Ver. 2

Reference Guideline

for Restoration by Eco-Compatible Approach in River Basin of Asia



Asian River Restoration Network

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(1) Why restore the river environment?

In the global hydrological cycle, rivers play a crucial part, especially in their relationship with humans. Rivers accommodate and nurture numerous living things, including we humans. We cannot live without the blessing of rivers.

We, humans, have received many blessings from rivers, as we obtain drinking water and foods from them, and use river water in our livelihood and economic production, as well as for hydraulic energy in transportation and power. Thus, we have found numerous ways to use rivers. At the same time, we have changed their flows skillfully, one way or another, to prevent floods from taking people's lives. In short, we have got along with rivers. The specific way to get along differs, needless to say, depending on each region's climate, land contour, etc. And this getting along has shaped each region's culture and socio-environmental climate.







Anyang River, Korea



Ochiai River, Japan

Yet we are paying a high price for reshaping rivers and consuming so much of their water. We have altered their natural hydrological cycles, and this in turn has resulted in the loss of much of the natural wealth and lovely landscape nurtured by such cycles. Today, river water is polluted, floods are more devastating than they were before, and fewer fish are living in rivers. These deteriorations are seriously and adversely affecting our lives and production.

All of the four major ancient civilizations of the world throve along a great river. As their populations and economy expanded, however, they destroyed the natural environment of their river basins. Many say such environmental deteriorations led these civilizations down the way of their own extinction. Modern science and technology have enabled humans to manipulate nature on a scale and at a speed never known before. We have controlled nature as we want to, for our economic wealth. We have obtained this wealth at the cost of drastic effects on natural conditions and cycles. Some of these effects are irreversible. Some are fatal.

As is typically evident in the spread of water supply and sewage systems, modern society has set people and rivers farther apart from each other. Many of us are not usually aware where our water comes from and where it flows from our lavatories and kitchen sinks. Moreover, few of us dare to approach a polluted river. We have changed the way we get along with rivers. As a result, we have become insensitive to changes happening in rivers, which lead to further aggravation of their environment before we know it.

Hydrological cycles exist and work in continuities, chronological and spatial. The chronological continuity connects the past with the future, while the spatial links together every corner of the earth, including subterranean areas and the atmosphere. A river right in front of us represents natural conditions and human activity in such continuities. In short, a river reflects the nature-human society of its basin.

We cannot live without working on rivers and using their water. Yet at the same time, a deteriorated river environment, where the water is polluted and unable to accommodate living things and lovely landscapes have been lost, is a sure sign that the health of the basin and the national territory we live in has been jeopardized.

Restoring a river's environment does not just mean planting green along a segment of it. Rather, it actually means letting a river restore its own original cycle of water, with its own natural power, by minimizing the influence of human activity. Furthermore, it means restoring health to the basin and the national territory behind the river running right in front of us. Restoring the river environment is essential, if we hope to hand down a beautiful, lush, global natural environment to our children, and if we want our descendants to live on this planet for many more years to come.

(2) Purpose of this guide

This guide is to show basic ideas and policies indispensable for restoring desirable river environments in Asia, raise the interest of readers in a river nearby, create an opportunity toward new projects for river restoration, and also support current river restoration projects.

(3) Target readers of this guide

This guide targets all people who want to bring rivers and waterfronts back into a healthy form and pass on rich river environments to the following generations.

(4) Outline and positioning of this guide

In the spontaneous regeneration sectional meeting of the 4th World Water Forum (held in Mar. 2006 in Mexico), two proposals were made in connection with establishing an Asian network related to river restoration and the preparation of an Asian river restoration guide toward

improvement of river restoration technology. In response to these proposals, the "Asian River Restoration Network" (ARRN) was established by Japanese, Chinese and Korean agencies jointly concerned in November of the same year.

In the ARRN, preparation of a river restoration guide was positioned as one of the primary objectives of the network activities, and Japanese, Chinese and Korean specialists are working toward establishing an engineering guide that can contribute to creating good river environments in Asia through discussions.



Contents of this guideline ver.2

In this guide, a menu of basic ideas and concrete measures toward river restoration is explained in a comprehensible form so that even non-specialists who are interested in improvement of the river environment can understand them easily as a primer to the "Asian River Restoration Engineering Guide" aimed at by the ARRN in the future.

The Guideline ver.1 was published in March 2009, and this Guideline ver.2 is an update of it. The revision for this Guideline ver.2 is intended to enhance the contents of the guideline so that it can serve as basic data that show the features and differences between Japan, China and Korea as regards various backgrounds, problems and measures regarding river environment restoration in Asia. A list of information sources (websites in English) has also been added to the Appendix as a reference for river environment restoration.

ARRN members will make continuous efforts to upgrade the glossary of river environment restoration terms, and to collect as many as possible reference cases containing lessons learned from experience in river environment restoration. We will also make efforts for the establishment of a practical river restoration technical guideline for Asia, which will present basic concepts for goals, methodologies and evaluation indicators of river environment restoration common to various Asian countries.

[Revision history of this Reference Guideline]

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2. Important viewpoints in understanding the true nature of a river

(1) Being familiar with the natural, historical and cultural transition of rivers

Since ancient times, rivers have brought great benefits to us such as water for drinking, food, amenity, and healing. At the same time, rivers have sometimes caused damage through floods and droughts. The history of the relationship between human beings and rivers is diverse, and rivers show how nature operates from past to present as well as the consequences of human beings' activities regarding rivers over a period of time.

To consider the future of rivers, it is of utmost importance to understand their historical and cultural change. This leads to a heightening of people's awareness to take good care of rivers as something familiar and to pass on a rich river environment to the following generations.



Column 1: History of river restoration in Japan, China and Korea

The major events related to river administration in Japan, China and Korea are summarized, and the past histories of river restoration in these countries are compared.

	China	Korea	Japan
1950's	1950s: China Government came up with the guideline of Huaihe River trainging "considering storaging up and discharge at the same time, to achieve the purpose of essential cure.	1950: Korean war happened and people paid no attention on the rivers. Sanitized and treatment facilities were not planned.	1957: Act on Specified Multipurpose Dams 1958: Water Quality Conservation Act on Public Water 1959: Ise Bay Typhoon
1960's	1960s: Chairman Mao called upon "Haihe River must be trained fundamentally". In the same year, Liujiaxia hydro project had	1961: The first river act was established based on Chosun River Order (1927).	1960: Erosion and Flood Control Law 1964: New River Law (Proper water use was enhanced) 1965: River Lot Occupation Permission Rule
		1072: By National Economic	
1970's	started working which was the first large-scale hydro project.	Innovation 10-year Plan, government established comprehensive river development plan.	1970: Water Pollution Control Act
1980's	1988: China's water law was enacted and establishes principles, general guidelines, and technical standards for water resources management.	1987: Polluted river purification project was pushed forward, and polluted bed sediment were dredged from severely polluted small-medium urban streams.	 1980: Formulation of Basic Plan of River Environment management began. 1981: Proposal on River Environment Management"(River Council Report) 1987: Hometown River Improvement Model Project was launched.
1990's	late 1990s: Water sectors of China began to explore the measures to restore rapidly degraded river ecosystems by means of emergency water diversion and achieved initiatory successes.	 1996: 'Guidelines on River Environment Control' were established. 1998: 'Standard for Planting and Management of Trees in Rivers' were established. 1999: 'River Act' was completely revised to include river environment plan in the river maintenance master plan, to apply nature-friendly methods, and to introduce the concept of river maintenance flow. 	 1990: Nature-oriented River Work was introduced. 1990: National Census on River Environments was started. 1993: Basic Environment Law 1995: Proposal on Future River Environment (River Council Report) 1997: Revision of the River Law (River environment improvement and river improvement were enhanced)
2000's	 2001: The 10th five-year plan launched a river restoration project to improve water quality and access to water 2004: The River Basin Committee expressed commitment to responsibility to maintain river health 2006: Launched the national water quality improvement project, "Water Pollution Control & Treatment" 2007: The 11th five-year plan included "restoration of the ecosystem", and launched nature restoration model projects 2009: An order by the Prime Minister obliged river predent to conduct 	 2004:'River Act' was revised to consider nature oriented river 2005: A technical standard of river design was revised 2005:"National River Urban Section Environment Maintenance Project" was started for environment-friendly river maintenance. 2009: major river restoration project and Ara canal project for multipurpose use of river were 	 2002: Act on the Promotion of Nature Restoration 2004: Invasive Alien Species Act, Landscape Act 2006: Basic guideline for Nature-oriented River Management 2007: The policy of "Building up and Preserving River Environments" reviewed 2008: A technical standard of river channel planning for medium and small-sized rivers 2009: A system to support "rivers and city planning"
	obliged river projects to conduct research on their influence on the natural environment	launched	2011: Deregulation to make river spaces more accessible

(2) Perceiving the river as a basin

The water of a river we see circulates in a "basin." The river moves substances on Earth such as water, sediment, nutrient salts, and living organisms. The characteristics of aspects of a river (flood, drought, water quality, living organisms, landscape, nature, and culture) in addition to climate, size, shape, and land utilization of the "basin" show that the state of the river results from and is affected by the way of living and the various social activities of the people living there for a long time.

When considering river restoration, it is very important to grasp the condition of the river, not only by looking at the streamflow or inside the river surrounded by levees or revetments, but also by considering the river as a horizontal phase of a "basin."



Upper reaches of Yangtze River (China)



River Basin of Nakdong River (Korea)



Kurobe River alluvial fan seen from the air (Japan)

(3) Understanding dynamism of rivers

The streamflow of a river changes every day. It is calm in its normal state, but the width of the water surface sometimes becomes extremely small and at other times, the flow is even disrupted due to water shortage. In the meantime, once a river is swollen, the streamflow will cut away the river bed and riverbanks and carry away riverside living organisms. Sediment flowing from upstream heaps up, and the form of the river may change.

In this way, stream flow changes at various time points naturally or artificially to its present form. Human beings and organisms in a river adapt themselves to the nature of the river and how it operates in order to live. When thinking of the river environment, it is important to understand the characteristics of the stream flow of the river.





The dry river bed (Yellow River, China)



Normal state (Gongreng River, Korea)



Flood condition (Gongreng River, Korea)



Normal state (Toyohira River, Japan)



Flood condition (Toyohira River, Japan)

(4) Grasping the role of rivers and stakeholders

We have sought a broad range of roles of rivers such as securing water resources for agriculture, industry, and disaster prevention, using the water surface and the riverfront for transportation by ship, recreation, and healing, and conducting fishery work to secure food. In addition, we have used rivers not only to obtain water but also to dispose of used water. Meanwhile, rivers are a place for various living organisms to live.

To find the desirable state of a river, it is important to grasp the lifestyles of the local people concerned in addition to the role of the river.



Weir for water intake

Water of life



Sightseeing boat



Use of the water surface for canoeing



Playing in the river



Multipurpose use of river terrace



Fishery work



Waterfront where landscape is good



Fish living in the river

Column 2: Stakeholders involved in river restoration and their division of roles - case of the Koma River in Japan -

The Koma River of the Arakawa River System (Saitama Prefecture) was designated as a target river of the Hometown River Improvement Project by the national government, and an improvement plan review committee was established by the river administrator in 1996. The committee sought the opinions of local residents through the heads of community associations. In order to reflect the opinions of a wider variety of people, it established the Komagawa Citizens' Council consisting of members selected from the general public (about 110 members) in March 2000, and held six meetings, including workshops, observation tours and opinion exchange meetings. After those opinions were reflected in the plan, construction work was begun. "Asaba Biotope" which was a feature of the improvement plan was completed in March 2003.

After completion, "Komagawa Furusato-no-kai", which was a citizen-led organization for maintenance and management, was established in June 2003 to reflect opinions and demands from the public in maintenance and management activities, and is actively working on effective use and maintenance and management of river facilities. The river is now expected to be used as a resource in the region.



Transition of approaches

		River administrators	Local government	Residents, etc.
	Infrastructure improvement	Embankment, sluice pipes, etc.		
Improvement phase	Facility improvement	Infrastructure improvement in Asaba Biotope	Parking lot, restrooms, multipurpose open space	
	Maintenance and management		Weeding, sludge dredging, waste disposal, etc.	Weeding, waste disposal, etc.
In-service phase	Utilization		Public relations of citizens' campaigns (leaflets and photo exhibitions), offer of a conference room, and provision of survey materials	Vegetation observation tours, wild bird watching tours, environmental learning, etc.

Division of roles

3. Basic items to remember in restoring river environment

(1) Clarifying problems of the river environment, taking the natural, historical, and cultural aspects of the river into consideration, to set targets for restoration.

To set the multi-purposes of river restoration including flood control, ecological recovery as well as aesthetics and amusement etc., it is important to consider the history of the river and the culture surrounding the river created in consequence.

Moreover, it is important to understand not only the natural environment but also the social environment showing how people have dealt with the river, as well as to clarify the problems in river environment, and determine what is to be restored as a solution to such problems.

Asian Monsoon Rivers are highly variable and productive. They go through floods and droughts every year. No rivers in this area have been free from flood protection works. Straightening, reinforcement, channelization, and disconnecting processes have taken place along the rivers against movable morphology with frequent erosion and deposition.

High natural productivity is sustained by relatively high temperature and humidity. Dense populations in Asian countries have been supported by rich irrigated paddy fields. These good conditions are often also good for invasive alien species. Land use demand has turned historic floodplain into farmlands and parking lots. Water quality is deteriorated not only in urban rivers but also in rural streams. Recreational use and public access have been lost in many cultural waterfronts.

River environment is not so simply structured that single project causes multiple damages and/or recoveries. Our present knowledge is too limited to build up a perfect plan to improve everything at once. It is necessary to identify prior targets for river restoration.



Old lively Sumida River around 1800



Sumida River with its life recovered today (Japan)

Below, let us see some problems of river environment in China, South Korea, and Japan.

(a) Problems concerning the water environment (quality / quantity)

(i) Problems on water environment in China (water quality and quantity)

A series of new water problems have risen in recent 20 years with population growth and rapid economic development, including: the increase of water pollution of rivers and lakes; excessive exploitation of water resources for living water due to the contradiction between the supply and requirement of water resources; large-scale reclamation of lakes, floodplains and wetlands; the destruction of soil and water resources because of deforestation and land reclamation in upper rivers; the negative impact of large-scale hydraulic engineering on river and lake ecosystems. According to statistics, the national emission of sewage and waste was 68 billion tons in 2003; the rivers whose water quality is worse than the IV* grade occupied 38% of the total river length; northern river pollution is more serious while the rate of standard-obtained of Haihe, Huaihe and Liaohe River water functional areas was less than 40%; water shortage of rivers in eastern region also increased.

(* Water quality IV means the water is lightly polluted.)



Dead fishes because of river water pollution (China)



Bloom in Taihu lake in 2007 (China)

(ii) Problems on water environment in Korea (water quality and quantity)

The state of the River has been deteriorating since the pollutants continued to accumulate within the riverbeds due to the reduction of water and increase of algae, especially during the dry season. Based on the water quality data from the Korean ministry of environment, annual water quality of most rural River has worsened although that of urban River has not worsened significantly due to the extra water supply (e.g., rainwater harvesting, exterior water pumping, etc.) to the urban River. Since wastewater from factories and other waste systems (e.g., daily sewage and livestock waste) flow into the rural river directly, water quality of most rural River has not been improved.



Agricultural pollutants around the river (Korea)



Contaminated urban river (Jang-su River, Korea)



Contaminated rural river (Seung-gi River, Korea)



Dryness of urban river (Do-rim River, Korea)

(iii) Problems on water environment in Japan (water quality and quantity)

The major problems that should be solved to maintain a good water environment include "water pollution" and "decrease in river flow rate in normal state".

Water pollution (pollution by hazardous substances and organic contamination such as eutrophication) is caused mainly by industrial effluent and domestic wastewater that increases due to population growth, and urbanization associated with economic growth. It has various adverse impacts, including damage to human health, deterioration of living environment such as impediments to water use, diminished awareness of the relationship between human beings and water, and deterioration of aquatic organisms and ecosystems. A decrease in river flow rate due to excessive use of water in rivers and basins may cause water pollution and adversely affect sediment transport in rivers, and lead to a deterioration of water-retaining and infiltration of surrounding soil, a decrease in groundwater level, and spring depletion. Furthermore, the loss of variation that rivers inherently have may bring a change to the habitats of living things.

To restore a desirable river environment, ensuring moderate water quality and quantity is a prerequisite for promoting creation of a lively waterfront space and restoring the natural environment in rivers as mentioned later. It is very important to comprehensively grasp and understand the problems relating to the water environment, as well as water amenities and biodiversity.



Pollution due to domestic wastewater in 1970's (Tama River, Japan)



Wastewater from a combined sewerage system in heavy rain (Kanda River, Japan)



Recession area downstream of a dam (Aga River, Japan)



Urban river which had once been a clear stream (Shibuya River, Japan)

(b) Problems concerning the affinity of the river space for water

(i) Problems on water amenities in riverfront space in China

In the hydrophilic space design of river, measures including straightening and deepening the river channel, reinforcement banks with concrete, increasing the height of embankments, dams building, and river diversions are adopted for flood control. These caused the loss of river channel and recreation area. Meanwhile, the open space of waterfront and other public urban space in many cities lack of reasonable convergence and transition, adequate open area and convenient public footpath directly associated with the waterfront.



Separation between river and people (China)



River affinity space improved (Taohuajiang River, China)

(ii) Problems on water amenities in riverfront space in Korea

Urbanization on river has several negative effects and one of them is loss of recreational use due to the lack of public access in parts of the basin. On the other hand, river is disconnected from its historic floodplain/wetland and appears to be highly over-utilized by the public. Significant utilizations for parking lots and farmland along the river have been a main problem in Korea, and brought considerable deterioration to the river landscape and water quality. In fact, well designed river restoration projects could also enhance river aesthetics and reduce landscape maintenance costs.



Parking lot (Yangjae-Cheon, Korea)



Farmland in Busan (Nakdong River, Korea)



River bed road in Daejeon (Daejeon-Cehon, Korea)



Straightened Concrete Channel (Hampyong-Cheon, Korea)

(iii) Problems on water amenities in riverfront space in Japan

Past river improvement works include the construction of high levees and steep revetments covered by concrete, which allowed us to ensure a very high level of security against floods. On the other hand, the riverfront space became inaccessible, and the water amenity space as a recreation area together with and the originally beautiful river landscape were lost. People lost interest in the riverfront space where the water environment had deteriorated, and city planning in urban river basins was promoted in disregard of rivers. Awareness of the relationship between rivers and human beings diminished. People's daily lives became more distant from rivers, and waterfront history and culture were gradually forgotten. As a result, the previous bustle of the riverfront space disappeared.

Recently, in order to restore the affinity and connection to rivers, there is an increasing need for efforts to incorporate river improvement in city planning, and enhance water amenities in the riverfront space.



River and urban area separated by high levees (Japan)



Inaccessible riverfront space (Japan)



City streets designed in disregard of the river (Japan)



River landscape spoiled by an expressway (Japan)

(c) Problems concerning the natural environment of the river

(i) Problems on the natural environment of the river in China

The stresses of hydraulic engineering on river ecosystem can be concluded into two aspects. First is from article alteration of rivers such as channelization and disconnecting of natural rivers. Second is the inter-basin water transfer project. Channelization of natural rivers include the linearization of longitudinal morphology, regularization of river transect and induration of slope material. The disconnecting of natural rivers include the longitudinal disconnecting of dam construction and the lateral disconnecting of embankment construction. Furthermore, exotic species are invaded into the rivers, lakes and reservoirs due to trade, immigration, tourism, war and many other factors. According to preliminary investigation, there are invasion species such as *Eichhornia crassipes*, *Ambrosia artemisiifolia L.* and *Mikania micrantha*.



River covered with artificial concrete revetment (Boyang River, China)



Species invasion-Water Hyacinth (China)

(ii) Problems on the natural environment of the river in Korea

Recently burcucumbers (Sicyos angulatus) introduced from North America has been spread rapidly along rivers, affecting substantially on the river ecosystem and resulting in declination of indigenous vegetation. In order to prevent spreading of burcumbers, local governments mobilize work forces to exterminate this introduced species, but fail to achieve desired results. Research is under way to develop ecological ways to eliminate burcucumbers.

Rapid introduction and growth of plants in the last decade have promoted land-forming waterfront areas with clean and plantless sands. Ecoriver21 research project has made a study to control land-forming.



Burcucumbers closely grown along a stream (Naesung River, Korea)



River of which waterfront is under way of landforming (Naesung River, Korea)

(iii) Problems on the natural environment of the river in Japan

Past river improvement works, including straightening and smoothing of river channels and development of revetments, have significantly increased security against floods, while various features, such as the destabilizing effects of floods that rivers inherently have, diversification of the natural environment, and longitudinal/transverse continuity, have been lost.

Reportedly, there have been many cases in which alien species have invaded rivers and have threatened the habitats of Japanese indigenous species in recent years.

Therefore, for the purpose of restoring ecosystems and other natural environments which had been destroyed in the past, the "Act on the Promotion of Nature Restoration" (2002) and the "Basic Guideline for Nature-Oriented River Management" (2006) were drawn up. Planning, design and construction have been carried out in view of the natural environment of rivers.



Destroyed waterfront environment where there is little natural/artificial destabilization (Ochiai River, Japan)



Losing transverse direction continuity by revetment (Itachi River, Japan)



Dry riverbeds covered with alien species (Chikuma River, Japan)

Column3: Restoration targets of nature restoration project in Japan

The Figure shows the proportions of each target of 51 recent nature restoration cases in class-A rivers of Japan. The restoration of tidal wetland/marshes comes first, and it is followed by countermeasures against exotic species/ conservation and restoration of specified species (rare species). Targeted species are crested ibis, Ciconia boyciana, Thorea okadae, etc., which are representative national or regional living organisms. Countermeasures against exotic species target plants such as Robinia pseudoacacia and Solidago altissima. In many cases, the restoration of particular species and countermeasures against exotic species are combined.

These are followed by the restoration of gravel bars, riffles/pools/river edges, and continuity between rivers and rice fields. "Regions/culture" at the right end is named as a restoration target in many cases, although it is not a target of nature restoration. This shows that regional activation efforts combining the basin and town planning are conceived as a part of nature restoration.



Restoration targets of 51 nature restoration project in class A rivers of Japan (up to 3 targets for each case)

Source: Foundation Riverfront improvement and Restoration, CTI Engineering Co., Ltd

(2) Planning river restoration from the viewpoint of the basin

In planning to restore a river or part of a river, it is important to consider it from the viewpoint of the whole basin (rather than considering it as a point or a line). Namely, we should consider the connection between phases such as water circulation, movement of sediment and living organisms upstream or downstream or horizontally to the land, as well as local people's activities centered around the river.



River restoration from the viewpoint of the basin

Source: Nurturing Nature and People · · · Exciting River Creation, Future River Environment, RFC

(3) Considering river restoration based on dynamism of rivers

For river restoration, it is important to respect to a maximum the natural and inherent activities of the river such as change of stream flow and river course. If a river is rehabilitated in excess its force, on the other hand, new problems may sometimes arise.



After dredging (2001.4)



After flood (2001.6)

River was dredged for flood protection purpose and sediment was deposited in river bed just after 2 months (Imjin River, Korea)



Attempt to restore the supply of sediment by transferring sediment deposited in the dam to downstream (Abukuma River, Japan)

(4) Proceeding with river restoration in cooperation with the local people concerned

To proceed with a river environment restoration project smoothly and continuously, it is important for the local people related to the river (community residents, water users, fishermen, administrative agencies, etc.) to cooperate closely from the first stage of setting a restoration plan and to find a restoration method that would be accepted in the surrounding region.



Field study about river dike in Hubei Province (China)



River restoration network's activity as part of an effort to improve river environment (Incheon, Korea)



Field study with the local residents and stakeholders (Tenou River, Japan)

4. Implementation approaches for river environment restoration

(1) Outline of measures toward river environment restoration

Methods of river restoration differ depending on the current river condition and the future target river condition. The situation may also be different depending on what is to be reproduced in the particular river. Therefore, it is important for the local people concerned to clarify the target of restoration and decide the order of precedence of measures to be taken.



An example of a river environment evaluation axis

In this guide, a sequence of measures to restore a good river environment is introduced, starting with activities that we can undertake. Cooperation with the administrative agency controlling the river is then described, which is indispensable for activities for the entire watershed. Cooperation with specialists such as engineers and researchers is also described, which is necessary for solving high-level technological issues.

We hope that readers can find a method of river restoration in this chapter after taking into consideration the "viewpoints in understanding the nature of rivers," "points to remember when restoring the river environment," and "circumstances of each river" shown in the first half of this guide.



Flow of scheme in this chapter

(2) Survey and research to clarify the nature of rivers

(a) Collection of information to be the basis for understanding basins and rivers

What we should do to restore the river environment is to research the actual condition of the river including its background and natural environment. Concretely, information on the history and cultural social environment showing how the river and people related should be collected through local people and documents. It is also necessary to understand the natural environment surrounding the river such as the quantity of precipitation in the whole basin, subsequent change in flow volume and water level of the river, water quality, and organisms living in the river through field study or by using the results of surveys conducted in the past.

Some of these basic researches can be conducted by us but for others, we should depend on specialists. In any case, however, obtaining information from these researches is the first step towards restoring the river environment.



Field investigation about river dike slope protection (Oujiang River, China)



Fishes survey (Korea)



Fishes survey (Japan)

(b) Studies and researches to obtain new knowledge

There are many points that have not been clarified such as the effect of human activities upon the river environment. To find the desirable river condition in the future, it is important to conduct academic researches and surveys in addition to conventional basic researches and to accumulate new scientific knowledge.



River investigation with laser scanning technology (China)



Analysis of relationship between vegetation and ground water level to prevent land-forming of water channels (Korea)

Grouping of populations which have a similar genetic structure based on DNA polymorphism analysis (example of 6 river systems in the central and south area of Miyagi Prefecture, Japan)

Column 4: Know the past and present of the river environment (Case of Japan)

The Ministry of Land, Infrastructure, Transport and Tourism and local governments have, since 1990, conducted a "national census on riverfront environments". The census covers 109 Class-A rivers and major Class-B rivers in Japan, as well as dams under direct control of the ministry, those managed by the Water Resources Development Public Corporation, and those subsidized by government. The purpose of the census is to collect and organize basic data by looking at rivers from an "environmental" perspective.

The census consists of several surveys, including a bio-assessment survey itemized into six categories (fish/shellfish, benthic animals, plants, birds, amphibians/reptiles/mammals, and land-dwelling insects and others), and river surveys examining the conditions of shallows, deep pools, etc. In addition, a "survey on the actual situation of river space usage" has been carried out to examine how rivers are used by people.

A bio-assessment survey is carried out on all the rivers surveyed in such a way that a series of surveys by category are completed over a period of several years.

The census results have been utilized as basic data which form the basis of many environmentally-conscious river projects.

As an example, the results of "national census on riverfront environments" can be collated as nationwide data on the actual condition and transition of river environments. Impacts can be summarized based on the census results as follows: • Secular changes in the habitats of alien organisms

· Compilation of case examples of the impact of alien organisms



(3) Creating awareness among residents in the basin

(a) Environmental education and capacity building

An important point in addition to basic research for river restoration is to find out what approach we can take on a regular basis, transmit such an approach throughout the region as part of ecological education, and preserve it through the generations.

To regenerate a once-destroyed river environment, there are many actions to be taken together with the government such as adoption of new laws and a water clarification system. However, there are many case examples reported in which the beauty of a once-contaminated river has been restored as a result of change in residents' use of daily water and increase in their concerns about the river.



Human chain campaign for river clean-up and restoration (Incheon, Korea)

River cleaning activity (Japan)



Example of various civil activities related to rivers

(b) Information-sharing

It is important to provide local residents with various river-related information and share the current river environment and activities toward river restoration among the local people concerned. Such an approach can strengthen the sense of community among the residents in the watershed area and contribute to increasing the number of supporters of river restoration activities.

Outside the watershed area, too, there are organizations that act toward improving river environment restoration. It is also important to share information about cases of success or failure with them and reflect such information in river restoration activities.



River Museum (Arakawa Museum of Aqua)

Holding a workshop



Date base on river environment (Date base of the national census on river environments) Books, pamphlets, and magazines on river restoration

(4) Building consensus for sustainable activities

To continue the river restoration approach, it is essential to establish a system where local people related to the river act cooperatively by sharing economical and spiritual benefits and values brought by river restoration.

It also is necessary in some cases to lobby the administrative agencies concerned toward introduction of new systems or easing of regulations to promote river restoration activities efficiently and smoothly.



Building consensus among stakeholders



Using a model to built consensus



Restoration of freshwater clams (Shinji Lake, Japan)



Regenerating storks in Maruyama River (Maruyama River, Japan)



Vitalization of the regional economy and water quality improvement by restoration of freshwater clams (Popular soup using local freshwater clams)



Vitalization of the region by regenerating storks (Local special products associated with the name of stork)

Column 5: Tools for visualization to help consensus building

At a meeting in which various river basin stakeholders participate for consensus building, an understandable explanation should be given to the participants according to their level of comprehension within a restricted timeframe. For that purpose, it is important to make use of "visualization" tools that give clear visual pictures of the project menu, its effects, etc.

The "RFC Viewer", for which research and development has been carried out by the Foundation for Riverfront Improvement and Restoration, is an example of such a visualization tool. It can instantly provide stereoscopic visual pictures of a river environment improvement plan, including nature-oriented river management and natural restoration of the river. It makes it possible to give a comprehensible explanation of river development to diversified targets, including the general public.



CG image reproducing the actual situation

CG image of a draft renovation plan

(1) Existing landform

(2) Excavation

Main features of the RFC Viewer

Plans for river channel forms, etc. (excavation/banking)

It is possible to freely carry out excavation or banking on the screen based on the existing landform, and to change (manipulate) the form of a river channel while visually confirming the progress. It is also possible to estimate soil volume in the area after it is changed.

Plans for landscaping

Trees, plants, animals and humans can be added to the image on the screen, which makes it easy to acquire a picture of landscaping. It is also possible to change the water level and confirm the image of the landscape according to the difference in the height of the water surface.

Modification of the downward-view point



Source : Foundation for riverfront improvement and restoration

(5) Securing healthy water quality and quantity

The first technological and political solution to restore rivers' environment is to restore the water volume and quality of rivers.

A river whose water is kept in good quality accommodates and nurtures a great variety of living things. Also, such a river is cherished by people. To improve the water quality of a polluted river, there are two kinds of solutions. One involves all the communities along the river, who make efforts to prevent polluted water from flowing into the river . The other purifies the polluted river's water, or brings some clean water into it.



Water quality improvement in the whole basin by sewer system

	-Approaches to reducing household wastewater
	Reduction of household load by basin residents / installation of wastewater treatment tanks / construction of sewers
Measures for the	-Approaches to reducing industrial wastewater discharged from factories and farms
whole basin	Wastewater regulations / reduction of wastewater load by each office / measures against agricultural wastewater
	-Other effective approaches
	Forest maintenance / proper land utilization control and improvement of recharging function
Measures for the river	-Installation of purification equipment (by the catalytic oxidation method, vegetation purification method, aeration, etc.) -Removal of polluted mud by dredging channels -Recovery of quantity of flow by discharging water reclaimed by cover systems

Example of measures effective for improving water quality

We take a lot of water out of a river for household, agricultural, and industrial uses. These intakes should be regulated. Also, the right volume of water must be maintained to let living things live and grow in it, and ships and boats run in the river. It is, therefore, important to let the right volume of water flow in the river to maintain a river's natural environment and uses.

Measures to secure the required volume of water include, among others, those to be taken by the communities in a river basin. For instance, they must not withdraw excessive volumes of water. Also, they need to store rainwater or let such water penetrate into the soil, to prevent rainwater from running into the river right away. There are other measures to secure new water sources – bringing in some water from another river basin, using water from treated sewage, and so on.



Babbling stream using treated water

Measures for securing new water sources	-Flushing discharge from a dam -Use of sewage-treated water -Water transmission from other basins
Measures for inside the basin	-Review and rationalization of each water right quantity (electricity generation, industry, and agriculture) -Improvement of the recharging function of the basin (construction of water-permeable paving and rainwater storage)

Example of measures for improving water quantity

Below, let us see some examples of the efforts to restore river water quality and volume in China, South Korea, and Japan.

(a) Efforts for restoration of water environment in China

Water treatment measures mainly include artificial wetland technology, bio-membrane technology, bio-manipulation techniques and plant purification technology. The function of artificial wetland is the physical-chemical-biological synthesis effects, including plant uptake, substrate adsorption and microbial degradation and so on. Bio-membrane technologies include biological corridor, biological filter and bio-contact oxidation ponds. Bio-manipulation technique aims to use the food chain hierarchy to control algal growth and eutrophication. Plant purification technologies mainly include biological floating bed and riparian plant repair techniques.



Heituwa artificial wetland of Guanting reservoir (Yongding River, China)

Heituwa artificial underflow wetland demonstration project aims to use artificial wetlands technology to control inflow pollution and improve water quality in Guanting reservoir. Heituwa artificial underflow wetland system consists of two parts: artificial wetland and stabilization pond. The system brings the heavily polluted water from the upstream of Guanting reservoir into the stabilization pond. After preliminary purification, part of the water discharge into the reservoir directly, the other part are introduced into the artificial wetland for deep treatment which can achieve the III-V* class standard of surface water.

* Water quality III means the water can generally be used in fishery. Water quality IV means the water is lightly polluted. Water quality V means the water is seriously polluted.

(b) Efforts for restoration of water environment in Korea

The Water Environment Management Master Plan proposed by the Ministry of Environment (MOE) presents the government's policy directions for the next 10 years (2006~2015). It aims to promote ecologically healthy water environment to ensure high quality water which breaks away from a policy that has been geared almost solely toward existing point sources of conventional pollutants deteriorating water quality, including BOD. The master plan presents policy directions for eight areas, including the promotion of ecologically healthy water environment. As a part of the plan, the government keeps expanding the investment in environmental infrastructures (e.g. wastewater treatment, sewerage treatment and sewer pipe) and enhancing investment efficiency.

Building various waste water facilities

To treat pollutant point source, sewage waste water treatment facilities, village level sewage pipelines, animal wastes treatment facilities, and reinforcement of TP treatment facilities should be constructed to secure healthy water quality. To control the pollutant non-point source, rainwater retention facilities, ecological detention pond, and agricultural pond and ecological wetland are also required.



Ecological detention pond and agricultural pound are installed (Korea)

(c) Efforts for restoration of water environment in Japan

Specific measures taken to ensure the quality and quantity of water include: (1) legal restrictions (e.g., control of water quality pollution in accordance with the regulations on industrial effluent and domestic wastewater, development of sewer systems, forest preservation in the entire basin area, and improvement of recharge functions by promotion of rainwater harvesting), and rationalization of water use; (2) supply of environmental flow (e.g. water conveyance from other basins, utilization of reclaimed water and surplus groundwater, and increase of river flow rate by flexible operation of dams); and (3) river purification (e.g. dredging of sediment, introduction of purification facilities to facilitate contact oxidation/pollutant removal by vegetation/aeration, and water quality improvement through river cleaning activities by local residents).



environment administration (Japan)

(1) Legal restrictions

For half a century since the enactment of the Water Quality Conservation Act on Public Water and the Law on Regulation of Industrial Wastewater in 1958, in order to prevent water quality pollution and enhance water retention capacity and recharge functions in river basins, the Japanese government have introduced various legal regulations, such as regulations on industrial effluent and domestic wastewater, regulations on underground seepage of hazardous substances, purification of polluted groundwater, and special measures concerning preservation of the water quality of drinking water sources. In addition, efforts to reduce the pollution burden are being made by establishing environmental standards and continuously monitoring water quality.

(2) Supply of environmental flow

In the Meguro River basin flowing through Tokyo Prefecture, water quality has significantly improved by developing sewer systems compared to the level during the period of great economic growth. Toward further improvement in the water environment, the following measures are being taken: release of reclaimed water under the Jonan Three Rivers Limpid Stream Restoration Project, utilization of surplus groundwater from subway tunnels, and experiments on water quality purification using water with a high concentration of dissolved oxygen. In collaboration with local communities, various efforts to improve water quality and quantity have been made for a long time to restore its waterfront environment where people can enjoy cherry-blossom viewing. As a result, the river is now designated as one of the "One Hundred Examples of Revived Waterways".



Utilization of reclaimed water and groundwater (Meguro River, Japan)



(3) River purification

In the Yamato River basin flowing through Osaka Prefecture, measures for effective water quality improvement have been taken with a combination of various purification methods: the "riffles and pools purification method" that uses the self-purification mechanism inherent in rivers, the "gravel contact oxidation method" that allows microorganisms on the surface of gravel to absorb and decompose polluting substances by making polluted water flow slowly through gaps between gravel, the "vegetation pollutant removal method" that purifies water by making water flow through reed fields which have a natural self-purification mechanism, and the "sand filtration + separation method" that purifies water by making water flow widely and shallowly through gravel laid as a contact material on the riverbed.

(6) Creating a lively waterfront and water amenity space

A second technological and political solution to restore river environments is to make rivers more accessible.

Along many rivers, many residents "get along" with the river in many ways, for instance using its water and the spaces along it daily, and holding traditional events and festivities related to it. Such river-human relationships have created a great diversity of local community cultures and history, while the waterfronts thrive with many living things, including humans.

It is, therefore, important to create more opportunities for people to "get along" with rivers by making them more accessible to people, so that people can use rivers safely and more comfortably. These opportunities help the people living along a river to become more concerned about it. This is crucial to restoration of the river's natural environment, including its water quality, volume and all the other aspects.

At the same time, development of such waterfront spaces should be integrated with city planning around the river, to improve the environment of the whole region along the river. Allowing waterfronts to thrive can lead to vitalization of the communities along them as well.



Water festival (Chao Pharaya River, Thailand)

Development of spaces with access to river water	 -Make it safe to access the water. -Build up facilities where people can relax and have a good time on the waterfront. -Build up facilities to make the waterfront and water surface safe to use. -Create tree shades on the waterfront.
Using the waterfront space	 -Use the waterfront and water surface for leisure activities and boat transportation. -Take a walk, or cycle along the river. -Hold enjoyable events and amusements specific to the waterfront. -Pass down traditional festivals and events related to water, generation to generation. -Hold activities to keep the river clean and care for the river.
Integration of the waterfront and city planning	-"Waterfront-facing" city planning -Create a space in the waterfront where community people can get together and have fun. -Create lovely integrated landscapes featuring both the communities and the waterfront.

Example of measures effective for improving water amenities



Landscaping of Yangtze River waterfront (Wuhan, China)

Below, let us see some examples of the efforts to restore water amenities in China, South Korea, and Japan.

(a) Efforts for improvement of water amenity of riverfront space in China

On the basis of realizing the social and economic functions of flood control and water supply, rivers can be restored to natural conditions through appropriate artificial intervention to improve the ecological value and aesthetic value. The riparian areas including floodplains, ponds and wetlands can be planned as the river protection and management areas with sufficient width or designed as ecological conservation area or public recreation area.



25 hectares grass are planted to form riparian green ring. The centre of the green belt are dotted with 13 distinctive small garden where are occupied by exotic architectural buildings and urban sculptures.

Water amenity space (Funan River, China)

(b) Efforts for improvement of water amenity of riverfront space in Korea

Businesses and amenities will be moved towards the waterfront to create a lively waterfront in many countries. The design goals are to combine natural features with great river restoration management plan to further enhance this already dynamic place to live, work, and visit.



Waterfront area made to a swimming pool for children and resting place for residents (Korea)



Green ways for strolling and cycling in the waterfront area of an urban stream (Korea)



A golf park for senior citizens in the waterfront area (Korea)

(c) Efforts for improvement of water amenity of riverfront space in Japan

Specific measures taken to improve the water amenity of riverfront space include: (1) development of water amenity space (e.g., building of water-friendly revetments and water amenity parks); (2) waterfront development in conjunction with town development (e.g., building of footpaths and open cafés at the waterfront); and (3) preservation of waterfront landscape (e.g. development of riverfront space in harmony with the surrounding landscape, and cleaning activities at the waterfront).



Water amenity space harmonizing waterfront area and town (Tsuwano River, Japan)

(1) Development of water amenity space

Tsuwano Town, through which the Tsuwano River flows, is a historic town that still carries the appearance of an old castle town with old town houses and roadside canals. In order to revitalize the region by using water culture in the Tsuwano River and channels, river restoration was started under the "Hometown River Improvement Project" in 1989. Diverse facilities were developed, including footpaths and stepped revetments allowing access to the waterfront, and masonry revetments matched to the landscape of Tsuwano Castle. As a result, a water amenity space in harmony with the Tsuwano River and historic town was created.

(2) Waterfront development in conjunction with town development

The Dotombori River flowing through the center of Osaka City had once been used as a ship course, irrigation canal, etc. But later, the riverfront and the city were separated by revetment development as part of flood control measures and water quality pollution. To restore the water city of Osaka, footpaths "Tombori Rier Walk" that could offer water amenities were constructed along the Dotombori River in 2004. Moreover, gateways to shops along the river were built in these footpaths, and the connection between the waterfront and urban area was restored.



Footpaths connecting the waterfront and urban area (Dotombori River, Japan)



Beautiful waterfront landscape protected by the region (Ichinosaka River, Japan)

(3) Preservation of waterfront landscape

In the Ichinosaka River flowing through Yamaguchi City, revetments were changed from concrete ones to masonry ones, and its historic landscape and habitat for fireflies were restored. Since then, local residents have continued cleaning activities and release of fireflies. For the purpose of creating a cityscape in harmony with the beautiful scenery of the Ichinosaka River which is a viewing spot for cherry blossoms and fireflies, the "Ichinosaka River Surrounding Area Landscape Guidelines, town development centered on the Ichinosaka River has been promoted.

(7) Restoration of nature to regain the natural environment of the river

A third technological and political solution to restore river environments is to bring nature back to the river.

Powered by natural erosions, transportations of substances, and depositions, rivers create a great variety of micro-topographies, which are in constant change. Taking advantage of such wealth of topographies, many living things live and grow in each locality, adapting to the local environment. Also, each river has its own, one-of-a-kind landscape. Moreover, these river spaces are connected to the upstream and downstream regions as well as to the surrounding land areas, enabling numerous living things to move among them.

In bringing nature back to a river, therefore, two things are crucial: one is to preserve or restore an environment where living things appropriate to the place can live and grow. The other is to ensure continuity with the upstream and downstream regions, as well as between the river and its surrounding basin.

At the same time, recently, expanding human activities have been bringing some species into places where they did not traditionally exist. These exotic species are threatening the existing species' life and growth. It is, therefore, also necessary to prevent entry of exotic species and eliminate such exotic influxes.



Securing river continuity (Anyang River, Korea)

Preserving or restoring the spaces where living things can live and grow	 -Minimize human alterations to the river and/or its surroundings. -Use natural materials, if such alterations are necessary. -Preserve or restore the variety of microtopographies, such as meandering, shallow waters and deep waters, artificial backwaters, sandbars, tidelands, waterfront vegetation, water springs, etc.
Ensuring continuity	 -Install fish passes in any structure that crosses a river. -Ensure continuity between a main river and its tributary streams. -Ensure continuity between a tributary stream and the marshes, rice paddies, etc., around it. -Preserve or restore the ecotones in the waterfront.
Taking countermeasure against exotic species	-Prohibit import of exotic species. -Eliminate exotic species.

Example of measures effective for restoring nature



Regeneration of the gravel river bed inherent (Kinu River, Japan)

Below, let us see some examples of the efforts to restore nature in China, South Korea, and Japan.

(a) Efforts for natural restoration of rivers in China

Expanding the floodplain space could enhance flood control capacity and the lateral connectivity of rivers and increase wetland area. River and lake interconnected project, cooperating with urban water operation system could ensure the water system connectivity. And sometimes if necessary, part of the dams should be removed. The meandering of river, the diversity of river cross-section and porosity of slope material should be restored to improve habitat spatial heterogeneity. The native species of river corridor should be restored, cooperating with necessary plant cultivation and other biological measures.



Natural river environment (Kuxihe River, China)

A series of engineering measures are taken during planning to improve the spatial heterogeneity of ecological landscape, maintain the natural meandering and follow the natural geo-morphological features. A variety of complex channel cross-section and porous permeable revetment materials are selected. At the same time, some measurements are utilized, e.g. fully maintaining the original landscape, such as waterfalls, making use of native vegetation, repairing the existing bridges and building a river landscape with a hydrophilic concept.

(b) Efforts for natural restoration of rivers in Korea

The water community in Korea is promoting collaborative activities that better coordinate the implementation of river restoration and local government, promote sustainable management approaches, and bring the know-how, energy, and strengths of many different stakeholders to the table. The government also tries to promote, facilitate and support best practice in river, watercourse and floodplain management across the Korea. Main focuses are to improve the environmental health of a river that is indicated by expanded habitat for diverse species. Enhancements may also include improved water quality and achieving a self-sustaining, functional flow regime in the stream system.



Eco-path secured through removal of weir (Hantan River, Korea)

Securing eco-path by removing weirs which lost their functions

A high weir located in the lowest part of the Hantan River was a structure of 2.8m in height and 190m in length, and has no fish ladder. The structure obstructs migration of fish and had a bad influence on the ecosystem. As the artificial structure is removed completely, organisms in the river can migrate freely, and the river has recovered its original shape.

(c) Efforts for natural restoration of rivers in Japan

Measures taken to conserve and restore biodiversity in rivers include: (1) efforts for conservation and restoration of the river environment, including the nature restoration project taking advantage of river disturbance effects; (2) river development focused on ensuring longitudinal/transverse continuity in rivers, including nature-oriented river management; and (3) eradication of alien species to protect ecosystems in rivers.

(1) Conservation and restoration of the river environment

The Chikuma River once had many streams with expansive sand gravel bars, and had been a very good biotope for river organisms.

But recently, its riverbed has been lowered by gravel extraction, etc., and its high-water channels have largely turned into land (aridification). It was also confirmed that plant species specific to riversides have decreased and that alien species, such as Robinia pseudoacacia and Sicyos angulatus, have invaded the area.

Therefore, high-water channels were excavated so that the power of flood could create a river environment suited to the spot. However, rivers have wide fluctuations in flowrates, etc., and it can be said that this situation is "only a phase in the fluctuation process". So the change in the environment should be observed by monitoring for a longer period of time.



Case in which high-water channels are excavated and natural disturbances are used (Chikuma River, Japan)



Creation of natural sandbars by maintaining sufficient river width (Kurome River, Japan)

(2) Ensuring longitudinal/transverse continuity in rivers

The Kurome River is an urban river, along which there are rows of cherry trees. Its existing riverbed was lowered to preserve the rows of cherry trees along river banks and ensure it's down flow capability.

By maintaining sufficient river width and leaving enough space to respond to changes in water routes and river banks due to the effects of the running water in the river channel, it became possible to allow sand gravel to accumulate in the inside bend, which led to success in conserving a river environment that would allow the creation of natural sandbars.

In recent years, the river has also become known as the site of a regional spring event, as well as a fishing spot where many people enjoy catching Ayu.

(3) Eradication of alien species

In the Kakita River, known as one of Japan's most famous spring water rivers, alien plants, such as Water speedwell, have grown thickly in the river channel and have threatened the habitats of precious species living in the Kakita River, such as Ranunculus nipponicus var. japonicus.

To respond to this, citizen volunteers have continued to engage in the eradication of alien plants in the Kakita River every month. Thanks to their efforts, the beautiful river environment has now been kept alive.



Eradication of alien plants in the river channel by citizen volunteers(above: before eradication, below: after eradication) (Kakita River, Japan)

5.Measures taken to achieve river environment restoration

(1) Case studies of river restoration in China

Xingjiangtang River

Background of river restoration

Xinjiangtang River is a plain river network, which usually has moderate flow velocity. Problems such as sedimentation, water and soil loss, shrinkage of water area, water quality deterioration are ubiquitous in Xinjiangtang River. More over, navigation in the river gradually faded away in recent years.

Bank erosion in Xinjiangtang River is mainly due to surface soil erosion caused by rain wash and slope collapse caused by wave scour.

According to preliminary statistics, of the all river sludge, 60% comes from slope collapse, 30% is from surface soil loss and 10% is from decomposed material of plant.

Project Planning and Design

In combination with the implementation of a research program financed by the Ministry of Water Resources, from 2004 to 2005, China Institute of Water Resources and Hydropower Research was involved in the construction of a pilot project for the ecological restoration of Xinjiangtang River in Haining County of Zhejiang Province by supplying technical consultation to local water sector.

The planning and design of Xinjingtang River follows the concept of design with nature to achieve the multi-purposes.

Present platform morphological patterns are kept and only a few local modifications are conducted to meet special requirements. The natural meandering and width of the river channel are maintained. Floodplain and riparian wetlands are rehabilitated. Natural cross-section profile is preserved as much as possible. Compound or trapezoid cross section is adopted only in particular conditions.



The effect and current situation of river restoration

By the implementation of these comprehensive measures, the results of Xinjiangtang River restoration project accord with primary design. The standard of flood control is improved; riverbank erosions are effectively controlled; water quality is improved; aquatic animals and riparian vegetation grow well and the project budget is greatly saved.

By analysis and comparison with historical river treatment achievement, the life cycle is

about 10 to 20 years with the only use of traditional river dredging. However, river dredging together with slope protection by use of ecological engineering technology can stabilize channel morphology effectively, and the life span is about 35 to 40 years which nearly double the old life cycle according to preliminary analysis.

The future management should pay more attention to river dredging, which can save investment and the river training will embark on a more effective circle.



The present Xinjiangtang River

Zhuanhe River

Background of river restoration

The Zhuanhe River, a segment of the north-ring water system, connects the Summer Palace and the Chaoyang Park. Zhuanhe River is an urban river system. Zhuanhe River was covered up from 1975 to 1982, and the river training project started from 2002 to restore the original appearance of its history.

Along with the development of social economy and people's constant pursuit for better living environment, people have put forward comprehensive requirements on the training of urban lake and river in many aspects including flood prevention, water quality improvement, ecology conservation and restoration as well as cultural landscape etc.

During the Tenth Five-year Plan period, Beijing focused on the training of water system in central urban and the investments were increased compared with the past years. In addition to traditional river training objectives, i.e. flood control and drainage, new objectives are added in the aspects of landscape and ecological rehabilitations in order to realize the harmonious coexistence of human and natural water.

Project Planning and Design

Its training follows the planning and design principles of maintaining its natural meandering and width. Stones and wood-like concrete piles, porous and pervious materials and live vegetation are applied for riverbank protection and erosion control.

The flood control standard is designed with 20 years-flood and checked with 100 years-flood. Wastewater discharge is under strict control and the water surface is expanded to 15-25m.

To develop tourism, the river is open to navigation. To this end, a new lock, 13 bridges, two docks, and a sluice are completed.

The effect and current situation of river restoration

Six scenic spots including historical and cultural parks, ecological parks, water scenes with stacked stones, waterfront veranda, hydrophilic land and green channel are formed along the river.

By the principle of maintaining the current status non-disturbance the basis, the bridge built in the Liao Dynasty is restored.

After river restoration of Zhuanhe River, the biological diversity is significantly improved, and the fish, frogs and other species come back to this river. Vegetation and human landscape are recognized by the majority of the residents.



The present Zhuanhe River

(2) Case studies of river restoration in Korea

Cheong gye cheon

Background of river restoration

The Cheong gye cheon, which flows in downtown Seoul was filled up with trash, ground and sand swept from the bare mountains and severely contaminated with wastes from shabby makeshift houses built alongside in 1940 to 1950s. It became a symbol of poverty and slovenliness, being filled up with trash and wastes.

During industrialization and modernization in 1960 and 1970s, the stream was covered with concrete and a 5.6 km-long, 16 m-wide elevated highway was completed over the stream in 1971 after four working years.

A multitude of large and small tool, lighting, shoes, clothes, secondhand book stores were opened one after another along the concrete-covered stream, attracting some endless lines of customers. Every day there were hundreds of thousands of vehicles passing through the covered stream and the elevated highway. The area eventually became the busiest and noisiest sector in Seoul. Then, in the 1990s it came to be regarded as a source of intense traffic, health and environmental issues.



Around 1950

After 1971

Present

Efforts for river restoration

First, Seoul metropolitan government removed the elevated highway and restored the dead stream under highway. The project was worked for 3 years from 2003 to 2005, with the budget of 291million US\$ aiming for the restoration of history, culture and environment of Seoul.

As Cheong gye cheon rarely has water in normal, the water of amount 120 thousand m^3 per day is supplied from Han River and underground water in subway stations. As a result, the water depth of 30~40cm can be maintained.

Another effort was made to excavate and restore historical objects and sites in this stream as well as in some other areas of the city.

Current situation and future prospects of river restoration

Seoul has a clean water flow and a clean environment for fishes and plants in downtown. Besides, two-lane roads were built on each side of the stream. The 22 bridges and the paths made on both side of stream help people take a rest alongside or nearby.

This work is making people regain the past pride of those living at the heart of nation's long history and splendid cultures.

Removal of covered concrete and restoration of stream gives the citizens the good open space and nature in downtown area and enhancement of the quality of life.

The City of Seoul is planning to expand green areas in residential area to 810 acre and to widen and develop access roads to the Han River. Also, the city has set the connective projects to build up a citizen's square and downtown culture/tourism belt designed to turn the downtown into a place for tourists, along with the Cheong gye cheon.

Osan cheon

Background of river restoration

Urbanization and industrialization, which started in the early 1960s, especially accelerated the degeneration of river ecosystems. Pavements with non-percolated material such as asphalt and concrete in urban areas caused lack of groundwater recharge and thus lack of stream flow recharge.

In 1994, Osan cheon was selected as a pilot project site and the project was completed in 2003.



Efforts for river restoration

The river was improved to a close-to-nature river using natural materials.

Parking lots were removed to make an ecological park and farming was banned on the flood plane.

Gently sloping levees (1:5) were constructed and ecosystem was restored.



Improvement of Concrete parking lots

Current situation and future prospects of river restoration

The BOD of the Osan cheon reached 2-5ppm, and it has remained stable to meet environmental standards after the project.

Response of local residents has increased due to greatly increased use of waterfront park. Government is monitoring to develop technologies about various environmental methods.



Stepping stone

Foot protection stone

Yang jae cheon

Background of river restoration

The Yang jae cheon, originating from a hilly and mountainous region, is located at the southwest part of the metropolitan Seoul, and flows though Gwacheon City. When large-scale housing projects were performed in 1970s, the river was straightened to provide flood protection.

Because of urbanization, the BOD of the Yang jae cheon reached 15mg/l and the river became a sewer-converted river.

Yang jae cheon "park river" project was carried out in 1995, to meet increasing interests in natural environments of local residents as living standards were improved.

Efforts for river restoration

The local government carried out the environment improvement project and some companies joined in voluntarily.

Various measures were taken to improve water quality. For example, a sewage system was improved and a water purification system was installed in the basin. The river was improved up to a close-to-nature river.

The Yang jae cheon has various waterfront facilities. (Swimming areas and rice farming experience place).



Today, this area boasts 10,000 visitors daily who come to see its changes and experience a refreshing green oasis within suffocating black smog and mob of the city. And various cultural events are held in waterfront such as film festivals and musical concerts. The BOD of the Yang jae cheon reached 2mg/I. This is an environmentally friendly area that is home to 36 different kinds of birds and about 22 types of fish and marine life. Gangnam-gu (District) office offered a new method of purification to improve river

a River Restoration Korea River Restoration Netw





environments.





(3) Case studies of river restoration in Japan

Sumida River

After the 17th century, town development in Edo was started by the Tokugawa Shogun ate. At the time, the Sumida River provided various types of entertainment, such as fireworks, cherry blossom viewing and houseboat cruising, while it served as the main artery of material transportation. The river attracted many people, and an abundant culture flourished which centered on the river.

Since the late 19th century, a number of factories and warehouses were constructed along the Sumida River because of convenient transportation by water and the population increased,

which resulted in an accelerated decline in water quality. In particular, during the period of rapid economic growth in the 1950s-1960s, when BOD (biochemical oxygen demand) reached 40 mg/L, the environmental degradation in the river reached its peak. River water became dark and muddy, and the surrounding area suffered an offensive odor coming from the river. In the Sumida River, the firework festival to mark the river's opening continued to be held even after the Meiji Period, and boat races had been held since 1905, which



attracted many visitors, but these were called off in 1962 due to the effects of water quality pollution.

On the other hand, because of floods which frequently struck the downtown Tokyo area, including the Great Flood in 1910, and ground sinkage which was accelerated by the overuse of groundwater, flood control measures have become increasingly important to protect the capital city Tokyo from floods and storm surge. To that end, the construction of storm surge levees was started in 1957 and almost completed in 1975. Completed vertical-wall-type



storm surge levees reaching a height of 3-4 meters, which were called "kamisori (razor) levees", separated the waterfront from urban areas along the river. As a result, the waterfront landscape that had long been loved by citizens and the bustle of people disappeared.

Since the 1960s, the development of sewer systems in the river basin area moved ahead at a fast pace, and the sewer system coverage finally reached 100% in 2010, a huge increase from just 10% in 1961. In addition, various efforts for water quality improvement have been made, including sludge dredging, tightening of regulations on industrial effluent, and induction of purification water from the Tone River. For the purpose of reinforcing the storm surge levees which were urgently constructed and improving their earthquake resistance as well as restoring water amenities, the construction of moderate-slope-type levees was begun in FY1980, and the construction of super levees was begun in FY1985. Especially in the area where super levees were constructed, a higher quality waterfront space was created by carrying out construction work in line with redevelopment of urban areas near the river and river facilities such as a park. Along with these projects, the construction of a terrace at the water's edge (footpath) and greening of revetments have been promoted.

5. Measures taken to achieve river environment restoration





Waterfront space as a recreation place for people

Biotope created on the terrace

BOD in the Sumida River decreased to 7.4 mg/L in 1978, falling below the level of environmental standards at that time, and it has been stably maintained at the level of environmental standards since then. The water quality of the Sumida River has been improved significantly, and there are indications that populations of fish, waterfowl and aquatic organisms on the river banks are recovering.

Offensive odors have disappeared, a water amenity space with a terrace on the water's edge has been created, and now many people gather again at the waterfront of the Sumida River. The fireworks festival and boat races were revived in 1978, and the number of cruises by sightseeing boat has increased. The river has become popular among tourists inside and outside Tokyo.

Tokyo Prefecture drew up an "Overall Plan for Improving Attraction of Waterfront Space in Tokyo" in 2006, and advocated emphasizing "restoration of the beautiful city of Tokyo surrounded by water and green corridors" in "Tokyo's Big Change--the 10-year Plan", which was drawn up in the same year. Thus, Tokyo will make further efforts to improve waterfront space including the Sumida River as an important pillar of urban design strategies.



Festive atmosphere during cherry blossom viewing season

Boat race

Jzumi River

The Izumi River is a small river flowing through lowlands at the bottom of the valley in the middle of plateaus in the west of Yokohama City, and takes its water from spring water of the Yato cliff line. Farmland and slope woods remained at the riverside of the middle and lower stream, while the riverside area had been rapidly urbanized because the area was near the center of Yokohama City. As a result, the river easily flooded even with small rainfall in the 1970s. To respond to this, steel-sheet-pile revetments were constructed and the riverbed was deeply excavated, which made the river inaccessible. It was really a sewage canal due to the serious deterioration of water quality.



Area along the Izumi River where woods and green spaces are left in the urban district

Since 1987, Yokohama City drew up a plan to utilize the land abutting the river and improve the river, in line with other projects for developing parks and conserving green space, while holding workshops for elementary school children living in the river basin. Then, the plan was actually begun after being designated as the Hometown River Improvement Project in 1989, and various waterfront bases were established, including the "Waterfront of Jizohara", "Waterfront of Higashiyama", "Waterfront of Sekigahara" and "Waterfront of Futatsubashi". For example, at the "Waterfront of Higashiyama", the river width was increased, and the shapes of flow channels and river banks were arranged to suit surrounding geographical features. The slope woods on the left bank of the river were also improved along with the development of river space. As a result, a greenery space that could attract citizens was created.



Waterfront of Higashiyama before improvement

In the improved waterfront space, children enjoy playing in the water and catching crawfish, and many people enjoy strolling along the river. It has become a space loved by citizens, and attracts a lot of visitors. At present, there are eight waterfront associations in the Izumi River basin, which take the lead in periodic river cleaning activities voluntarily carried out by local residents. Through those activities, people can feel close to the river, and an increasing number of people are becoming more interested in rivers. Thus, the waterfront space has become deeply entrenched in the community.

With the increase in sewer system coverage, the water



Present waterfront of Higashiyama



Present waterfront of Higashiyama

quality of the Izumi River has improved, maintaining a BOD of 5 mg/L or less since 1996, when it had decreased from 10 mg/L or more by 1993. Thanks to such water quality improvement and river improvement work, as regards the habitats of living organisms, there has been an increase in their populations. At present, Yokohama City is taking various measures based on the "Action Plan for Izumi River Basin Water Circulation Restoration" drawn up in 2002 with the aim of restoring the water quantity/quality and clear spring water of the 1950s.



Present waterfront of Higashiyama

】 Kushiro River

In the downstream area of the Kushiro River, there is about 180 km2 of an expansive wetland. This, Japan's largest wetland, is the habitat of precious animals and plants, and is the first of Japan's wetlands to be designated as a wetland of international importance under the Ramsar Convention in 1980. The great flood of 1920 served as a trigger for a fully-fledged flood control project for the



Kushiro Wetland

Kushiro River, which started with river improvement by straightening streams meandering through Kushiro Moor. Also in the basin area, development had been promoted. As a result, part of the wetland was turned into farmland and urban districts, and the surrounding area was deforested.

Such river improvement and changes in land use increased sediment inflow into the wetland and decreased flood frequency, which resulted in about 20% decrease of wetland area over 50 years from 1947 to 2004. This caused deterioration in wetland landscape and scenery, and made a serious impact on wetland ecosystems, including a decrease in the population of rare wild species and deterioration in the habitat of Japanese red-crowned cranes.



Changes in area of Kushiro Wetland (1947-2004) Source : Kushiro Development and Construction Department, Hokkaido Regional Development Bureau, MLIT

The Ministry of Land, Infrastructure, Transport and Tourism set up a "Review Committee on River Environment Conservation in Kushiro Wetland" in 1999, and started efforts for river environment conservation and management in Kushiro Wetland. After the "Act on the Promotion of Nature Restoration", the "Kushiro Wetland Nature Restoration Association" was set up in 2003 in collaboration with the Ministry of Land, Infrastructure, Transport and Tourism, the Ministry of the Environment, the Ministry of Agriculture, Forestry and Fisheries, local residents, NPOs, local authorities, and academic experts, and then a nature restoration project for Kushiro Wetland was launched in earnest. With the aim of restoring the "wetland environment before designation under the Ramsar Convention", this nature restoration project promotes consideration and implementation of a wide range of efforts to be made in the whole basin, including prevention of sediment inflow into the wetland, restoration of meandering streams, restoration of wetland, and tree-planting on bare ground and degraded land.

5. Measures taken to achieve river environment restoration

The nature restoration project for Kushiro Wetland aims for "recovery of wetland ecosystems in quality and quantity", "restoration of circulation that maintains wetland ecosystems", and "creation of a society that can achieve a sustainable relationship with the wetland". The members of the Nature Restoration Association are promoting the project based on the division of roles. The progress of these efforts has been checked every five years, and the details have been reviewed every 10 years. In meandering streams restored in Kayanuma district, the presence of aquatic organisms has been confirmed, and some people enjoy fishing. It is expected that the goal of restoring the wetland landscape and ecosystems that had been in the past, will now be achieved.

The Kushiro River and Kushiro Wetland are known as a nesting place of Japanese red-crowned cranes, one of Japan's special natural treasures, as well as one of Japan's famous sightseeing spots which attracts many tourists who look forward to canoeing and nature watching. Efforts for nature restoration in Kushiro Wetland are regarded as a pioneering example in Japan, and it is expected that they will be further promoted toward the achievement of goals.





Restoration of meandering streams in Kayanuma district



Special national treasure, the Japanese red-crowned crane



Canoeing

Appendix 1 Countermeasure Chart for River Restoration (draft)

This countermeasure chart (draft) introduces concrete technics/policies to achieve the Chapter 4 "Implementation approaches for river environment restoration". We continue to revise this chart to complete the technical guideline for river restoration through discussions by ARRN members.

Countermeasure Chart (1/2)

4.(2)Survey and	research to clarify the nature of rivers
Phase 0 :	Collection of basic information for understanding basins and rivers
Principle/Concept	Studies and researches to obtain new knowledge
Phase 1 :	Collection and classification of basic information (channel shapes, growth and habitation of living
Basic Approach	things, hydrologic data, water level, and water quality, etc.)
	Survey on the nature and social properties around the basin (Grasp of unique properties according to
	nature and climate, living environment, industrial economy, social culture, etc.)
	Hydrologic survey (rainfall, water level, flow volume, flow velocity etc.), Water quality survey
	(physical / chemical water quality, biological water quality)
	Survey on waterfront utility, facilities, river landscape etc.
	Grasp of the ecosystem in river zones (physical characteristics of ecosystem dynamics,
	characteristics of vegetation, and characteristics of animal community, etc. in river zones)
	Grasp of the condition of water cycle system (basic survey / method for learning the past / present
	/ future condition of water cycle system, etc.)
	Survey on sewage treatment (sewage treatment, wastewater treatment, etc.)
	Characteristic survey on hydraulics and water quality in lakes and dam reservoirs (present state of
	eutrophication and accompanying changes in biota / ecosystem, etc.)
	Quantitative measurement by water pollution analysis etc. and forecast (elucidation and grasp of
	phenomena concerning water quality, establishment of water quality analytical models, etc.)
	Collection of related guideline and toolboxes on river restoration
Phase 2 :	Promotion of research and survey for obtaining new findings (setting of water quality items,
Advanced	elucidation of water pollution phenomena, development of prediction / evaluation techniques, study
Approach	on river ecology etc.)
	Implementation of pilot projects for deeper understanding and recognition (setting of model rivers
	etc., implementation of pilot projects)

4.(3)Creating aw	areness among residents in the basin
Phase 0 :	Environmental education and capacity building
Principle/Concept	Information-sharing
Phase 1 :	Establishment of an information sharing system
Basic Approach	Public announcement and publicity activities for the effect of the project (information provision to
	mass media etc.)
	Public relations and awareness raise on river restoration (brochure, newsletter, books etc.)
	Information dispatch (river condition, water quality, water level safe information etc.)
	Environment education
Phase 2 :	Program development of environment education and personnel training
Advanced	Establishment and publication of database on rivers, establishment of support center
Approach	

4.(4)Building con	isensus for sustainable activities
Phase 0 :	Building consensus and legal/institutional scheme
Principle/Concept	Co-ordination with stakeholders (cooperation and adjustment with various plans)
Phase 1 :	Local commitment (basic policy, cooperation between promoting bodies, promotion system,
Basic Approach	assessment)
	Application of PDCA cycle
	Installation or reconstruction of legal and institutional framework
	Economic evaluation of environmental volume (CVM etc.)
	Training of facilitator for helping consensus formation
	Others (installation of public-involvement system, town meeting)
Phase 2 :	Establishment of co-research/technological development organization by public sector and private
Advanced	sector
Approach	combination
	Installation of basin management system (IWRM etc.)

Contents included in this reference guideline **ver.2**

Phase 0 : Approaches toward Water quality improvement Principle/Concept Approach to improving quantity of flow Phase 1 : Setting of environmental standards for water quality (health items, living environment items, etc.) Planning/Design Setting of consolidation object of water quality (appropriate goals according to the purpose of water use, of contamination, etc.) Legislation concerning wastewater control (factory Law, agricultural chemicals regulation law, water pol control law, environmental pollution prevention act, etc.) Comprehensive measures, groundwater contamination measures, drinking water source measures, lake water or conservation measures, groundwater contamination measures, drinking water source measures, etc.) Formulation of sewerage plan, improvement plan / design for treatment facility, sludge treatment facility, etc.) China of required flaw quartity (onvironmental flaw gets)
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Formulation of sewerage plan, improvement plan / design for treatment facilities etc. (sewage treatment, s disposal, rainwater drainage plan, facility plan, water treatment facility, sludge treatment facility, etc.)
Sotting of required flow quantity (anvironmental flow atc.)
Setting of required now qualitity (environmental now etc.)
Consideration of the effect of measures, grasp of project cost (calculation of construction cost and mainte expenses, etc.)
Project implementation according to priority (determination the urgency of project and implementation project according to the urgency, etc.)
Adaptive / step-by-step implementation of project (adaptive management that performs a project step by with feedback to the plan according to situations)
Phase 2 : Direct purification technology for rivers, lakes, etc., execution method thereof, and device considered for th Construction/ (gravel purifying method, vegetation purifying method, etc.)
Maintenance Construction method for sewerage treatment facilities etc. and device considered for the site (construct piping facilities, pumping station facilities, water treatment facilities, sludge treatment facilities, etc.)
Construction method considering the surrounding environment and device considered for the site (constru- with less impact on the surrounding environment)
Implementation of continuous monitoring (water quality control [rivers, sewage facilities, etc.], arrangem the river water automatic monitoring system, etc.)
Implementation of follow-up and assessment (environmental standards achievement ratios and p assessment of the effect of policies)
Improvement of the river register and implementation of facility maintenance (register improvement, f
Improvement of the sewage register and implementation of facility maintenance (register improvement, f maintenance, etc.)
Formulation of monitoring method and implementation of monitoring (implementation method, superstabilishment, etc. for monitoring pollutant sources)

4.(6)Creating a l	ively waterfront and water amenity space
Phase 0 :	Creating a waterfront unified in the region
Principle/Concept	Water amenity activities to rediscover the attraction of the waterfront
Phase 1 : Planning/Design	Formulation of water affinity improvement plans (development of water amenity facilities such as water park, amenity-oriented revetment, policy to use for recreation)
- 5, 5	Formulation of river landscape plans (development of good riverscape)
	Formulation of policy to utilize the environment, disaster prevention, and space functions provided by rivers.
	Formulation of a comprehensive improvement policy for town planning with river utilization (urban restructuring with river utilization)
	Planning recreation activities related to history and culture
	Plan harmonizing flood control plan with environmental measures (environmental measures in consideration of flood control plan)
	Consideration of the effect of measures, grasp of project cost (calculation of construction cost and maintenance expenses, etc.)
	Project implementation according to priority (determination the urgency of project and implementation of the project according to the urgency, etc.)
	Adaptive / step-by-step implementation of project (adaptive management that performs a project step by step with feedback to the plan according to situations)
Phase 2 : Construction/	Technology for enhancing river affinity, execution method thereof, and device considered for the site (amenity oriented revetment, water park, green way, biotope, etc.)
Maintenance	Construction method considering the surrounding environment and device considered for the site (construction with less impact on the surrounding environment)
	Implementation of continuous monitoring (monitoring for conservation of river landscape etc.)
	Implementation of follow-up and assessment (impact evaluation and minimization of harmful impact)
	Setting and implementation of maintenance (formulation of a maintenance plan etc.)

4.(7) Restoration of nature to regain the natural environment of the river						
Phase 0 :	Securing the continuity of the river					
Principle/Concept	Conserving a diversified ecosystem by using the regenerative ability of nature					
Phase 1 : Planning/Design	Setting of the environment to be preserved and measures (growth areas (riffles and pools / revetment), spawning ground, fish pass)					
5, 22 5	Formulation of a nature-friendly river work project (measures for canceling problematic river works, and measures for raising the entire level of river works)					
	Formulation of a nature restoration project plan (goal setting, draft plan formulation / forecast, analysis, etc.)					
	Formulation of measures against alien species (measures / control on influence by invasive species)					
	Formulation of a water cycle plan (planning for the entire basin from the upper to down streams taken in consideration of the dynamic property of flow regime, comprehensive sediment control)					
	Plan harmonizing flood control plan with environmental policy (particularly, urban river improvement plan, maintenance of flood control function, conservation of biodiversity, etc.)					
	Consideration of the effect of measures, grasp of project cost (calculation of construction cost and maintenance expenses, etc.)					
	Project implementation according to priority (determination the urgency of project and implementation of the project according to the urgency, etc.)					
	Adaptive / step-by-step implementation of project (adaptive management that performs a project step by step with feedback to the plan according to situations)					
Phase 2 : Construction/ Maintenance	Engineering method, construction method, and device considered for the site in nature restoration projects (phased implementation / management, consideration for elements that influence rivers and the structure of their surrounding space, securing of continuity with branch rivers and flood areas through correction of level difference in water surface, etc.)					
	Construction method considering the surrounding environment and device considered for the site (construction with less impact on the surrounding environment)					
	Implementation of continuous monitoring (monitoring for conservation concerning ecosystem, water cycle, etc.)					
	Implementation of follow-up and assessment (impact evaluation and minimization of harmful impact)					
	Setting and implementation of maintenance (formulation of maintenance plan and basin-based management, measures and management focused on ecosystem and natural resources, etc.)					
Contents included in this reference guideline ver.2						

Appendix 2

List of resources for river restoration (Only web site in English)

No	Basic information				Feature of information	
	Title of Web site	Country	Organization	URL	Case projects	technical guideline
1	Literature river restoration	Europe	European Centre for River Restoration (ECRR)	http://www.ecrr.org/ecrr-literatu re-river-restoration.html		0
2	Projects river restoration	Europe	European Centre for River Restoration (ECRR)	http://www.ecrr.org/projects-riv er-restoration.html	0	
3	ECRR past activities	Europe	European Centre for River Restoration (ECRR)	http://www.ecrr.org/ecrr-procee dings.html	0	
4	Search for Life Projects	Europe	Financial Instrument for the Environment of EU (LIFE)	http://ec.europa.eu/environmen t/life/project/Projects/index.cfm	0	
5	Sharing European environmental datasets, maps, charts and applications.	Europe	European Environment Agency (EEA)	http://www.eea.europa.eu/data- and-maps	0	
6	Map of River Projects	Britain	The River Restoration Centre (RRC)	http://www.therrc.co.uk/rrc_cas e_studies.php	0	
7	London Rivers Action Plan	Britain	The River Restoration Centre (RRC)	http://www.therrc.co.uk/lrap.ph p	0	
8	RRC Conferences	Britain	The River Restoration Centre (RRC)	http://www.therrc.co.uk/rrc_con ferences.php	0	
9	Manual of River Restoration Techniques	Britain	The River Restoration Centre (RRC)	http://www.therrc.co.uk/rrc_ma nual_pdf.php		0
10	References (Manuals, References of General Interest, and Scientific Publications)	Britain	The River Restoration Centre (RRC)	http://www.therrc.co.uk/rrc_refe rences.php		0
11	River Corridor and Wetland Restoration	USA	USA Environment Protection Agency	http://www.epa.gov/owow/wetla nds/restore/	0	0
12	Restoring Rivers	USA	American Rivers	http://www.americanrivers.org/o ur-work/restoring-rivers/	0	0
13	American Rivers Publications and Reports	USA	American Rivers	http://www.americanrivers.org/li brary/reports-publications/	0	0
14	Restoration & Management	USA	JOSEPH M.WHEATON	http://www.joewheaton.org/rive r-links/restoration-management- 1	0	0
15	River Restoration and Integrated River Basin Management	USA	JOSEPH M.WHEATON	http://www.joewheaton.org/rive r-links/river-restoration-and-inte grated-river-basin-management	0	0
16	USGS Fact Sheets (listed by Environmental Theme)	USA	US Geological Survey (USGS)	http://water.usgs.gov/wid/index- environ.html	0	0
17	Projects in North Carolina	USA	US Geological Survey (USGS)	http://nc.water.usgs.gov/project s/		0
18	PROGRAM OVERVIEW	USA	U.S. Fish and Wildlife Service (U.S. FWS)	http://www.fws.gov/mountain-p rairie/pfw/r6pfw2h.htm	0	0
19	Stream Survey Publications	USA	U.S. Fish and Wildlife Service (U.S. FWS)	http://www.fws.gov/chesapeake bay/streampub.html	-	
20	Stream Corridor Restoration	USA	Stream Corridor Restoration	http://www.nrcs.usda.gov/Techn ical/stream_restoration/	0	0
21	Maryland Streams	Australia	Maryland Department of Natural Resources	http://www.dnr.state.md.us/stre ams/	0	0
22	ARRC Publications	Australia	Australian Rivers Restoration Centre	http://australianriverrestorationc entre.com.au/resources/		0
23	Sustainable management of running waters	Switzerla nd	WSL, Eawag,	http://www.wsl.ch/land/products /rhone-thur/en/publications.php		0
24	Nature conservation in the Netherlands	Netherla nds	Netherlands Ministry of Agriculture, Nature Management & Food Quality (NMV)	http://www.minlnv.nl/portal/pag e?_pageid=116,1640354&_dad= portal&_schema=PORTAL		0
25	List of projects with the chosen topic: Water	Denmark	Danish National Environmental Research Institute, part of the university of Aarhus (NERI)	http://www.dmu.dk/Internationa I/Water/Projects/	0	
26	CIRF Projects	Italy	Centro Italiano per la Riqualificazione Fluviale (CIRF)	http://www.cirf.org/php/inglese/ home.htm	0	
27	IWHR Publications	China	China Institute of Water Resources and Hydropower Research (IWHR)	http://www.iwhr.com/zswwenglis h/index.htm		0
28	World's WATERFRONT: JAPAN	Japan	Japan River Restoration Network (JRRN)	http://www.a-rr.net/jp/en/water side/domestic/index.html	0	

Epilog

- For promotion of further river environment restoration in Asia

We issued this guideline in the hope that it will contribute to motivating a new movement to look at issues related to nearby rivers and watershed areas and restore them to be in healthy condition.

This guideline introduces the basic idea of river restoration in plain words as a primer to the "river restoration technical guideline in Asia" which the ARRN aims to establish, but it does not cover all the necessary points in considering river environment restoration issues.

We will complete the practical technical guideline for river restoration through discussions by ARRN members, which can satisfy citizens tackling river environment improvement, engineers working for government or companies, and researchers supporting them academically.

The ARRN will make continuous efforts not only to publish the guideline but also to provide opportunities to share useful information and exchange people related to river restoration. For this purpose, your continued support and cooperation would be appreciated. The outline of the ARRN is available at the following website, and if you send your comments about this guideline to the ARRN secretariat at the following e-mail address, it would also be appreciated.



About ARRN

Background of ARRN Establishment

In the "River Restoration in Asian Monsoon Region" session cosponsored by three countries of China, Korea, and Japan that was held in the 4th World Water Forum in Mexico City in March 2006, the necessity of cooperation among Asian countries was emphasized, and it was recommended that a network and a database should be established to exchange information on river/watershed restoration, and that a technical guideline specifically suitable for the Asian monsoon region should be developed. As a response to this recommendation, the "3rd International Forum on Waterfront and Watershed Restoration" was held in Tokyo in November 2006, and "Asian River Restoration Network (ARRN) " was formally established by concerned organizations of China, Korea and Japan.

Objectives

ARRN aims to contribute to the creation of rich Asian water environment for the following two purposes as a non political organization.

- To establish a mechanism to exchange and share case studies, information, technologies, and experiences related to river/waterfront restoration in the world and in the Asian countries, with engineers, researchers, ecologists, government officials and citizens through events and websites.
- To establish a river/watershed restoration guideline that can be utilized in the Asian monsoon area with similar social and natural environment, and improve knowledge and skills of network participants.

Activities

ARRN carries out following activities to achieve the above-mentioned objectives.

- Activities involving exchanging and sharing information through newsletters to be distributed on the web-site and by e-mail
- To hold workshops and forums with a view to provide a platform to introduce or compile information on the latest global waterfront situation and case studies of improved waterfront environment
- To draw up or revise guidelines for the restoration of rivers and watersheds
- To conduct joint studies to be undertaken by participating countries to support the provision of information for study purposes
- To exchange lecturers from participating countries
- To translate and publish books on the restoration of rivers and watershed



ARRN's establishment ceremony (Nov. 2006)



Outline of ARRN network activities

List of photo and figure suppliers

Water Quality Engineering laboratory, Tohoku University				
Kushiro Development and Construction Department, Hokkaido Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism				
Chikuma River Office, Hokuriku Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism				
Yamato River and National Highway Office, Kinki Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism				
Toyooka River and National Highway Office, Kinki Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism				
Miharu Dam Management Office				
Bureau of Environment, Tokyo Metropolitan Government				
Bureau of Construction, Tokyo Metropolitan Government				
Shimane Prefecture				
Toyooka city				
Yokohama city				
Aqua Restoration Research Center, Public Works Research Institute				
Japan National Tourist Organization (JNTO)				
Foundation for Riverfront Improvement and Restoration				
CTI Engineering Co., Ltd.				
Docon Co., Ltd.				
SUGANO Printing Co., Ltd.				
NPO Azame Group				
NPO Groundwork Mishima				
Jianhua LI				
Kazuya Egami				
Rino Sugahara				
Yoichiro Fukutomi				
Takahiro Sakamoto				
Yuj Miura				
Shinichi Yoshimura				
Beijing Institute of Water				
China River Restoration Network				
Korea River Restoration Network				

ver.2

Reference Guideline for Restoration by Eco-Compatible Approach in River Basin of Asia

March, 2012

<Publishing>

Asian River Restoration Network

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Japan River Restoration Network (JRRN) has a role of ARRN secretariat from Nov. 2006 to Oct. 2012. Secretariat of ARRN and JRRN is operated by **Foundation for Riverfront Improvement and Restoration** and **CTI Engineering Co., Ltd.** as joint study on development of Asian River Restoration network.

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