvement of the Biwa–Yodo Basin governance? To answer this question, we need to review the specific RS components in the context of lake–river basin management. They include:

1. Water regulation (e.g., reduction of runoff and flooding magnitudes and incidences; aquifer recharge being strongly influenced by changes in land cover; water storage potential being affected by the conversion of wetlands or the replacement of forests with croplands or croplands with urban areas, etc.)
2. Erosion regulation (e.g., vegetative cover playing an important role in soil retention and the prevention of landslides)
3. Water purification and waste treatment (e.g., filtering of impurities and decomposition and assimilation of organic wastes, detoxification through soil and subsoil processes)
4. Disease, pest regulations, and pollination (e.g., changing of the abundance of human pathogens and disease vectors, reduction of crop and livestock pests and diseases)
5. Natural hazard regulations (e.g., reduction of damages caused by large storms, flood water retention by lake and river riparian wetlands, coastal ecotones such as mangroves and coral reefs)

These RS features must have been inherent to any land–water system in a pristine state (e.g., like during the prehistoric time). We need to take note here of the following two aspects of RS in addressing the evolving basin governance issues. The first is about the possible gap between the inherent RS capacity that remains more or less unchanged over time as versus the PS capacity that is likely to increase over time because of human interventions. The second is about the shifting balance among the four component services, i.e., RS, PS, CS, and SS, over the evolutional history of basin governance.

As for the first of the two aspects, take for example, the case of flood mitigation capacity inherently associated with natural wetlands, i.e., natural RS. As the flow regime is transformed from more lentic–lotic state in the prehistoric and early historic era to a more hydrostatic–hydrodynamic state in the last centuries, the inherent RS capacity would become comparatively inadequate against the increasing flood frequency and magnitude as a result of increasing pursuits for more PS. As a result, the shortage in the RS capacity of wetlands for flood mitigation has to be compensated for by such facilities as levees and flood control weirs that serve as artificial RS. Similarly, the magnitude of the inherent RS assimilative capacity of nonpoint sources of pollution became comparatively inadequate against the increasing quantity of pollution loads, as well as the increasing magnitude of the runoff coefficient. As a result, the reduced RS capacity has to be made up for by such facilities as drainage and treatment ponds artificially constructed.

As for the second aspect, i.e., the shifting of balance between RS and PS (as well as CS and SS in many cases), the current state may be to pursue as much PS as possible, taking advantage of the inherent RS. Because the inherent RS would remain unchanged, while the pursued PS would increase, resulting in an imbalance between the two, many cases indicate this imbalance would also adversely affect the quality of the CS, as schematically shown on the left-hand side of *Fig. 22*. Over time, a necessary amount of RS must exist to support the level of PS activities pursued by human interventions, not by nature. This regaining of the balance through many rounds of artificially introduced cyclic process is shown on the right-hand side of *Fig. 22*. This restoration process will require consideration for (1) *institutions* to manage the lake–river and their basins for the benefit of all basin resource users; (2) *policies* to govern people's use of such resources, and their impacts on the lake–river ecosystem; (3) *involvement of people* to facilitate all aspects of lake–river basin management; (4) *technological possibilities and limitations* that are often quite dictating in regard to long-term decisions; (5) *knowledge and information* of traditional, as well as modern scientific nature, forming the basis for informed decisions; and (6) *sustainable finance* to support implementation of all of the above activities. These six domains of actions are collectively designated as Six Pillars of Governance (Nakamura and Rast 2014). The Six Pillars of Governance must be strengthened to make sure the pursuit of above PS–RS balance is in the right direction, with involvement of a wide range of basin stakeholders. This proposed social science methodology is named "Ecosystem Service Shared Value Assessment (ESSVA)" and is currently being tested for some selected lake–river basins in Asia and Africa on a pilot-scale basis. The conceptual framework depicted as *Fig.* 22 is also included in the report for SPG (Shiga Prefectural Government 2011b) and also in the UKLG study report (Union of Kansai Governments 2016).

In summary, the ES Framework can be usefully applied to address the evolving issues toward improvement of the Biwa–Yodo Basin governance by retrospectively projecting the outcome of past (historic) human–nature interactions within the Basin. The ES analysis should take into account the scales of spatial sphere (basin, sub-basin, upstream–downstream, natural circulation, urban metabolic circulation, and trans-basin interactions), the scales of temporal sphere (geo-historical and historical transition from lentic–lotic to hydrostatic–hydrodynamic), and the scales of perceptional sphere (individual experiences, community traditions, upstream–downstream conflicts and contentions, etc.) Balancing over time of PS, RS, CS, and SS and their trade-off analysis may serve as an important contribution to the application of ES concept in the analysis of lake–river basin governance into the future.

## Conclusions

The following are key observations of this chapter:

1. Many major lake–river basin systems of historical importance are known to have undergone long-term transformations of land–water linkage structures and flow regimes, i.e., from a more lentic–lotic state (more natural) to a more hydrostatic–hydrodynamic state (more artificial). The governance challenges facing such a lake–river basin system also underwent transformational history, though often quite implicitly. Taking into account the above general observation, this chapter highlights the governance challenges facing the Lake Biwa–Yodo River Basin, focusing on three thematic subject areas, i.e., (a) point and nonpoint sources of pollution; (b) Integrated Flood Risk Management; and (c) governance of participation: communities and citizens.
2. As for item (a) above, the GIS outputs of point and nonpoint source water quality trends over the past 20 years were presented in some detail. While the focused time span is only on the order of a few decades, the assessed outputs represent the cumulative historical stresses resulting from long-term population dynamics, changes in industrial structures, and ubiquitous land use changes having taken place over past several decades, as well as the transformations of land–water linkage and flow regime having taken place over many centuries. The challenges facing nonpoint source issues are far more encompassing than the point source issues, and there is now growing interest in what are called the multi-policy solution approaches.
3. As for item (b), while the subject of Integrated Flood Risk Management (IFRM) approach proposed by SPG and possible adoption by UKLG focuses on the site-specific flooding risks of riverine floodplains, the background leading to this proposed approach goes far back in history, including the contentious trans-jurisdictional upstream–downstream relationship. The inauguration of UKLG, a symbol of the decentralized rather than the centralized decision-making for basin governance, is hoped to successfully address other challenging basin governance issues, also having been left unattended in the maze of sectoral approaches.
4. As for item (c), while a major focus was directed to the participatory governance for managing Lake Biwa for sustainable resource use and the so-called the Lake Biwa Model, full appreciation of the evolving process requires understanding of the historical implications of the relationship between the upstream Lake Biwa region and the downstream Yodo River region. The unique participatory governance approach promoted by SPG also has its historic roots in paddy agriculture, as well as its cultural heritage associated with Lake Biwa itself. On the other hand, there have been gradual demographic infusions from downstream, gradually diluting the social and cultural identity of the Lake Biwa region, a subject of possible future study.
5. Finally, the ES Framework was applied to address the evolving issues toward improvement of the Biwa–Yodo Basin governance by retrospectively projecting the outcome of past (historic) human–nature interactions within the Basin. The ES analysis should take into account the scales of spatial sphere (basin, sub-basin, upstream–downstream, natural circulation, urban metabolic circulation, and trans-basin interactions), the scales of temporal sphere (geo-historical and historical transition from lentic–lotic to hydrostatic–hydrodynamic), as well as the scales of perceptional sphere (individual experience, community traditions, upstream–downstream conflicts

and contentions, etc.) Balancing PS, RS, CS, and SS over time, and their trade-off analysis, may serve as an important contribution to the application of the ES concept to the analysis of lake–river basin governance into the future.

## Acknowledgments

We would like to thank the editors for invitation to contribute to this publication and for their patience and guidance to complete the manuscript. We also thank Dr. Walter Rast, Professor Emeritus of Texas State University, for his editorial improvement comments.

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