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On the Progress of River Restoration and the Future View in Japan and Asia

Katsuhide Yoshikawa

ABSTRACT: In Japan, many rivers have been regulated to prevent flood damage and to make advanced land-use possible, responding to the rapid urbanization and economic growth that occurred during the 1960s. Great results have been achieved from the viewpoint of river improvements. But river environments have been spoiled and rivers throughout the country have become uniform and monotonous. In response to demands concerning river environments, river works that took the environment into account began to get underway in the 1990s. The River Law was amended in 1997, positioning the "improvement and preservation" of the river environment as another objective, in addition to flood prevention and water resource development. In addition, the Natural Reproduction Law was enacted in 2002. With this progress, the environmental preservation and restoration of rivers has been vigorously promoted.

Many Asian countries are experiencing rapid population increases and urbanization. In these countries, river management increasingly needs to take into account the environment. It has also become important to establish international networks.

In our paper and in the oral presentation, we present on the following:

- 1. Introduction to the progress and future outlook for river restoration in Japan
- 2. The river environments in Asian countries subject to rapid population increases
- 3. The Asian river restoration network

KEYWORDS: restoration, population increase, urbanization, Japan, river low, nature restoration low, river restoration network, Monsoon Asia flood mitigation, history

Introduction

This paper will describe the changes in river environments in Japan, which has undergone an age of dramatic demographic expansion, progressive urbanization and economic growth, and initiatives in consideration of river environments and the natural regeneration of rivers will be introduced. The formation of a network on river environments will be reported focusing on Asian countries that are now experiencing truly dramatic demographic expansion and remarkable urbanization and economic growth. Exchange and cooperation in this field is expected to be promoted with European countries and other regions, focusing on countries in Monsoon Asia.

1. Demographic expansion, urbanization, economic growth and river regeneration in Japan

(1) Demographic expansion, urbanization and economic growth in Japan

The Japanese population has increased almost consistently as shown in Fig.-1 during the past 2000 years. Except for the latest 50 years or so, this expansion has been proportionate to the increase in cultivated land area and rice harvest resulting from the development of river flood plains as paddy fields for rice cultivation. And the majority of both the land inhabited by people and towns has come to be located in flood plains could be reached by river floodwaters.



Fig. -1 Demographic changes in Japan in the last 2000 years

The development of flood plains has been carried out by draining the water from marshes and making them into paddy fields and by drawing irrigation water from rivers and preventing floods with embankments.

Fig. -2 shows the Japanese population in the last century and in the coming century. Compared with the demographic changes in the UK and France shown in Fig. -2, demographic expansion in Japan appears to have been so dramatic it could be called a population explosion.

This population increase has brought with it progressive urbanization and considerable economic development. An example of urbanization is given in Fig.-3 on Tokyo Metropolitan Area. And, today, as shown in Fig. -4 and -5, towns are located in flood plains that are lower-lying than the river flood level. In Japan, about 50% of the population and about 75% of property are located in flood plains that could suffer a flood disaster. This social characteristic is a feature of countries in Monsoon Asia, including Japan, unlike most countries in the West, etc.



Population (Million)

Fig. -2 Demographic changes in Japan in the last century and the coming century

With the progressive urbanization of the flood plains, forms of land use also switched from previous uses based on the assumption of flooding to use for housing, construction, manufacturing plants, etc. that does not allow for flood damage. The problem of urban flooding emerged and grew more serious. In face of this reality, to protect urbanized areas from flooding, besides the expansion of river width, embankments were made higher and riverbeds were dug deeper to increase the downflow capacity of flood waters in limited river land. That period was also a time when people who suffered flood damage took the national government to court on the grounds of delayed river improvement. It was also a time when the water quality of rivers rapidly deteriorated.



Fig.-3 Urbanization of Tokyo Metropolitan Area



Fig. -4 Japanese towns that have developed on lower-lying land than the river flood level



Fig. -5 About 50% of the population and 75% of property are located in flood plains at risk of flooding

(2) Shape of rivers that emerged at that time and efforts for restoration

At that time, preventing floods became the main objective, residents also left rivers whose water quality had deteriorated, there was hardly any of the modern-day awareness of the river environment, and river improvement and restoration was carried out with the aim of flood control. As a result, meandering rivers that were prone to flooding and incompatible with urban use were straightened and monotonous rivers such as the typical example in Photo.-1 emerged. It was also a time when rivers also left people's awareness.

Later, from about 20 years ago, efforts were begun by citizens' groups and some administration officials to make use of rivers for towns and communities, to restore nature and to consider river use and the environment when they improve rivers. An example of such early initiatives can be seen in Photo.-2. Photo.-2 is the same example as Photo.-1, Itachi River in Yokohama City. At this river, an attempt was made to construct a river walk on both sides of the

river and to restore the ecosystem in the river, resulting in a river in which children could be seen playing.



Photo. -1 Example of a typical monotonous urban river (Itachi River, Yokohama City)



Photo. -2 Example of the regeneration of an urban river (Itachi River, Yokohama City, the same river as in Photo. -1)

(3) Changes in the relationship between rivers and the citizens

If we look back briefly at the relationship between rivers and people in Japan in recent years, we can see the kind of changes described below. After the Second World War, Japan experienced an age of remarkable demographic expansion, urbanization and economic development, but even so until around the time when the Tokyo Olympics were held in 1964, in Japan's regions, through activities such as farming, fishing and play, a deep relationship between rivers and the citizens remained. However, in regions that underwent considerable urbanization, affected by the breakdown of the close regional community, the deterioration of the environment due to the contamination of river water, the dumping of rubbish, etc., and river construction for flood prevention, the relationship between rivers and the citizens weakened.

In addition, not only in urban areas but also in agricultural areas, farmland construction was carried out to raise rice productivity and enable labor saving, and combined with the concretization of nearby waterways and the effect of pesticides, as well as the trend for farmers to take jobs as salaried workers, the relationship between watersides and people was dramatically diminished.

Then after the Tokyo Olympics, in connection with campaigns to increase the physical strength of Japanese, river sites came to be taken over as sports parks (lesser rights than leased land) and used as the city parks that are lacking in cities. Later, from about 20 years ago, river landscaping from the viewpoint of making use of river space in regional development and town development began to be promoted. From around that time, examples of river use and river restoration in consideration of the ecosystem, like the previously mentioned Itachi River in Yokohama City, and examples of river improvement works taking into account the river environment began to appear.

Later in recent years, people's awareness of the environment increased dramatically, and the same also applied to river environments. Then, symbolically, in connection with the construction and operation of Nagara River Estuary Dam and other dam construction, there was also a strong opposition movement by the people, and, in terms of the river environment, a new relationship between rivers and citizens has begun. The experience of nature and environmental studies at rivers are also now being promoted.

(4) Consideration for the river environment and efforts for natural regeneration

In the course of this period, in 1990 near-natural river construction methods (known as *tashizenkoho* or nature-oriented construction methods in Japan), which had come to be practiced in Switzerland and other parts of Europe, came to be adopted as a model. In 1991 river projects to facilitate fish migration upstream began as a model.

In 1995 river management taking the environment into consideration was proposed by the River Deliberation Council, and in 1997 the River Law, under which the aims of river management had previously been only flood control and water resources development, was amended, the environment was added to the aims of river management, and the establishment of river improvement and restoration plans with community participation came to be legally recognized. Alongside this amendment of the River Law, nature-oriented construction methods became regarded as the rule for all river improvement. In 1998 nature-oriented construction methods also became standard for repair works on disaster-stricken rivers.

In 1999 a meeting on the creation of an "Wa no kuni," a society which is sustainable, simple, and emphasizes quality, under the auspices of the Prime Minister reported not

only on the creation of a society in accord with nature, but also on adaptable ecosystem management and natural restoration-style public works. Also in the 2002 new biodiversity national strategy measures for natural restoration were set forth. Then, in January 2003 a law promoting natural restoration was approved.

Against this background, the natural restoration and natural regeneration of rivers gradually came to be promoted.

Today, nature-oriented river development through systematic river improvement and river disaster repair works aimed at increasing flood controllability have become normal and works are underway in several thousands of locations every year. At the present time there are a few examples of the natural restoration of rivers, since it has only been a few years since this began, but such projects have begun at rivers such as Kushiro River Kushiro Marsh and Ara River and so on.

There are plans to proceed with river improvements and the natural restoration of rivers, in the future, taking account of the environment including the restoration of lost rivers.

(5) Initiative for watersheds and urban restoration in accord with nature (National research and development project)

In Japan, future research and development is decided and going to be promoted at the Council of Science and Technology Policy, Cabinet Office chaired by the Prime Minister. Out of 8 research and development areas, the environment field as well as life, information and substances/nanotechnology are seen as the four priority areas. In the environment, since 2002, alongside global warming research, etc., the Council has been promoting an initiative for watersheds and urban regeneration in accord with nature that includes rivers (shown in Fig. -6).

This research includes making people's lifestyles, land use and economic activity in rivers and river flood plains to be symbiosis with nature, and promotes research into areas such as those shown in Fig. -7. It also designs and presents watersheds and urban

Environmental Initiatives

- 1 Global Warming
- 2 Zero Waste, Resource Recycling
- ³ Technology for "Watershed/Urban Regeneration in Accord with Nature"
- ④ Total Risk Management Technology Pertaining to Chemical Substances)

1 Life Sciences

• ⁵ Changes in the Global Water Cycle



Fig. -6 Initiative for watersheds and urban regeneration in accord with nature is one of the research initiative by the Council for Science and Technology Policy, Cabinet Office.



Fig. -7 Research components of initiative for watersheds and urban regeneration in accord with nature

regeneration scenarios. In the environment field, in connection with water and rivers, the Council is also promoting a global-scale water-cycle change initiative aimed at solving and alleviating water problems in regions with rapidly expanding populations worldwide, especially Asia.

All these initiatives relate to cities and urban civilization and water and rivers and, while placing the emphasis on Monsoon Asia, the Council is also trying to promote these initiatives in cooperation with all those concerned throughout the world.

2. River environments in countries in Monsoon Asia, etc. with rapidly increasing populations

In Japan and advanced Western countries, the days of rapid demographic expansion and dramatic urbanization are almost over, and an age of gentle and slight demographic expansion or sudden demographic decline like in Japan has now arrived. (See Fig.-2 and Fig.-8)

As shown in Fig.-8, the populations of advanced countries including Japan are predicted to remain virtually level, while the populations of Asian countries, which even now account for about 60% of the world population, are estimated to increase more and more in future.



Fig. -8 World population estimates

In the days of rapid demographic expansion and progressive urbanization in Japan, as illustrated in Photo.-3, river water quality deteriorated and bad-smelling rivers emerged. Scenes like this must have been seen in the West after the industrial revolution, in cities such as London and Boston when they underwent urbanization about a hundred years ago.



Photo. -3 Tokyo with its deteriorated river environment View of Sumida River (1970s)

In cities in Monsoon Asia that became urbanized comparatively early such as Tokyo, Singapore and Seoul, which once experienced such a period, river environments improved. But in cities in Monsoon Asia such as Shanghai and other Chinese cities, the Bangkok Metropolitan Area in Thailand and Manila in the Philippines that are now undergoing rapid urbanization, such scenes can indeed be seen today.

In the countries of Monsoon Asia that are experiencing remarkable development, the improvement of rivers and other waterways as urban infrastructure as well as consideration for the river environment and the restoration of nature are becoming important themes for the years ahead.

In response to this problem, contributions harnessing experience in Japan and the West are sought.

As explained earlier, Japan is committing itself as a nation to a global-scale water cycle change initiative for the water problems of regions with expanding populations, focusing on the countries in Monsoon Asia. As part of this, we would like to create an information and human resources network on river environments in cooperation with people in Europe and America, focusing on Asia.

3. Network on Asian river environments (including natural restoration)

As explained above, to contribute to problems including natural regeneration, focusing on Asia, a river environment network is considered to be constructed.

Therefore, starting with information provision and exchange on global precedents and practical examples, it will be intended to create a network of people with experience of involvement in the resolution and alleviation of the problems faced. This kind of discussion was also done in the 3rd World Water Forum in Japan, 2003.

Fig. -9 shows an image of the network on Asian river environments. As a first step, it is planned to start information provision on advanced experiences in Japanese, English, Chinese and Korean by the spring of 2004. Advanced experiences that have now been collected and collated are of the kind shown in Table 1, including every kind of example



Fig. -9 Image of network on Asian river environments (including natural regeneration)

from (1) localized nature-oriented river improvement taking into account the environment and the restoration of river meanderings at Kushiro River to (2) the regeneration of total rivers such as Sumida River, Tama River, Singapore River and the Rhine (upper basin), and (3) the regeneration of the water environment in basin units such as the Mersey River basin and Chesapeake Bay and its basin.

While cooperating with scenario research into sustainable basin water policy in areas with rapidly expanding populations (joint research with multiple universities funded by the Japan Science and Technology Agency), we plan to form a human network, making a presentation to Asian and other countries at a special session of the Asia Pacific Association of Hydrology and Water Resources in Singapore in July 2004 and calling for cooperation.

In this effort, it is expected to cooperate not only with Europe and America, but also with Asian countries that have advanced experiences.

Conclusion

Changes in river environments and recent initiatives have described in Japan. It has been also reported about the countries in Monsoon Asia that are expected to enter a tough phase in future in terms of river environments and the water problems of regions with rapidly expanding populations, and it is discussed about contributing to their resolution and alleviation.

In cooperation with people from many regions including Europe, we would like to be involved in the improvement, restoration and management of rivers in light of the environment in the coming age, including the formation of a network of relevant information and experience as well as a human network, focusing on the countries of Monsoon Asia.

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Author:

Katsuhide YOSHIKAWA

Director of Technical Coordination & Cooperation Division, Foundation for Riverfront Improvement and Restoration

Professor at Politics and Media Research Center, Keio University Graduate School Ichibancho FS Bldg. 3rd Floor, 8 Ichibancho, Chiyoda-ku, Tokyo 102-0082, Japan E-mail: yosikawa@rfc.or.jp

Country	Name	Summary of Efforts for Restoration of Nature
Japan	The Itachigawa River	The efforts to restore the original river depth, the waterside vegetation and the microtopography of the riverbed, such as the shallows and deep pools that were there before the river improvements were undertaken to restore the natural abundance of the waterside. A river walk was also set up on both river sides.
Japan	The Moizarigawa River	The re-improvement project commenced in 1986 because of rapid urbanization and degraded flood control safety after the original river improvements. The nature-oriented river improvement and waterside development gave birth to a waterfront space that enriched the city life.
Japan	The Sumidagawa River	With water quality improved through stricter regulations on industrial effluent and construction of the sewerage system and with the waterside development, Sumidagawa River successfully recovered from the deterioration of the river environment. It serves as an advanced model for natural regeneration in Asia.
Japan	The Tamagawa River	The expansion of the sewerage system and other efforts resulted in the recovery of water quality and the return of living creatures. Sweetfish had disappeared from the Tamagawa River in the era of rapid economic growth but started to return in the late 1990s. It is estimated that in the spring of 2002, more than 1.1 million came upstream to the river.
Japan	The Tsurumi- gawa River	To restore a sound water circulation system after it was damaged by rapid urbanization, governments and citizens in the river basin started the process of preparing the "Tsurumigawa River Water Master Plan," which represents a set of guidelines for the restoration effort. Focusing on reestablishing a sound water circulation system in the river basin, the Master Plan is expected to implement effective and tangible measures in the fields of low water, environment, risk control and utilization as well as conventional flood prevention (high-water works).
Japan	Dokai Bay	Dokai Bay, which had once been a "bay of death," was restored through regulations on industrial effluent, construction of a sewerage system and dredging of polluted sediment in a cooperative effort involving industry, the government, academia and citizens. Its maritime ecosystem has now been restored and the tiger prawn catch has resumed.
Japan	The Kushirogawa River	The Kushiro Wetland was ruined through recent economic activities in the watershed areas. To protect and restore it, a number of efforts to rebuild the meandering course and riverside forests is getting underway.
Japan	The Shibetsu- gawa River	A river improvement scheme involving the restoration of nature is currently under way. It is aimed at restoring the Shibestsugawa River as it was in the past with its natural riches. To investigate the effect and the impact on natural restoration, meanders were reproduced in a trial in part of the zone where the river course had been straightened in the past.
Japan	The Arakawa River	As an attempt to protect and recreate the natural environment that was damaged by urbanization, biotope regeneration and large-scale development of the waterside area (the construction of a very mild slope dikes combined with the redevelopment project) were undertaken.
South Korea	The Cheonggye- cheon River	The urban river, once transformed into an underground drain, was restored to its original look by removing the elevated highway over the river. As a result, the river is going to become as it had been in the past. Meanwhile, redevelopment of the riverside area is to be conducted. This type of urban redevelopment project is unprecedented, and has attracted worldwide attention.
China	The Changjiang River	In the wake of the catastrophic flooding in 1998, the Chinese government announced a comprehensive water control package that emphasizes restoration of the wetland and forests. A project for removing the dikes of 877 lakes across the country to re-transform them into flood control basins is being implemented to restore the water retention function of the river basin.

China	The Huangpu- jiang River	The quality of the water, which had once been darkish and malodorous, in the Suzhou River that flows through the city of Shanghai was improved by 2000. As a consequence, the water quality of the Huangpujiang River, which merges with the Suzhou River, was also improved. Development of waterside spaces on both banks of the Huangpujiang River transformed the areas along the river from industrial zones to residential and office districts.
Singapore	The Singapore River	The Singapore River became polluted through urbanization. Strong efforts, including the introduction of a ban on pig farming in the river basin, were made to restore the river. There was also a river improvement scheme combined with the city development (Garden Island). As part of the project, paved esplanades were constructed on both sides of the river.
USA	Boston Bay	Restoration of the increasingly polluted Boston Bay area was conducted with the participation of citizens. In particular, a large-scale sewerage project contributed to dramatic improvements in the water environment. In addition, a waterside restoration project is underway, which includes the construction of an underground road to replace the elevated highway that has separated the waterfront area from the downtown area.
USA	Chesapeake Bay	The "Chesapeake Bay Program" was initiated as a package for the revitalization of the river basin to restore the environment of the polluted bay. Under this program, construction of the sewerage system, effluent regulations, improvements in agricultural management, bio-removal of nutrient salts, strengthened environmental education of citizens and other initiatives are being undertaken.
USA	The Everglades /The Kissimmee River	In Florida, wetland revitalization is underway to promote the de-pollution of the contaminated river water using a biological method, with action being taken especially against phosphorous. For the Kissimmee River, reconstruction of the meandering river course in the section where the course was straightened is being done to restore the wetlands.
Germany	The River Rhine	River improvements in the upstream zone of the River Rhine resulted in a decrease in floodplain functions and an increase in flooding in the downstream area. A comprehensive flood control scheme for the Rhine is in place to protect and restore the river ecosystem, to regain the flood control function in the upstream area of the Rhine and to recover the hydrological cycle.
The Netherlands	The River Rhine	Activities in the Dutch part of the River Rhine aimed at enhancing the river environment focus on reducing the inflow of pollutants for enhanced water quality, environmental restoration in floodplains, the revival of the free movement of fish and improvements in habitat diversity.
Denmark	The River Skjern	Considered to be the largest-scale river restoration project in Northern Europe, the "River Skjern Restoration Project" focuses on the revival of its meandering course, a landscape of the area around the river and conservation of the flora and fauna, especially the population of wild salmon.