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ISSN 0386-5878
Technical Memorandum
of PWRI No. 3265

River Management and Planning in Japan

March 1994

Environment Department

River Department

PUBLIC WORKS RESEARCH INSTITUTE

Ministry of Construction

1, Asahi, Tsukuba-shi, Ibaraki-ken, 305 Japan

**River Management and
Planning in Japan**

by

Dr. Shuichi Ikebuchi
Professor, Department of Technology,
University of Kyoto

Mr. Yukihiro Shimatani
Head of River Environment Division
Public Works Research Institute

Mr. Akira Terakawa
Head of Hydrology Division
Public Works Research Institute

Mr. Hideaki Kawasaki
JICA Expert, Ministry of Construction

Synopsis:

This report consists of 4 papers which were presented by 4 Japanese presenters at "The International Symposium-MANAGEMENT OF RIVERS FOR THE FUTURE" held in Kuala Lumpur, Malaysia on 16-18 Nov. 1993.

Dr. Ikebuchi presented "River Management in Japan" as a key note speaker, Mr. Kawasaki, "River Administration and International Aspects in Japan", Mr. Terakawa, "Comprehensive River Basin Management in Japan" and Mr. Shimatani also did "River Environment Administration and New Trial in Japan".

Key Word: River, Management, Environment, Administration Planning,
Water Quality, Concervation of Nature, Restoration.

序

本報告書は、1993年11月にマレーシアで開催された国際シンポジウム「River Management for the Future」に発表した4人の日本人発表者の論文を集めたものである。

池淵はキーノートスピーカーとして「日本の河川管理」について包括的に、川崎は「日本の河川管理制度」、寺川は「総合的河川・流域管理」について、島谷は「河川環境」についてそれぞれ報告した。

日本における河川管理制度について、このような広い観点より、かなり詳しく英文でまとめられたものは従来なかったといってよい。今後、当該分野における日本の制度と計画の考え方を、海外の技術者に広く紹介する上での資料として役立てば幸いである。

1994. 1. 26

京都大学工学部教授

土木研究所環境部河川環境研究室長

土木研究所河川部水文研究室長

JICA長期専門家（建設省）

池淵周一

島谷幸宏

寺川 陽

川崎秀明

Preface

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There have been no English version of this kind of report which introduces river management and river planning concept in Japan.

It's our great pleasure if this report would contribute to introduce Japanese river management experience to the foreign engineers working in the same field.

Dr. Shuichi Ikebuchi
Professor, Department of Technology,
University of Kyoto

Mr. Yukihiro Shimatani
Head of River Environment Division
Public Works Research Institute

Mr. Akira Terakawa
Head of Hydrology Division
Public Works Research Institute

Mr. Hideaki Kawasaki
JICA Expert, Ministry of Construction

January 26, 1994

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RIVER MANAGEMENT IN JAPAN

Shuichi Ikebuchi

Professor, Water Resources Research Center, Disaster Prevention
Research Institute of Kyoto University

INTRODUCTION

This paper is a report on the development process of river management in Japan and the projects relating to river management. The river management brings to focus on the operation and maintenance of related facilities in a narrow sense and the same time on all aspects of the arrangement of law, the formation of organization, the series process of planning, design and construction, and the operation and maintenance of constructed facilities in a wide sense. The river management in this paper is made mainly from the latter sense.

Since ancient times, rivers have played an important role in Japanese life, as it is a country that have developed on cultivation of rice in alluvial lowlands. In the long history of river management in Japan, the progress in river management from Meiji Era (from 1868) is remarkable and important. The rapid increase in population is apparent from the figures of about 30 million inhabitants at the beginning of Meiji Era (1868), about 60 million at the beginning of Showa Era (1926) and about 120 million at present time. This pressure of population since Meiji Era have brought about the great changes in social, economical and river situations. And the large scale projects have been promoted with those changes. Then this paper is made focus on the river management since 1868.

Before entering into the discussion of the main theme, the natural and social characteristics of rivers in Japan are described first.

Japan situated on the eastern periphery of the Eurasian Continent, is constituted of the four main islands stretching from the southwest to the northeast. The total length reaches 2,000 km, while the maximum width is only approximately 300 km. Through the narrow mainland are running spinal mountains as high as 2,000 m to 3,000 m, causing rivers to have steep currents, short watercourses and small drainage basins. For example, the Tone River, the largest in Japan, has the drainage area of approximately 17,000 km² and the watercourse length of approximately 300 km.

Besides, approximately 70% of the land is sloped mountain range and of the residual 30% habitable land, only 1/3 is plains. Most of the plains are alluvial lowlands and floodplains.

Meteorologically speaking, the Japanese Archipelago are situated on the border between the Eurasian Continent and the Pacific Ocean, where the mixture of the continental and marine climates occurs. It provides a passage for depressions, which bring about rich precipitation. Due to Japan's topological characteristics, it is likely to become localized torrential downpour very often. Every year, from the early June to the middle of July, a line of discontinuity named "Tsuyu" (seasonal rain) front stagnate in the trough between two high pressures over the Pacific Ocean

and over the Sea of Okhotsk, causing torrential downpour. From August to September, tropical cyclones hit Japan as typhoons, bringing much precipitation in wide areas and causing great floods and disasters. Incidentally, the annual average precipitation is approximately 1,800 mm, which is much higher than the world average of approximately 800 mm.

The above-mentioned topographical and meteorological features form the natural characteristics of rivers in Japan. The major characteristics are as follows:

1) Due to steep slopes of river basins and relatively short river channels, the water flows rapidly and easily cause floods.

2) The (specific) peak flow discharge per basin area of each river is relatively big, and is 10 times or sometimes 100 times bigger compared with that of major rivers of other countries.

3) The hydrograph is very sharp in shape.

4) The coefficient of river regime, the ratio of the max discharge and minimum discharge in a year of each river, is between 200 and 400, 10 times larger than that of continental rivers.

5) Runoff of sediment is large in amount.

Since ancient times, the Japanese people have been living mainly on the cultivation of rice in alluvial lowlands formed by flooding, making communities at places which are suited for utilizing river water as irrigation water. Thus, despite the fact that they have been subjected to the danger of inundation, the Japanese have been living in gratitude of precipitation and rivers as blessings of Nature. These basic attitudes of land utilization have not been changed until now. That is why the population and the industry are so densely concentrated in waterside areas in danger of flood damages. Table 1 shows that the approximately 50% of the population, approximately 75% of the properties and approximately 10% of the land area are concentrated in inundated areas.

In addition, rivers had been used in pre-modern days as navigation routes as well as great arteries for goods transport. The development of each region has been made in close relationship with the rivers.

As is shown in Fig. 1, the Western countries have such extensive plains, and the advanced utilization of hills outside inundated areas are

Table 1. Population and Properties within Flood Hazard Areas

		1965		1975		1980		1985	
		Real Number	Rate	Real Number	Rate	Real Number	Rate	Real Number	Rate
Population (10 thousand)	National	9,828	100.0	11,194	100.0	11,706	100.0	12,105	100.0
	Flood Hazard Area	4,500	45.8	5,231	46.7	5,640	48.2	5,894	48.7
Properties (10 ³ billion)	National	197	100.0	494	100.0	593	100.0	742	100.0
	Flood Hazard Area	116	58.8	334	67.7	427	72.0	553	74.6

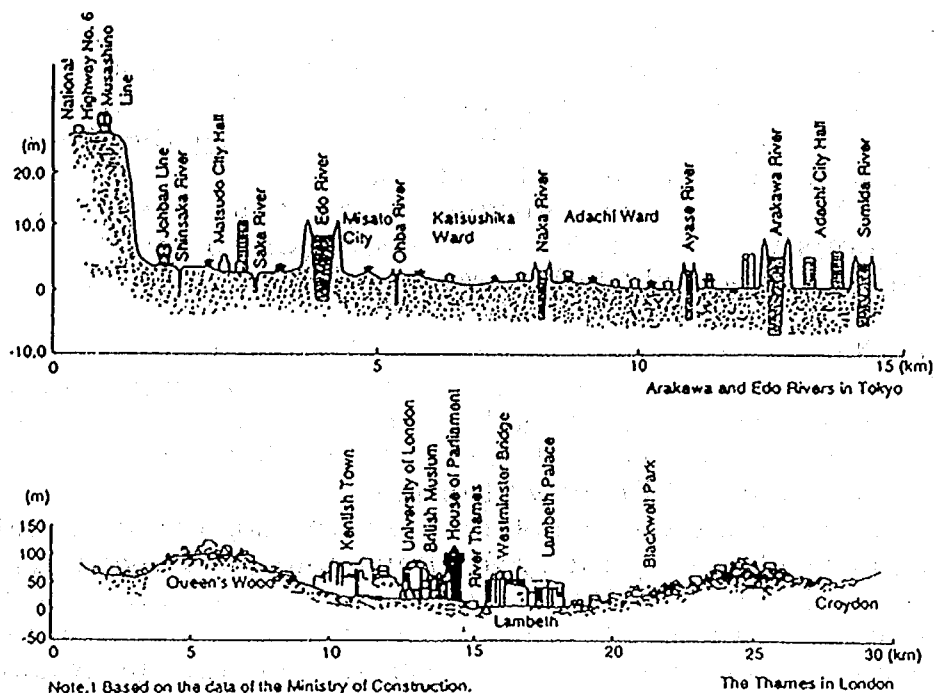


Fig. 1. Section Comparison between Tokyo and London

developed so much that the influence of inundations has been confined to narrow lowlands along rivers. Japan, however, is destined to develop advanced land utilization in alluvial lowlands (inundated areas) located lower than flood water level. As a result, it is highly imperative there to enclose the floods in artificial spaces of river channels to make them flow down safely.

PROGRESS IN RIVER MANAGEMENT AGAINST FLOOD DISASTERS

In our country, prevention of flood disasters is always the basis of river management due to the characteristics of the national land and its utilization as described above. Therefore various efforts have been made in its history.

In the beginning of Meiji Era (from 1868), Dutch engineers were invited. Mainly low water channel fixing works for navigation and sand control works were carried out under their guidance.

In 1893 and 1896, Japan was attacked by heavy floods which became the motive to formulate the River Law.

River Law drafted in 1896 became a strong support to a modern administration and improvement works of rivers in Japan against the flood disaster. This law is called the old River Law. In the initial stage of the old River Law, the flood control projects were carried out only large rivers.

There also occurred big flood disaster in 1902, 1907 and 1910. The flood in 1910 gave enormous disaster all over the country, making an epoch in the promotion of anti-flood actions, consequently an extraordinary flood control investigation council was set up to discuss on measures to overcome flood disasters. In 1911, "First Flood Control Plan" was authorized.

From Taisho Era (from 1912) to the beginning of Showa Era (from 1926), Japan had not have big floods. During these years World War I

occurred, followed by world economic recession, meanwhile flood control works had been steadily carried out based on the "Second Flood Control Plan" formed in 1921 and the "Third Flood Control Plan" formed in 1933. Soon after World War II (1941-'45) broke out, leaving the flood control works behind in priority of national projects.

After the War big floods ironically attacked the devastated land of Japan continuously. Isewan Typhoon (1960), which tolled the lives of 5000 inhabitants, attacked Chubu area causing high tidal flood in the area of the coast of Ise-bay.

Soon after the disaster "Erosion and Flood Control Emergency Measures Law" was drafted in 1960, and at the same time "the First 5-Year River Improvement Program" had started securing continual national budget allocation for flood control works. Then, "River Law" was drafted in 1964. This law is called the new River Law.

It was made from the view point of both the flood control and water use, and was necessitated by the great changes in social, economical and river situations. The main objectives in the revision were the clarification of river management, the flood control plan for the whole river system, the water use administration for the whole river system, and the construction and management of dams.

From the 1960's to around 1973, the year of the first oil shock, Japan experienced such a high economic growth as rarely seen in the world history and a remarkable development of heavy, chemical and machine industries, resulting in the enhancement of people's standard of living. This economic high growth urged the rapid urbanization process resulted in dense concentration of population and properties in urban areas, particularly in three major metropolitan areas. As the river improvement could not cope with such rapid changes, the urban flood damages increased greatly since the late 1960's. Thus, the improvement of urban rivers became an urgent issue.

The following are flood control issues brought by the rapid urbanization:

(1) The population and properties in inundated areas increased due to the development of the lowlands around urban areas, where the river improvement is insufficient. This meant an increase in the objects for damages and an decrease in the retarding function of river basins.

(2) The water-retention and retarding function of river basins decreased due to the development of upstream basins. Also, the improvement of drainage facilities caused an increase in the run-off rate, earlier time of concentration of flood, and increase in the run-off.

(3) In some cities, the pumping of ground water caused a progress in ground subsidence and an increase in inner water inundation.

(4) Dense population in urban areas hampered a smooth acquisition of sites and a progress in river improvement.

As the flood control of urban rivers was a basic condition for the security of urban areas, the second 5-Year River Improvement Program (1965-1967) and the third 5-Year River Improvement Program (1968-1971) were proposed.

The large-scale measures against various problems on flood control arising from the rapid urbanization during the period of high economic growth were taken after the economy entered into the period of stable growth. During this period, the 5-Year Flood Control Program was made from the fourth (1972-1976) to the eighth (1992-1996).

After a long absence in the period of high growth, the levee crevasses of large rivers occurred again in succession for three years (the Tama River in 1974, just after the first oil shock, the Ishikari River in 1975, and the Nagara River in 1976), causing flood damages for urbanized areas.

Through those periods the recent flood and slope failure disasters bring the following characters. (1) Increase of disasters in urban areas, (2) increase of inundation due to lack of drainage capacity, and (3) large ratio of the dead people by debris flow and landside to those by all of natural disasters. And dike breaks in large rivers have made us recognize the importance of improvement of such large rivers again.

PRESENT MAJOR POLICY OR PROJECT IN RIVER MANAGEMENT AGAINST FLOOD DISASTERS

Development of Preventive Measures against Flood Exceeding a Design Level

In recent years, big disasters have occurred because of levee breaks and collapse in big rivers where improvement is considered to have been progressed relatively. Since there are big population and assets, as well as important administrative functions are concentrated in basin areas of such big rivers, in particular, in the major metropolitan areas such as Tokyo and Osaka, it is recognized that levee breaks, if occurred

once, would cause serious social damage. Therefore promotion of improvement of big rivers is strongly needed.

Hence the Policy for Promoting the Measures against Flood Exceeding a Design Level was proposed in March 1987. Based on this proposal, the improvement of highly regulated levees (super levees) are now being carried out in the Tone and Yodo Rivers to avoid the great damages resulting from levee crevasses caused by floods exceeding a design level. These levees are wide enough to defend against overflow and infiltration for a long period of time. The super levee is just a kind of crisis management from a view point of the structural measure against flood disasters. The explanation of super levee project is shown in Fig. 2.

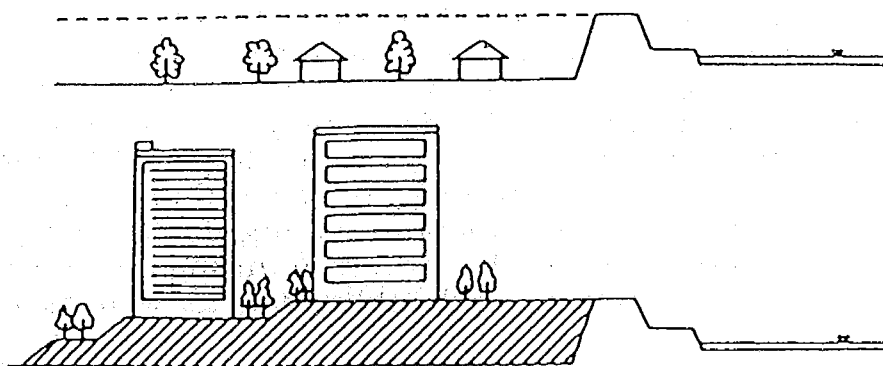


Fig. 2. Explanation of the "Super Levee" project

Promotion of Flood Control Corresponding to the Development of Urbanization

Recently, areas having possible danger of frequent floodings have spread because of rapid progress of national land development in river basin areas, of resultant increase of flood discharge due to urbanization, and of decrease of safety against flooding of rivers due to urbanization in flood areas.

In June 1977, the River Council submitted a "Interim Report on the Policy for Promoting Integrated Flood Control Measures". This report pointed out the necessity for implementing the integrated flood control measures to cope with a decrease in the security against flood damages and sediment disaster, caused by the development of river basins and rapid urbanization, resulting from high growth of economy. They included the adequate preservation of water-retention and retarding function of river basins and the improvement of warning and evacuation system. Based on this report, Ministry of Construction started the Project for the Integrated Flood Control Measures for Specified Rivers to promote the river improvement. Besides, it created the Council for the Integrated Flood Control Measures for Basins, composed of agencies concerned, to make the plan for the improvement of river basins. It also publishes the pictures of experienced inundation area, as well as the forecast picture of inundation areas, as a means of controlling run-off in basins and of improving warning and evacuation systems.

In March 1988, the River Council made a proposal on the "Policy for Implementing the Integrated Flood Control Measures". It advocated to include, as an object of integrated flood control projects, those basins occupied mostly by built-in urban areas, in addition to rapidly urbanized areas. It also advocated to set the improvement target in accordance with the matured development of future cities, and to make an overall plan that clarifies the appropriate responsibility sharing in the improvement of flood control facilities, sewerage system and river basins.

As of March 1993, there are 17 rivers designated as specified rivers for the integrated flood control measures, such as the Tsurumi, the Nakagawa and the Ayase Rivers. A council is created for each river basin to carry out the integrated flood control measures in cooperation with the State, prefectures and local municipalities in the basin. The implementation of the measures must include the improvement of facilities for preserving the water-retention and retarding function of river basins, to say nothing of the steady improvement of the rivers and the sewerage system. To achieve this purpose, Ministry of Construction created a loan system to furnish funds to projects for improving and perpetuating regulating reservoirs or for constructing facilities for storage and infiltration. The local public entities are engaged in the preservation of water-retention and retarding function making use of public welfare facilities, such as schools and parks, and in granting subsidies for the land having facilities for storage and infiltration as well as retarding function.

In built-in urban areas, expanding the present river channels or the improvement of regulation reservoirs requires much spending and long period to acquire the site and so it is extremely difficult to actualize the project. In these areas, the improvement of multi-purpose retarding

reservoirs, regulation reservoirs making use of underground spaces, and diversion channels are being constructed systematically keeping harmony

with urban improvement. Fig. 3 shows the conceptual presentation of integrated or comprehensive flood control measures.

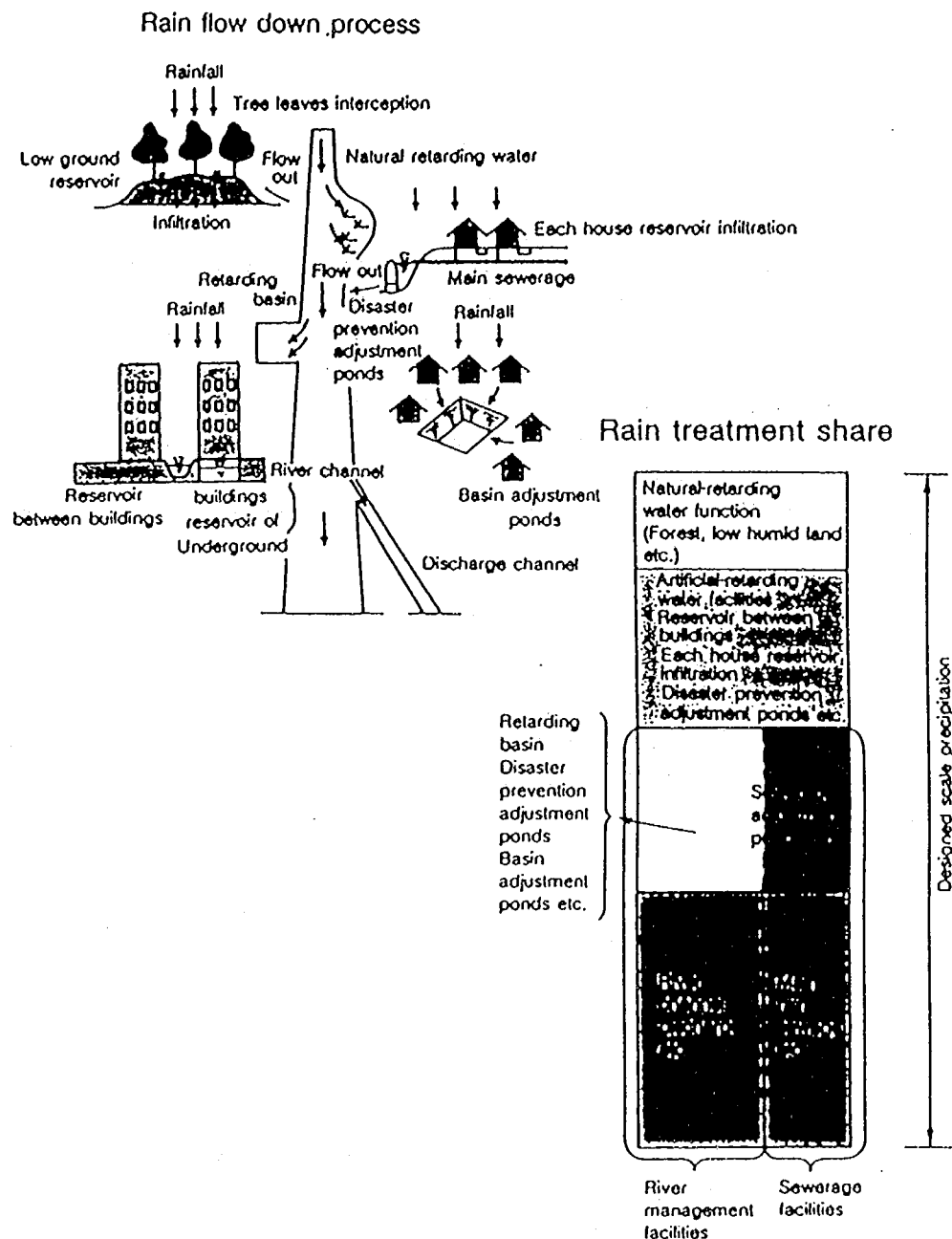


Fig. 3. Comprehensive Flood Control Measures

Promotion of Preventive Measures against Landslides

Due to recent concentration of population into cities and following extension of urbanized areas including extension of social facilities, in addition to the natural conditions of Japan including the topographical and geological characteristics which easily cause sediment disasters,

danger of suffering sediment disasters, represented by debris flow, landside and collapse of steep slopes, has been in an increasing trend.

Therefore, it is necessary that works for providing debris control measures should be promoted positively, and that in order to protect lives and assets from debris flow by providing sufficient information about areas containing danger of debris flow and by establishing warning and refuge systems, comprehensive preventive measures should be promoted further.

Promotion of Enlightenment Dissemination to Residents Concerning Flood Control and Instructive Training of Flood-fighting Activities by Municipalities along Rivers

Under the recognition that the river management has a certain limit, river management staffs must improve their skill and cultivate a professional eye to see phenomena strictly. At the same time, it is also necessary to ask residents to understand that the flood control that deals with Nature has an inevitable limit in the essential nature. Especially, in order to learn flood control technology and to be enlightened of flood ideology for members of flood control associations etc., it is important to execute comprehensive training of flood control works in case of disaster, including data transmission, rescue, relief etc. Through those training the flood fighting activity is carried out effectively.

Advanced Information Systems and Advancement of Hydrology

The operation and maintenance of dams are executed to achieve the purposes of constructed dams. In the procedure of flood control by dams shown in Fig. 4, the acquisition of hydrological and meteorological information and runoff prediction based on that information are very important elements.

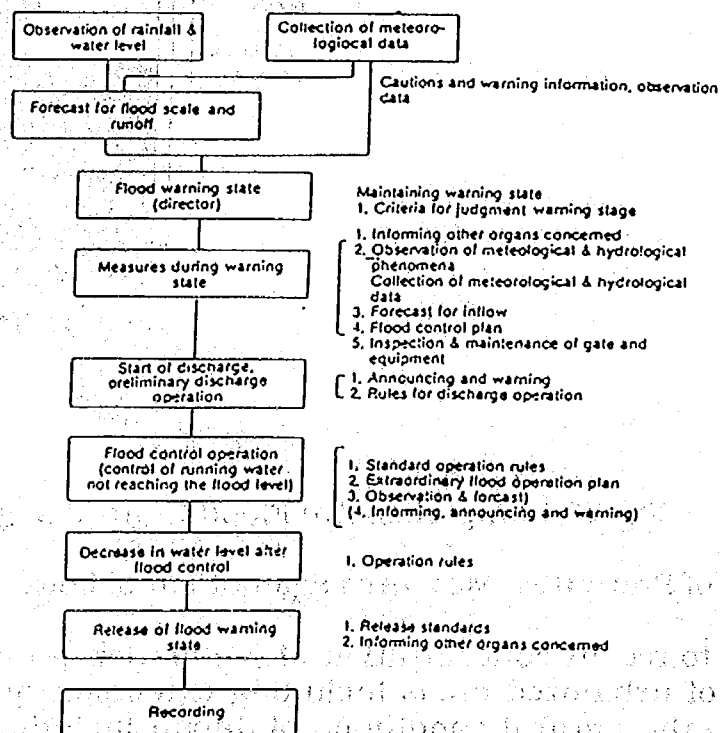


Fig. 4. Procedure of Flood Control by Dams

In order to provide us with accurate hydrological and meteorological information on rivers and basins more promptly, Foundation of River and Basin Integrated Communications (FRICS) was founded in October 1985.

FRICS employs a system combining a high-speed communication network and a group of satellite computers. This system is not only highly rational and functional but also extensive in scale in its operations. Thus, information collection network is designed to collect the latest Hydrological and Meteorological information through cooperation with Ministry of Construction and prefectural governments. In order to perform this function, FRICS also works on research, surveys and studies of technology. The information provided by FRICS is thus in every respect useful not only for disaster prevention but also for industry and daily life.

FRICS also employs radar rain gauges to measure rainfall. The radar system observes echoes of radio beams reflected back by rain drops. As it measures rainfall on an areal basis, it can detect local torrential downpours. These data are renewed in every five-minutes and make it possible to see changes of rainfall intensity and raining area quickly. It will also be possible to forecast rainfall in the area concerned.

In addition to radar rainfall data, FRICS supplies data on water stage, rainfall and water quality transmitted from telemetry stations of Ministry of Construction at any time. FRICS also uses telemetered data from prefectural governments. With such a wide range of sources, FRICS collects data when disaster occurs.

Data on rivers and basins collected from a wide range of sources are analyzed and studied by the help of computers and accumulated in a data bank. They are processed and turned into easy-to-read picture images so that they meet user's needs.

As for the research activities, many methods of short term rainfall prediction using the radar have been proposed. These short term rainfall prediction methods basically extrapolate pattern of the movement of rainfall distribution or reflectivity, detected by radar. Moreover after installation of a volume scanning radar available for operationally getting three-dimensional distribution of the radar reflectivity with a high spatial resolution, a physically based method using those information also has been developed.

On the other hand, methods for the real-time flood forecasting have been developed. The method consists of the following procedures; 1) applying the Kalman's filtering-prediction theory into the stochastic state-space model of rainfall-runoff system, 2) updating the state estimate using new observations of rainfall and discharge, and 3) repeating the similar algorithm by adding the above predicted rainfall.

Using hourly observed data, Kalman filter can compute not only the predicted values but also the covariance matrix of the prediction error in a sequential manner. This is why Kalman filter is often applied to various problems of water resources systems.

For the flood warning, for example, we can compute the exceedance probability of river water level over the predetermined level from results of a few hours ahead prediction. According to their values, we may judge the flood risk and send any warning message to the community.

The real-time operation of reservoir for flood control is another applied problem. Based on the predicted mean and variance of inflow into reservoir, stochastic dynamic programming theory and artificial

intelligence techniques such as expert system and fuzzy inference theory are aggressively developed in this field.

DEVELOPMENT AND MANAGEMENT OF WATER RESOURCES

The average annual precipitation in Japan is approx. 1,800 mm, and it can be said to be relatively large. From the view point of water utilization, however, the figure is not high enough in terms of per capital population. Additionally as the rice paddy agriculture and other human activities have historically depended mainly on river waters, lowflows under natural condition have completely been allocated for rice paddy irrigation. Therefore new development of water should utilize intermittently available river waters (including floods) using the temporal smoothing function of storage reservoirs. The shape of intermittent part of hydrograph is roughly a series of various sizes of triangles. The reservoir capacity to be required to assume the constant yield of X increases in proportion to X^2 . It means that as the river water utilization rate becomes higher, the required reservoir capacity increases exponentially. In rice producing areas, since the basic utilization level is already high, we have to face the problem of diminishing marginal utility of reservoir storage as soon as municipal and industrial water uses develop. Under those circumstances the Water Resources Development Promotion Law and the Water Resources Development Corporation Law were enacted in 1961, and the development of water resources have been promoted by dam construction.

In particular along with the improvement of living standards and industrial growth, water use increased rapidly from 1965 through 1975 by 1.6 times (Fig. 5). The multi-purpose dams were planed and constructed for supplying such increasing water demand.

As described previously this rapid growth caused serious problems in major metropolitan areas, including water shortages in dry seasons, subsidence of ground due to excessive pumping of ground water, and water contamination due to increased discharge of wastewater, calling for early solution.

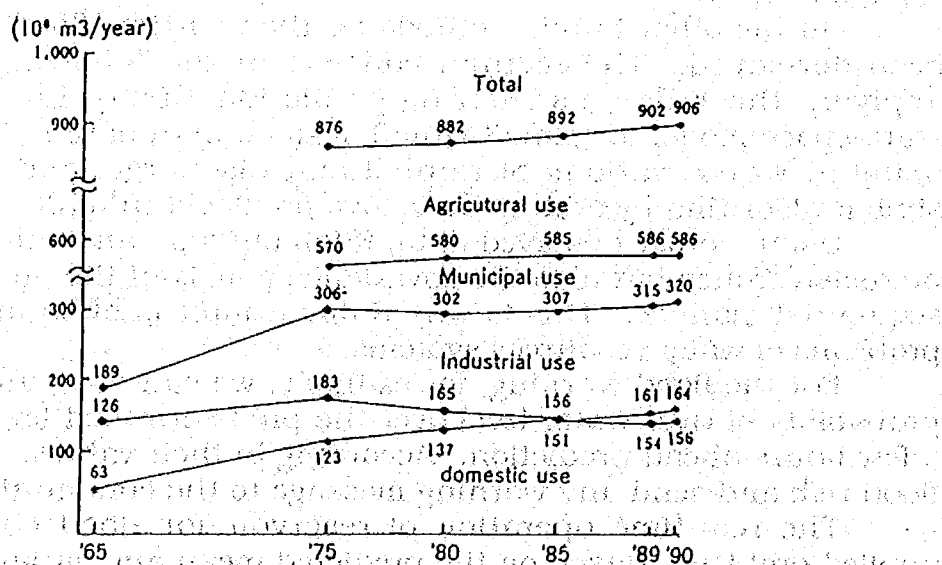


Fig. 5. Changes in Water Use in Japan

The trend of water supply in recent years shows different aspect in each area. In areas such as large towns and their peripheries where the capacity of water supply is tight, the growth of water demand is in slight down trend as a result of uplift of water saving consciousness, of efforts towards efficient water utilization as well as of the influence of not rapid growth trend of our economy, but the supply of water has been still behind its demand.

While in medium and small cities, towns and villages, where the original unit of water consumption has been increasing, because of the marked development of urban function and upgrading of living standard in recent years, together with the increasing trend of population there, water demand have brought a sudden uptrend.

As described above, water demand from the long-term viewpoint shows an uptrend, having regional features, due to reasons such economic growth, upgrading of living level, increasing of small families in young generation, etc.

PRESENT MAJOR POLICY OR PROJECT OF WATER RESOURCES DEVELOPMENT AND MANAGEMENT

Promotion of Comprehensive Water Resources Development

In view of the trend of water demand during recent years, demand for water itself has shown slight slowdown in its upward trend, reflecting the stable economic growth of our country, water saving and progress of efficient water utilization. However, since living water has shown a steady up trend of about 3% a year, water demand as a whole is estimated to continue its increasing trend towards the future.

While, in areas such as big city areas where that capacity of water supply is tight, the present situation is such that, due to water resources developments which cannot catch up with water demand, it is unavoidable to rely upon an unstable water supply condition which causes inability to take water particularly during the drought season.

In order to cope with such situation of water supply, it is necessary that construction of water resources development facilities including multi-purpose dams, estuary weirs, channels for adjusting river flow etc. should be promoted, and that water resources development suited for the characteristics of water demand of each region should be promoted.

Dam construction as Measures for Extraordinary Drought

The current standard to calculate a reservoir's capacity for water supply is based on the drought of a once-a-ten-year probability level. If a reservoir is operated according to this rule right from the planning stage, on the average, it will completely empty once in ten years. Thus some measures, such as reduced release to cope with anticipated drought, are more frequently used than the design standards themselves, i.e. once-a-ten-year frequency.

Table 2. Major Water Shortage

Year	Name of City	Duration of curtailed water supply	Year	Name of City	Duration of curtailed water supply
'64	Tokyo	7.10~10. 1 84days	'84	Gamagori and other cities	10.12~ 3.13 154days
'67	Kitakyushu Nagasaki	6.19~10.26 130days 9.25~12. 5 72days		Tokai and other cities	8.13~ 3.13 213days
				Cities along the Yodo river	10. 8~ 3.12 156days
'73	Matsue Takamatsu Naha and other cities	6.20~11. 1 135days 7.13~ 9. 8 58days 11.21~ 9.24 239days	'86	Gamagori and other cities	8.28~ 1.26 152days
				Tokai and other cities	9. 3~ 1.26 146days
				Cities along the Yodo river	10.17~ 2.10 117days
'77	Cities along the Yodo river Naha and other cities	8.26~ 1. 6 134days 4.27~ 4. 7 176days	'87	Tokyo and other cities	6.16~ 8.25 71days
				Gamagori and other cities	8.24~ 5.23 274days
'78	Cities along the Yodo river Kitakyushu Fukuoka	9. 1~ 2. 8 161days 6. 8~12.11 173days 5.20~ 3.24 287days	'89	Tokai and other cities	9.12~ 3.17 188days
			'90	Naha and other cities	2.27~ 4.26 59days
'81	Naha and other cities	7.10~ 6. 6 326days	'91	Tokyo and other cities	7.23~ 9. 5 45days
				Naha and other cities	6.10~ 7.21 42days

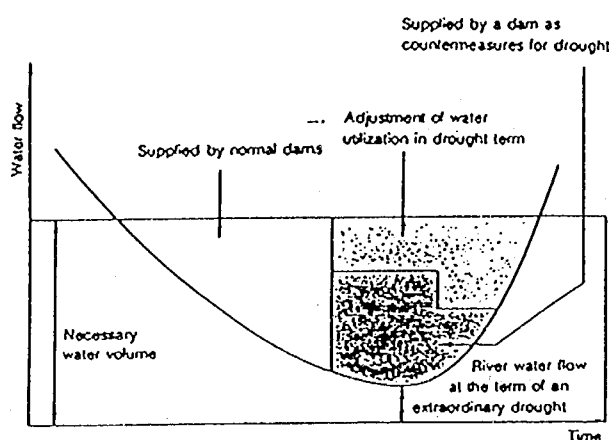


Fig 6. Dam against Extraordinary Drought

In recent years, water shortage or drought have been experienced in one place or another. Table 2 shows the recent major water shortages. Although water shortages have been limited to relatively short period of time, serious damages could be inflicted on production activities if they occurred at the seasons when water is most needed. Furthermore because of the improvement of living standard water is used for diverse purposes in today's life and our society cannot function properly without it.

Then Ministry of Construction recently presented a proposal to eliminate the above problem on the design standard by planning reservoirs with additional capacity right from the very beginning (Fig. 6).

Dam Administration during Droughts and Research Activity

Water supply by dam reservoir during the ordinary period is performed so as to provide the discharge (scheduled volume of intake + river maintenance flow) to be secured at the water utilization control point downstream of the dam. However, if it is not possible to cope with expected future droughts as a result of a decrease in the reservoir storage, the water supply from the dam will be reduced and each water user will try to economize water. In certain cases, the relation between the water economization rate and reservoir storage is predetermined on the basis of

previous discharge data and, if a drought exceeding the limit of water occurs, then the water saving operation is started in accordance with the predetermined water saving rules based on the adjustment with water users. However, in most cases, the water saving method is discussed in the Conference after the reservoir storage has been decreased by drought and then the water saving operation begins.

As described above, the decision making process does not depend only on the technical conditions but also involves political and social factors. Considering the case of shortage of water, the authority has to decide between reducing part of the release to the users and assuming the risk of a coming collapse of the system. In addition, there are many factors which cannot be estimated in terms of probabilities due to various uncertainties both in the whole meteorological prediction and in the hydrological processes. The human expert operator many times performs better than automatic or optimized control. It would be desirable for an operation model to incorporate the experience and judgement of the operator, such as capability of self adaption and ability to derive effective operation procedures in the presence of uncertainty. Furthermore, the knowledge from the senior operator can be kept to help younger operators. From those points of view, the rule-based reservoir operation considering long range forecast has been developed.

The model considers information of medium and long range weather forecast by the Japanese Meteorological Agency. The main hydrological and reservoir state variables considered influencing this decision are compiled in a rule based algorithm. Fuzzy theory is applied as the mathematical framework for rule evaluation, due to its capability to deal with uncertainties caused by ill-defined criteria, combining the hydro logical information and the actual experience of the user.

Co-operation between Ministries

As described previously, the Ministry of Construction is directly or solely involved in river management against flood control as central government agency. The following central government agencies, however, are involved in the water resources development and management.

Ministry of Construction; planning, implementation and supervision of water resources development and sewage policies, National Land Agency; Coordination for determination of water resources development plans in principal river systems, Ministry of Agriculture, Forestry, and Fisheries; Development of agricultural infrastructure for procurement of agricultural water, forest conservation policies, Ministry of Health and Welfare; Policies relating to drinking water supply, Ministry of International Trade and Industry; Policies relating to industrial water, Agency of Natural Resources and Energy; Policies relating to hydroelectric power generation, Environmental Agency; Policies relating to water quality conservation in river basins. This administrative structures produced from the historical formation process of Japanese government system are not the unitary management system.

As for the integrated or comprehensive management, the increasing co-operation between ministries is necessary more and more with the tuning in of the different laws.

ENVIRONMENTAL AND ECOLOGICAL CONSIDERATIONS IN RIVER MANAGEMENT

Another problem that appeared to the surface during the period of high economic growth was the degradation of urban environment. Rivers have intrinsically an aspect of providing "environment" that satisfies spiritual and aesthetic need of the urban residents, as public spaces with water surface, river banks and high water channels, along with an aspect of "flood control" and "water use". During the period of high economic growth, degradation of the water quality of urban rivers progressed, turning them into "ditch rivers". This was due to the untreated or scarcely treated wastewater from factories and offices, or the domestic wastewater from homes in general. Rivers, which should be a symbol of a city, turned into a troublemaker that gave harm to citizens with stink, for example. Thus, the environmental pollution, including water contamination, became a serious social issue during the period.

The countermeasures against it started with the enactment of the laws concerning environmental pollution. The Environmental Pollution Prevention Law was enacted in 1970, placing factories and business establishments under strict regulation and guidance. Moreover as the environmental target in water pollution control for public waters, the Government has established environmental quality standards, which should be met to protect human health and conserve proper living environments. As concerns protection of human health, the standards apply equally to all public waters, while for conservation of living environments, standard values have been separately established for individual types of water areas in rivers, lakes and the sea, classified by terms of use.

Improvement and Purification of Water Quality

Although water pollution of rivers has been fairly improved owing to the water conservation measures and spread of sewerage, some rivers in highly urbanized area are so polluted due to inflow of drainage from households that fish cannot live in. Therefore river dredging has been performed to remove accumulated mud, one of the causes of river contamination. Moreover comprehensive improvement plan including the introduction of water for environment and the installation of water-purifying channels and facilities is to be put into effect.

In recent years, with the rising living standards and intensification of socioeconomic activities, the attitude of the Japanese people has been undergoing a change from that of simple pursuit of quantitative wealth to that of pursuing qualitative riches, a life with greater spiritual satisfaction and leisure.

This trend is reflected in the river management. In addition to the considerations for flood control and water utilization, the need to conserve and create beautiful and peaceful river system environments is attached. Ministry of Construction has been promoting various measures which reflect this importance of river system environment policies.

Improvement of Water-front Environment

Rivers (including lakes and marshes) which provide water and green open space are the nature most familiar to us, and they occupy 3% of the total land area. In particular, in congested cities, rivers play an important role in providing citizens with places for recreation, fire belts and refuge squares in case of earthquakes and disasters. Therefore, it is the important themes today to enhance these functions offered by rivers and lakes, and to give rest to citizen's living and create comfortable living environment for them, by securing sufficient quantity of water and maintaining the quality of water.

For this purpose, the following measures have been deployed:

(1) Control of water environment

Aims at consistent and comprehensive control of water quantity and quality by utilizing abundant records and data related to the water volume and water quality of rivers, by utilizing sufficient knowledge about hydrological characteristics and purifying characteristics, and by means of future forecast of water volume and water quality based on the conditions of land utilization and water utilization of river basin areas.

(2) Control of space environment

Aims at execution of environment improvement projects for rivers and various model projects to facilitate proper utilization and preservation of river space, with various expectations, requirements and many other conditions for river space taken into consideration, and while giving through consideration to harmony with whole river and its basin area.

Implementation of River System Environment Policies

The rivers and the lakes around us, with their water and greenery, as well as the large variety of animals and plants living there, provide spaces where we can find peace and quiet. Ministry of Construction conducts "national censuses on river environments" and various other environmental surveys for a regular and continuous assessment of the conditions surrounding fish, birds and plants living in and around rivers and the uses to which the spaces around rivers are put. The results of these surveys and the views of the local residents and academic experts are taken into account in devising the "master plans for river environment management" which lay down basic policies for the comprehensive and systematic implementation of projects relating to the conservation and creation of river system environments.

Measures are taken in accordance with those master plans for the conservation and creation of habitats for various animals and plants, and the creation of rivers where people come into contact with water and with other living creatures and the creation of satisfactory living environments is promoted through the creation of rich and beautiful river system environments that answer a wide variety of needs.

When implementing construction projects, studies are conducted to predict and evaluate the effects of the projects in accordance with the Cabinet Order "concerning the Implementation of Environmental Impact Assessment", and utmost care is taken to ensure harmony between the projects carried out and the natural environment through investigations for necessary measures.

"Conservation and Creation of rich and beautiful river system environments" has been made the pillar of the "8th Flood-Control Projects

Five-Year Programme" starting in 1992 financial. In various projects on streams, steep slopes and sea coasts, too, harmony will be aimed at between the measures for the conservation of the national land and those for the conservation of the environment, and positive efforts will be made for the promotion of projects that will contribute to the conservation and creation of river and coastal environments.

WATER MANAGEMENT TOWARD THE 21ST CENTURY

Recent situations have the tendency from river management to water management and we consider it an important step forward. Future improvement related to those situations is considered as follows.

Promotion and Implementation of Integrated or Comprehensive Water Management

As described previously, the increasing consciousness of environmental aspects and the complexity of problems have led to the recognition that the surface water, groundwater, sediment, river banks, technical infrastructure and physical, chemical and biological characteristics should be considered as a whole, as a "water system".

And our wish for improvement of quality of life needs the increase of safety level for flood control, the promotion of stable supply and safe water quality for water utilization, and the improvement of water quality and the conservation and creation of rich and beautiful water environments. Fig. 7 shows its conceptual presentation.

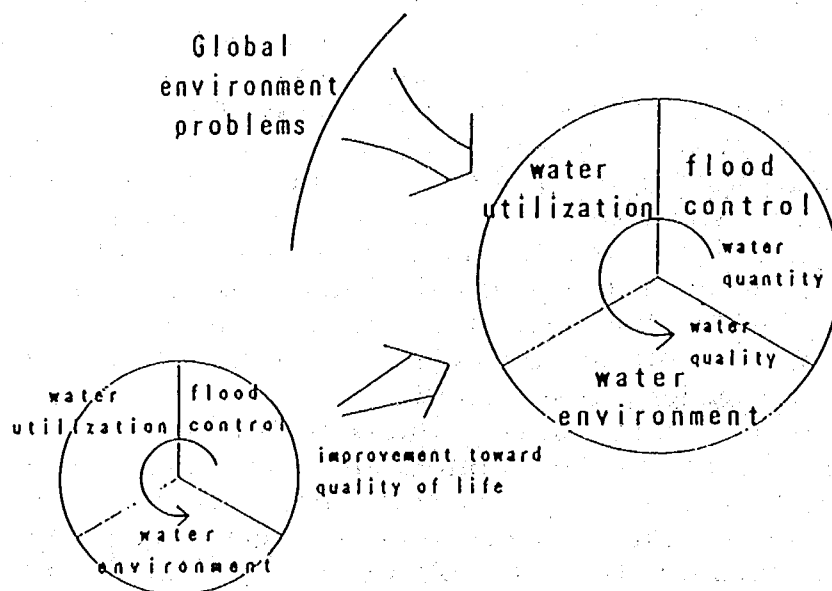


Fig. 7. Expansion and Progress in Water Management

Under those circumstances the concept of "Integrated Water Management" is essential. And it is necessary that the approach to implement the integrated water management is investigated in haste.

Risk Version in Water Management

What comes next after having prevented confronting danger in flood and drought? One must expect to eliminate unforeseen risks to achieve more stable life and to develop more comfortable environment. Conceptually, this change may be called "from necessity to satisfaction". Now our next targets are creation of amenity and reduction of risk water management. The former is sought in projects of water (river) front development. Two of our proposals for risk reduction were already presented. One is "DROUGHT CAPACITY", which is additional reservoir capacity as measures for extreme or extraordinary drought, and the other is "SUPER LEVEE", which is never-breaking, extraordinary wide levee.

Cooperation and Communication to Create Consensus about Water Management with Residents.

The decrease of safety level in flood control aspect, the degradation of water quality and the decreasing of natural environment are considerably due to process of urbanization. Residents can enjoy benefit of flood mitigation and water utilization gained by flood control and water resources development, and at the same time they must recognize the impact of their urbanization process on river system.

Moreover recently, with an increase in leisure hours and enhancement of people's standard of living, the demand for the utilization of river spaces, especially in urban areas, is also increasing and becoming diverse. Thus, various conflicting demands concerning water surface utilization are entangled within limited river reservations.

Then to understand the social, economical and cultural backgrounds behind those situations and to arrive an agreement between the increasing number of people who have an interest in such water management problems, more co-operation and communication among related planning and management authorities and residents are needed including more data and new instruments for policy analysis.

The prospective view enable the river making or water environment making, to be promoted in concert with the town making in municipalities, taking account of resident's opinions. For example, they make effort to promote the movement of "making town resistant to flood damage" to create a town that can reduce the damage to the minimum during floods exceeding a design level, in encouraging seepage of rainwater into the ground and forming sound hydrological cycle, or in constructing facilities resistant to inundation, such as waterproof board and pilot structures.

Recognition of Global Environmental Problems

There has been a rising worldwide concern about the deterioration of the global environment. Global warming, acid rain and desertification are among the global environmental problems, which pose serious problems for the conservation of the national land and acquisition of water resources, such as the rise of the sea level, changes in the rainfall patterns and destruction of the vegetation by acid rain.

Studies are conducted on such items as the changes in rainfall patterns and the methods for predicting the changes, and on the effects of the acid rain on rivers and lakes with the aim of elucidating the factors

behind the environmental problems, while efforts are made to solve the environmental problems through promotion, for example, of the use of the thermal energy of river water (heat pump) and the potential energy of river water (hydroelectric power generation), which involve little emission of carbon dioxide, promotion of water transportation and recycling of waste materials.

By the way how do we think about and what do we act on global environmental problems? There is big gap in recognition between our life styles and their impact of global warming. We must recognize that nature is an active self-organic system and keeping harmony with nature is essential in sustainable development.

CONCLUSIONS

In this paper river management in Japan was reviewed in its historical process and related projects. The rivers and the environments are changing dramatically, with the result that the improvement of environmental functions is becoming a focus in river projects, as well as the flood control and the water utilization that had the absolute priority in river projects before. The integrated or comprehensive water management should be made in progress not only in individual aspects of flood control, water utilization and river environment, but also in their whole system, under the recognition that the river creation in harmony with flood control, water utilization and environments has much greater importance in realizing safe and comfortable towns and regions.

ACKNOWLEDGEMENTS

Thanks to staffs of Ministry of construction for informing me many references. And also thanks to Dr. Yamamoto for referring his special lecture on the historical process in flood control.

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RIVER ADMINISTRATION AND INSTITUTIONAL ASPECTS IN JAPAN

BY

Hideaki KAWASAKI

**JICA Expert (River Engineering) to DID, MALAYSIA
from Ministry Of Construction, JAPAN**

ABSTRACT

The river administration in Japan is pertained by complicated legal system, but it is easier to grasp River Law as the central axis. Many relevant laws start from the River Law, and end with the River law, which is the legal foundation of Japan's river administration. The basic concept of the River Law fully revised in 1964 is that every river and its water is property for public use. Rivers are therefore systematically and comprehensively administrated in every river basin by the river administrator.

In Japan, the river administrator has many authorities over the river and water resources management under the River Law. The River Bureau under Ministry Of Construction is the river administrator of major rivers and governs the nation-wide river and water resources administration and the national policy. So far, the river administrators have implemented various and enormous river works by themselves in Japan, and the authorities the River Bureau cover many permissions or regulations from the view-point of suitable national land conservation, prevention of disasters, water and land utilization, river and environmental maintenance.

The River Bureau which is one of the most powerful, biggest and highest technical agency, has supported Japan's economical development and contributed toward better living condition.

* JICA : Japan International Cooperation Agency

DID : Department of Irrigation and Drainage

The writer is despatched to River Engineering Division, DID, from Japan's Government as a long term technical advisor, and at the same time, his original position is a Deputy Director of River Planning Division, River Bureau, Ministry of Construction.

1. INTRODUCTION

The Japan Archipelago is geographically and topographically susceptible to the elements. Floods and droughts always used to be a problem and continuous efforts were made to control the impact of these extremes. Also, ways of preserving and maintaining scarce water supplies were passed down from generation to generation ultimately becoming an intrinsic part of Japanese culture.

As Japan's famous proverb says " One who controls water, controls the land ", over the years the Japanese government has expended enormous financial and human resources to control its rivers. In this process, the river administrator has played basic and essential roles, and the river management has developed and entertained many and various requests of the public. Today, the land protected by levees and dams provides the basis for Japan's active economic scene, and the plentiful and ready supply of clean water greatly sustains the lives of the people.

Similarly, Malaysia is historically called as "Negara Sungai" (the river state), and "River" is one of the most attractive key word of the people of the world.

Additionally, River Management and Water Resources Management are very closely linked, and this paper takes River Administration to include Water Resources, and introduces its system in Japan from the view-point on legal and institutional aspects.

2. BASIC CONCEPT OF RIVER ADMINISTRATION

From ancient times, natural rivers have given many benefits through water, as well as causing many damages by floods, etc., and it has still been a basic national policy for the welfare of the people to administrate rivers properly.

River Law (Article 1) emphasizes the basic concept that "The purpose of this Law are to contribute to the national land conservation and development of the country and thereby to maintain public security and promote public welfare, by administering rivers comprehensively to prevent occurrence of damage due to floods, high tides, etc., utilize rivers properly and maintain the normal functions of the river water ".

2.1 Purpose of the River Administration

The main purpose of the river administration is to promote the effective water use which is indispensable for the national development, as well as to upgrade the safety of the people's life and property. In other words, river administration is essential for the nation in a sense that it manages the safety and water closely related to the people's existence.

Another main purpose is to maintain the better river environment. In recent years, this importance has rapidly increased with the aggravation of water quality and the shortage of urban open spaces.

2.2 Principles of the River Administration

To satisfy above the purposes, the River Law is based on the following principles.

(1) Property for Public Use

The river flow should not be a private property but a Public one. However, the land of a river can be a private property under the precondition that the public use have priority.

River Law (Article 2) stipulates " A river is a property for public use, and its conservation, utilization and other forms of administration shall be properly performed so as to attain the purpose." , and " The water of a river cannot be made the subject of a private right".

(2) Maintenance of Normal Function of the River Water

This term is one of the most essential principle of River Law. This term means that the river flow should be secured for public profits connected with rivers. More concretely, it refers to the functions in which the river flow fulfills, under normal conditions, for maintenance of river mouth, preservation of water quality, prevention of damage from drought and salt, preservation of precious landscape and wild life, maintenance of the water level necessary for permitted water use, aquatic life and navigation, etc.. Since these functions are closely related to the river environment, this importance is rapidly increasing in recent years.

For this, the river administrator instructs water users to secure the necessary quantity of river flow under this principle, and this instruction has helped many river flows revive, which had lost after the operation of facilities such as dams.

(3) Unification and Neutrality of the River Administrator

With the diversification of river utilization, the problems around rivers has been complicated, and the necessity of effective river administrator is becoming higher.

This principle means that one who executes river works should be the river administrator who manages water and lands in a river, and the river administrator should be neutral to water and land users to oversee them judicially. Because the modern river administration needs systematic and comprehensive authorities strongly to promote unspecified public profits.

(4) Consistency of Administration in a River System

This most famous principle means that rivers in the same river system should be administered under the same plan by the same river administrator, in order to perform efficient and systematic river administration by each river system.

In Japan, the river administrator made out the policy and long term plan in every river system such as "Master Plan for the River Works" , and properly implements the river administration including many regulations and permissions, numerous river works and maintenance, etc., under this principle.

(5) Stabilization of existing water uses

This principle means that **existing water uses should be respected**, and the permission to new water use be appraised judicially by the river administrator, considering the influence to existing water uses and the whole balance of water resources.

In Japan, as low flows in many major river are almost occupied by existing water uses, there are no surplus river flows in droughts. This means a new water use has to depend on a water resources development project such as dams usually, under this principle.

(6) Higher Priority to the same basin water use

This principle means that a water transfer to outside of a basin should be limited not to affect the present water uses, the future water demands, and the normal river function of lower reaches, in the basin.

Generally, the water transfer from the other basin is the easier measure to resolve the problem of a water stress and water resources unbalance. However it has been becoming very difficult in adjustment of the interests concerned between different basins, moreover it might break the systematic basin water use order and cause another water stress problem in future.

Therefore, the river administrator need promote the water resources policy, considering the balance between these risks and national profits.

(7) Promotion of Multipurpose Dam

A multipurpose dam means a dam for joint use having a flood control purpose and various water use purposes such as hydro power, water supply, irrigation, or the like.

Today in Japan, multipurpose dams constitute most of dams, because favorable dam sites from the viewpoint of topography and geology have decreased in number, while the request for dam constructions have been increasing with the economic development, and as such multipurpose dam is deemed cost effective.

From this viewpoint, **multipurpose dams have been given higher priorities by laws**, and until now, the river administrator have constructed mostly multipurpose dams in Japan.

(8) Structural Safety

Any river administration facility and any other structure in the river area (dam, levee, bridge, weir, gate, etc.) **must be safe in consideration of various river conditions**, and structural standards to this should be specified.

Japan is the very susceptible land to natural disasters such as floods, typhoons, earthquake, volcanic activities. Whereas almost structures in the river area are quite important for the people's and convenience, and these structural defects may endanger the people's lives and properties in floods.

The river administrator strictly keeps the structural standards designated by River Bureau, and instructs and examines the owners of structures other than river administration facilities to keep the standards.

2.3 Policy of the River Administration

Under the above concepts, the following features on the policy can be pointed, and they are closely related each other.

(1) Flood Control and National Land Conservation

a. Regulation

River or land utilization should be strictly regulated in flood prone areas or for national land conservation.

b. Promotion of Flood Mitigation Project

From the viewpoint to keep disasters to a minimum, flood mitigation projects (levee, dam, flood way, etc.) should be implemented as smoothly as possible, and the river administration facilities shall be maintained in good conditions. As such, it is important to expand the institution of the land acquisition and the finance.

c. Disaster Countermeasure, Restoration and Relief

Disaster restoration project should be financed by the national aid, from the stand-point of smooth restoration and stabilization of the national life. In case of emergency, necessary staff and materials should be mobilized to decrease the damage as much as possible. Additionally, victims of disasters should be sufficiently relieved by the special measures.

(2) Stabilization of Water Use

a. Adjustment and Permission

Adjustment and permission to various water users should be comprehensively achieved considering the whole river system balance, normal function of the river flow, flood control, environmental aspects.

b. Promotion of Water Resources Development Project

In order to meet various water demands increasing with the national development, water resources development projects and water use rationalization should be promoted.

(3) Maintenance of River Environment

a. Regulation and Utilization

From the viewpoint that aggravation of water quality affects the people's life, strict regulations on water quality should be conducted. And from the viewpoint of natural contacts with people and disaster prevention in urban area, rivers should be utilized as a natural recreational zone incorporating water and the precious urban open space.

b. Promotion of River Environment Project

In order to meet various river environmental requests in accordance with increasing national affluence, river environment projects (water quality, recreation, etc.) should be promoted.

3. RIVER CLASSIFICATION

3.1 River

According to the River Law (Article 4), river means public streams and water areas. This means legally river includes not only natural streams and water bodies such as rivers, lakes and marshes but also such artificial streams like flood-way, etc., that have been constructed to serve a purpose for the general public. This term does not include artificial streams and water areas provided for a specified use, such as channels for agriculture or power generation, urban sewerage, irrigation ponds, etc.. Therefore, we must distinguish a river to be provided for unspecified use from the others.

3.2 River Administrator

The River Law (Article 7) defines that the river administrator shall be a person who administer the river designated by the law. This means that the river administrator shall perform the river works, and permit or regulate the water use and land use in the river area. So, the law clarifies his many exclusive duties and authorities on the river. In other words, the River Law stipulates the reinforcement of the river administrator's authorities so as to contribute to the national development and the public welfare.

3.3 Classification of River and the Administrator

In the River Law (Article 3,4,5), legal rivers are classified as class A river or class B river decided according to river system's socioeconomic importance. The river administration is done by setting classification below.

(1) Class A rivers are those rivers which belong to Class A river systems linked closely on the national economy and people's living standard which are designated by the Minister Of Construction. The administrator of these rivers is the Minister Of Construction, but the administration of specifically designated sections of such rivers without trunk rivers is generally entrusted to the prefectural governor concerned, except matters concerning the approval on specified water rights.

Class A rivers in 1992 : 109 river systems, 13,711 river,
87,090 km (total length), 239,947 sq. km (total basin area)

(2) Class B rivers are those rivers which belong to Class B river systems linked closely to the public interest and which are designated by the Minister Of Construction. The administrator of these rivers is the prefectural governor.

Class B rivers in 1992 : 2,691 river systems, 6,944 river,
35,610 km (total length), 108,002 sq. km (total basin area)

(3) In addition to Class A and Class B rivers, there are so many small rivers that necessitate administering from the viewpoint of local interest and inhabitant's daily life amenity, etc.. The provisions of the law are applied to each river designated and administered by the head of the city, town or village.

Other smaller rivers than the above mentioned, to which the River Law is not applied at all, are administrated under Local Government Law or National Property Law.

3.4 Classification of River Area

(1) River Area (River Law, Article 6)

The river area means the area where land or water occupancies and acts excluding river works shall be regulated, and the River Law stipulates the different purposes of the following three parts of the river area by the cross section.

No.1 Area : the land where the water of a river flows continuously and land similar to that condition, but excluding the land which presents temporality such conditions owing to flood, etc..

No.2 Area : the site of river administration facilities.

< River Administration Facility > (Article 3)

This term means a dam, weir, sluice, levee, revetments, ground sill, or other facilities that have the function of increasing public benefits from the water of a river, or eliminating or decreasing public losses.

No.3 Area : the land on the riverside designated by the river administrator as necessary to perform unifiedly with the area mentioned in No.1 area.

(2) River conservancy area (Article 54,55)

When the river administrator deems it necessary for the conservancy of the river bank or river administration facilities, he may designate an area adjacent to the river area as a river conservancy area. This regulation has well helped rivers conserve its precious environment and the facilities in advance.

(3) Projected River area (Article 56 to 58)

In case the river administrator deems it necessary for execution of any river works, he can designate as a projected river area a stretch of land which is to have a lane included in the river area by execution of the river works.

After the river administrator has obtained the title of the land of the projected river area, the land shall be regarded as land within the river area even before the land becomes the river area as far as the application of this law is concerned. This is a quite effective regulation to promote big projects on river works smoothly such as dams, etc..

4. CONCEPT OF THE RIVER MANAGEMENT

The river management and the river administration overlap, and are sometimes confused. However, it can be taken that the river management is a practical part of the river administration.

The river management consist of administrative matters and virtual matters. The former manages legal permissions or regulations, river registers, etc.. The latter manages planning, constructions or maintenance of the river administration facilities, daily observation, operation of facilities, etc.. So section 4.1 to 4.4 show administrative matters, and 4.5 to 4.13 show virtual matters.

The River Bureau prepares many administrative regulations and technical standards on the above under the River Law, and a work office in each river performs more practical river management.

4.1 Regulations Concerning Use of Rivers

The following regulations are to be strictly kept on the administrative and technical basis, as sometimes the following irregular acts may endanger structures, decrease the flood discharge capacity, cause unnecessary water stresses, deteriorate river environment and the water quality, and have other unfavorable effects on the river course maintenance.

(1) Permissions

Any person who want to do the following acts shall obtain permissions from the river administrator.

- a. Occupancy of the river water. (River Law, Article 23)
- b. Occupancy of land within a river area. (24)
- c. Extraction of earth, sand, stone from a river area. (25)
- d. Construction, reconstruction or removal of a structure on the land within a river area. (26)
- e. Land excavation, banking, cutting or any other act which alters the land configuration within a river area. (27)
- f. Planting or felling of trees within a river area. (27)

(2) Prohibitions and Restrictions

Any acts of the following are prohibited or restricted without the approval from the river administrator.

- a. Floating trees and bamboos down a river and the passage of boats and rafts. (Article 28)
- b. Acts which is likely to hinder the river administration by affecting the course, cleanliness, discharge, etc., of the running water. (29)
- c. Use of structure built with permission (30)

In this case, any person permitted Article 26 shall pass the completion inspection by the river administrator, and cannot use the structure until after it has passed the inspection.

4.2 Water Use Right

(1) Concept of Water Use Right

Water use right given by the river administrator is based on the River Law (Article 23) that "any person who want to occupy the water of a river shall obtain the permission from the river administrator", and generally article 24 (occupancy of land) and 26 (construction of a structure) accompany this water use right.

Water use right is classified by purpose to four type ; water use right for domestic water, industrial water, irrigation water & hydro-power. Moreover, it is historically classified to permitted water use right and customary water use right (this means it had been occupied before the old River Law enactment and legally it is taken as permitted water use right).

As mentioned above, Water use right is the exclusive and continuing right, while quantity of river flow is susceptible to various meteorological factors. This problem causes numerous cases that water can not be supplied sufficiently in droughts. For this, the river administrator adopts the concept of Standard Drought Year (mostly, return period of 10 years is used) as Drought Safety Measure, and he permits a new water use after the confirmation of no influence to existing water uses in Standard Drought Year.

Additionally, in many water-stressed rivers, there can be a temporary water use right, which is given only when river flow is sufficient and when its water resources development is on going, and in the case a new water use is urgent and important socio - economically.

(2) Coordination of New water Use (River Law, Article 38 to 43)

In the permission procedure of a new water use, the river administrator can prepare the opportunity of coordination or compensation to existing water users.

(3) Coordination in Case of Drought (Article 53)

In the case of an abnormal drought, which makes it difficult to properly use the river water for the permitted water use purposes, the permitted water users shall consult each other. In cases where no agreement concerning the above matter is reached, or it may seriously harm the public benefit without urgent coordination, the river administrator can make necessary intermediation or arbitration for the coordination among water users.

4.3 Regulations on Dams to be Permitted

(1) Dam Construction and Operation

River Law stipulates a dam to be permitted shall keep the following regulations , considering that dam's construction and operation may cause serious consequences to existing functions of rivers. Water users of dams shall strictly keep these regulations managed by the river administrator.

- | | |
|---|-------------------------|
| a. Maintenance of existing function of river | (River Law, Article 44) |
| b. Observation of water stage, discharge, etc. | (Article 45) |
| c. Information of condition of dam operation in flood | (Article 46) |
| d. Preparation of "Regulations for dam operation" | (Article 47) |

- | | |
|--|--------------|
| e. Prevention of expected harm through dam operation | (Article 48) |
| f. Preparation of a record on dam operation in flood | (Article 49) |
| g. Appointment of engineer as chief superintendent | (Article 50) |

(2) Instructions for Flood Control (Article 52)

In cases that a disaster has been caused or there is a strong probability that a disaster will be caused by floods, according to the necessity, the river administrator can instruct the owner of the permitted dam to take necessary steps on the dam operation to prevent or minimize the disaster considering the overall situation in the river system.

4.4 Supervisory Disposition

The River Law (Article 75 to 78) stipulates that in case a person to whom a permission or approval has been given in accordance with the provisions of the law violates the provisions or terms of the approval, the river administrator can annul the permission or approval, make some alteration to it, suspend its effectiveness, etc.; if necessary, order the person to take such action as to restore the works to the original condition or some other actions.

4.5 Basic Data

(1) River Register (Article 12, River Law)

The river administrator should prepare and update a set of registers on the rivers he administers, which comprises a register of the present river condition and a register of water use, in order to ensure the existing rights and grasp the present river condition for the systematic management.

(2) Investigation and Survey

The river administrator collects or investigates the hydrological data (rainfall, water level, flow discharge, etc.), topographic data (aerial photograph, survey map, cross-section, flooded areas, etc.), geological data (worksite geology, material, ground water level, fault, crack, etc.), flood and drought damages, water quality, flora and fauna, and other data, in order to analyze river characteristics and perform suitable planning.

4.6 Master Plan for the River Works

The river administrator should prepare "Master Plan for the River Works" (Article 16, River Law) which is to ensure comprehensive river administration in the river system.

The master plan contains the policy and basic plan for flood mitigation, water resources, river environment, and other matters which will be the basis for executing river works, by taking into consideration the design high-water discharge, the conditions of flood damage caused in the past, the present water and land use, the future water demands and land development, and river environment, by effective coordination with national land plans.

4.7 River Works

According to the River Law (Article 8), this legal meaning is **works executed on a river in order to increase public benefits, eliminate or diminish public losses through the water of the river**. Generally, river works include earth works (banking, excavation), revetments, hydraulic structures (dam, weir, water gate, sluice, water way, pump station), countermeasures for storm surge, improvement of river environment, etc., but legally river works are classified by the following works for rivers or river administration facilities.

< River works by the river administrator >

- a. Executed on the above Master Plan, which includes the following case d.
- b. Urgently executed for disaster restorations.
- c. Executed for repair.

< River works by a person other than the river administrator >

- d. Executed after the river administrator's agreement, in case a river administration facility and another person's facility is built as one for a joint use. (Article 17)
- e. Executed for a compensatory work necessitated by an another person's work which affects a river, after river administrator's instruction. (18)
- f. Executed after river administrator's approval. (20)

< Works other than River works by the river administrator >

- g. Executed for a incidental work necessitated by river works. (19)
- h. Executed for maintenance.

4.8 Master Plan for River Environment Management

The river administrator shall conserve, improve and manage for the good of river environmental condition on water quantity and quality, natural landscape, water life, etc..

In this point, the river administrator prepares "Master Plan for River Environment Management", which consists of the **water environment management** (monitoring of water quality and water quantity, the facility control, water environment improvement project, etc.), and the **spatial environment management** (suitable conservation and utilization of river open space, improvement of river open space, advice to river works and permissions, coordination for the project) .

4.9 Flood Fighting

Flood fighting has been necessary from old times, and this purpose is to take flood defense actions by the people along a river, to prevent a flood, to minimize its damage, to protect life, and property and to maintain the safety of the public.

Flood Fighting Law was enacted in 1949 to intensify these traditional associations and activities. This law makes clear the first responsibility belongs to a **flood fighting administering body** (city, town , village), secondly belongs to the prefecture. Under this law, the Minister of Construction gives the necessary advice or suggest to prefectures and the bodies, and when he deems that a certain river is likely to cause a serious disaster, he issues " **Flood Fighting Alarm** " for them. After this alarm, the flood fighting corps is dispatched to the site.

4.10 Operation of the River Administration Facility

According to the River Law (Article 14), the river administrator should prepare "Operational Regulation for the River Administration Facility" for the main facilities (dam, weir, gate, etc.), and operate properly according to this Regulation.

4.11 Flood Forecasting

Flood forecasting is indispensable to the preparation for refuge of inhabitants in a flood, the operation of facilities (dam, weir, etc.) and the flood fighting activity.

According to Flood Fighting Law, major rivers (43 river system, 80 river) which may cause a severe loss to the national economy, are designated as Flood-forecasting River to forecast jointly by the Meteorological Agency and Ministry Of Construction. Additionally, all Class A river shall issue Flood Fighting Alarm according to each flood forecasting.

4.12 River and Basin Information

Considering the above and flow management, the River Bureau has endeavored for the facility improvement, and the Bureau provides 7,000 rainfall or water-level gauge stations including 3,000 telemetric stations, and 25 radar rain gauge station in 1991. Further more, these river and basin data networked systematically by each basin facilitate more accurate and quick transmission of information in case of urgency and normal condition.

Foundation of River & Basin Integrated Communications, Japan (FRICS) established in 1985 has been disseminating these precious data, and advancing various utilization of them.

4.13 Enlightenment and Popularization on River

In spite that rivers are closely related to societies, with the urbanization and the trend toward the nuclear family, the consciousness on rivers (floods, drought, benefits, etc.) is becoming lost among the younger generation.

For the purpose of promoting proper realizations among inhabitants and societies on the river and life, it is important and indispensable to advertise plainly the necessity of the river functions and to elevate the spirit of our river.

For this, the River Bureau has performed various and numerous activities including love river and other campaigns, events, issues, school educational programs, advertisements through mass-media, etc.. These activities are intensified during following main month designated by the River Bureau, and are performed by the governments, prefectures and municipalities.

- a. Flood Fighting Month (May)
- b. Comprehensive Flood Control Promotion Week (15 to 21, May)
- c. Sediment run-off Disaster Prevention Month (June)
- d. Sand or Gravel Extraction Disaster Prevention Month (June)
- e. Love Our River Month (July)
- f. Love Our Seacoast Month (July)
- g. Ten Days Friendly Forest and Reservoir (21 to 31, July)

4.14 Structural or Technical Standards for River Management

According to the River Law (Article 13), any river administration facility or any structure of Article 26 shall be safe on consideration of the water level, discharge, topology, geology, other river conditions, as well as dead weight, water pressure and other anticipated loads.

For this, the River Bureau prepares many standards.

(1) Cabinet Order Concerning Structural Standards for River Administration Facilities, etc.

With regard to major facilities (dam, levee, ground sill, weir, sluice and sluice way, pump station, intake tower, bridge, inverted siphon, etc.), this technical standards established in 1976 from the viewpoint of the suitable river administration. **Any structure shall adhere to this standards.**

(2) Technical Criteria for River Works

This is a manual for many river works which comprises of survey, investigation, planning, design, construction and maintenance.

This wide-ranging criteria described in detail technique is quite useful for any civil engineer, and it has been revised with the progress of technologies since 1976.

(3) Definition of Dam

Since dams are large and socially important structures, it is not permitted to build a dam which is unable to meet the criteria of the river administration. Thus, not only the dams to be constructed by the river administrator but also dams to be constructed by owners other than the river administrator must also meet the above criteria.

The River Law (Article 44) and the above standards defines that a legal dam means a dam whose height measured from the foundation ground up to the crest is 15 meters or more, built for the purpose of storing or taking river water.

5. LEGAL SYSTEM OF RIVER ADMINISTRATION

The river administration is performed by many legal institutions because river or water are the foundation for human life and economy. However it is based on the River Law, and most of relevant laws including Specified Multipurpose Dam Law, Sand Control Law, Seacoast Law, etc. are derived from the River Law.

Generally, the legal institutions can be classified into three purposes, which are the upgrading of safety of the national land against flood or other disasters, stabilization of the water supply and maintenance of the river environment.

The following laws are major laws to suit different purposes, and moreover these laws can be classified to some provisions of planning, project, regulation, financial measures, etc., from the viewpoint of countermeasures.

5.1 River Law (first in 1896, major revision in 1964)

This law is the legal foundation of Japan's river administration including water resources. At the same time, it is the sole comprehensive law which covers the above three purpose.

The old River Law was enacted and promulgated in 1896. Though this was one of the earliest comprehensive and modern river codes in the world, had been found to be inadequate to deal with the administration of rivers in view of the current social and economic development.

A major revision of the Law was effected in June 1964, which really made a forward step for the modernization of the control systems. The new law is aimed at forming and improving the system necessary for comprehensive administration of rivers. Until now, there have been several minor revisions, and there are many ordinance and regulations in order to implement this law. River Law consist of 7 chapter and 109 Articles, as follows.

Table 1 Items of River Law

Chapter I.	General Provisions	(Article 1 to 8)
Chapter II.	Administration of Rivers	(Article 9 to 58)
Section 1.	General Rules	(Article 9 to 15)
Section 2.	River Works, etc.	(Article 16 to 22)
Section 3.	Use of Rivers and Regulation on Rivers	
Subsection 1.	General Rules	(Article 23 to 37)
Subsection 2.	Coordination of Water Utilization	(Article 38 to 43)
Subsection 3.	Special Provisions on Dams	(Article 44 to 51)
Subsection 4.	Steps to be Taken in Emergency	(Article 52 to 53)
Section 4.	River Conservancy Area	(Article 54 to 55)
Section 5.	Projected River Area	(Article 56 to 58)
Chapter III.	Expenses Connected with Rivers	(Article 59 to 74)
Chapter IV.	Supervision	(Article 75 to 79)
Chapter V.	River Council and Prefectural River Council	(Article 80 to 86)
Chapter VI.	Miscellaneous Provisions	(Article 87 to 101)
Chapter VII.	Penal Provisions	(Article 102 to 109)

5.2 Laws Related to Upgrading Safety of National Land Against Disasters

(1) Flood Fighting Law (enacted in 1949)

Stipulates necessary matters concerning flood fighting such as flood fighting activities, flood forecasting, responsibility of a local municipality, etc., which are carried out in the flood.

(2) Disaster Measures Basic Law (1961)

The basis of disaster measures, and stipulates the disaster prevention system, disaster prevention planning, emergency measures, restoration, etc..

(3) Financial laws

The following laws assist smooth implementation of the above works by financial measures.

- * Erosion and Flood Control Emergency Measures (1960)
- * Flood Control Special Account Law (1960)
- * Law on National Treasury Share of Expenses for Restoration of Damage to Public Civil Engineering Facilities (1951)
- * Law on Special Financial Aid in case of Severe Disaster (1962)

(4) Sand Control Law (1897)

The Sabo administrator shall designate the Sabo area, and implement Sabo works or some regulations, to prevent sediment run-off in upper stream or mountainous areas.

(5) Seacoast Law (1956)

The seacoast administrator designates seacoast conservation areas, and implement seacoast conservation works or some regulations, to prevent seacoast disaster caused by high-tide, etc..

5.3 Laws Related to Stabilization of Water Supply

(1) Specified Multipurpose Dam Law (enacted in 1957)

This was established as a special case of the old River Law to centralize the construction and management of multipurpose dams, which have the purposes of flood control, domestic or industry water, hydropower, and maintenance of normal function of river water.

Planning, construction and operating of the specific multipurpose dams are to be centrally performed by the Minister of Construction who has the ownership of the dams as the river administrator, and he shall give water users "the right to use a dam" instead of a joint ownership. This law eliminated the great bottleneck which existed in the previous joint facilities method and has had great impact upon the promotion of construction of multipurpose dams.

(2) Water Resources Development Promotion Law (1961)

This law was established for promoting the comprehensive water resources development, and rationalization of water utilization in order to secure the domestic and industrial water for which demand increased as a result of the industrial development and increased urban population. By the enforcement of this law, it becomes necessary to designate the river systems for water resources development, determine "Master Plan for Water resources Development" for these river systems, and to build dams in order to assure a water supply to urban areas where the demand for water is greater than the supply.

Until now, in 6 major river systems (Tone, Ara, Yodo, Kiso, Yoshino, Chikugo), the Master Plan was made out, and accelerated water resources developments in these rivers.

(3) Water Resources Development Public Corporation Law (1961)

In according with the Master Plan for Water Resources Development above, these water resources development works shall be carried out by Water Resources Development Public Corporation under the supervision of the Ministry Of Construction.

The main purpose of the Water Resources Development Public Corporation is to build and operate the facilities for developing and utilizing the water resources such as dams, estuary weir, lake and pond water level control facilities for lakes, multipurpose channel, channels exclusive uses and others under the Master Plan. Among these facilities, the construction of dams for flood mitigation can be carried out as "river works" and, in this case the Corporation is authorized to have a part of the powers of the river administration.

(4) Special Measures Law for the Reservoir Area Development(1973)

This law was enacted in order to rebuild the submerged environment and to improve the living environment and industrial foundation in the surrounding areas at the time of construction of large scale dam, to stabilize the livelihood and improve the welfare of the community residents and to promote the construction of dams.

According to this law, a reservoir area improvement plan must be formulated and land slide control works and improvement works for roads carried out, small water supply and sewerage provided. The government is to take the necessary financial and reconstruction measures for the livelihood of residents whose properties are submerged as a consequence of dam construction.

5.4 Laws Related to Maintenance of the River Environment

(1) Basic Law for Environmental Pollution Control (1967)

Clarifies the responsibilities and duties of environmental pollution on industries, government, and local government, and provides the basic policy (noise, water pollution, subsidence, etc.), to secure the healthful and cultural life of the people.

(2) Water Pollution Prevention Law (1970)

Stipulates the effluent standards from factories, etc. to public waters (river, lake, harbor, etc.), and the regulations to control the effluence from factories, etc..

(3) Sewerage Law (1959)

Stipulates the necessary provisions for the promotion of sewerage projects to contribute the suitable urban development, and conserve the water quality in public waters.

(4) Nature Conservation Law (1972)

Stipulates the basic concept and duties on nature conservation, and the basic policy including designation of the nature conservation area, etc..

5.5 Other Laws Related to the River

(1) Public Waters Reclamation Law (1921)

With regard to reclamation of nationally owned lands in public water areas, this law stipulates the permission of reclamation and the belonging of ownership.

(2) Sand or Gravel Extraction Law (1968)

From the view point of prevention of disaster caused by this act and proper development of this industry, stipulates necessary regulations including a registration of contractors, permissions, a sand extraction plan, etc..

6. ORGANIZATION OF RIVER BUREAU AND THE BUDGET

6.1 Organization in Ministry Of Construction

In order to cope with various problems related to rivers, the Ministry Of Construction was formed and the River Bureau was provided as its internal bureau, by enactment of the Ministry Of Construction Establishment Law on July 1, 1948.

Today, the River Bureau shown in Figure 1 consists of 1 department, 9 division and 6 sections, and they respectively work on river planning, river improvement, flood control, river management, dam construction, water use and river development coordination, disaster rehabilitation, sand control measures, coast preservation, etc. Besides those above, the Bureau provides 8 Regional Construction Bureaus (Tohoku, Kanto, Hokuriku, Chubu, Kinki, Chugoku, Shikoku, Kyushu) who practically implement various river works and river administration, and Public Works Research Institute who implements various research and development. Moreover in addition to these direct organizations, the Bureau leads Hokkaido or Okinawa Development Agency, and 47 Prefectures. As a result, the River Bureau's policy can cover all of Japan.

6.2 Budget

The budgets related to River Bureau are for prompting projects related to rivers, dams, sabo, seacoasts, slope prevention measures and disaster rehabilitation, and amount to about 2,772 billion YEN in total for the fiscal year 1993 (April to March).

Table 2 Budget Related to River Bureau
(1993 Budget after revision) Unit: billion YEN

Project Item	* Public Expenditure	National Expenditure
River	1,187	661
Dam	** 534	357
Sand control	395	236
Seacoast	68	40
Slope Prevention	95	48
Specified Flood Control	50	25
Facility (housing, sewerage)		
Sub - Total	2,331	1,368
Disaster Restoration	441	319
Total	2,772	1,687

* This consists of National and Prefectural Expenditure.

** This means the expenditure for the flood mitigation only. The Dam's project cost managed by River Bureau is to about twice, including other purpose's expenditures.

Additionally, about 400 dam projects are currently handled by the River Bureau and consist of 260 multipurpose dams, 43 flood control dams, and 95 small scale for living dams.

6.3 National Land Agency

The National Land Agency was established in 1974, to separate the function of national land planning which had been charged by The Ministry Of Construction. The Water Resources Department is a department under this, and is in charge of coordination on national water resources planning. However, since the department has no project, the River Bureau as a major agency concerned supports the planning and performs the policies.

7. River Council

The River Law (Article 80 to 86) stipulates that " River Council established in the Ministry Of Construction shall conduct investigation and deliberation on the matters placed under its jurisdiction by this law, and in addition, on other important matters on rivers at the request of Ministry Of Construction. The River Council may express its opinions to the administrative agencies concerned regarding the above matters."

According to this provisions, the River Council have proposed many significant reports, and played very important roles in the meaning to lead River Bureau's policies and philosophy, such as the following major reports.

- (1) Promotion Policy on Comprehensive Flood Mitigation Measures (1977, June)
- (2) Policy on River Environment Management (1981, Dec.)
- (3) Promotion Policy on Comprehensive Water Resources Measures (1981, Dec.)
- (4) Revision on Permission of River Area Occupancy (1983, Oct.)
- (5) Promotion Policy on Measures to Exceeding Flood (1987, Mar.)
- (6) Execution Policy on Comprehensive Flood Mitigation Measures (1988, Mar.)
- (7) Promotion Policy on Drought Measures (1988, Mar.)
- (8) Basic Policy on River Improvement in Future (1991, Dec.)

8. CONCLUSION

Since the legislation of the new River Law which means a fresh start of Japan's river administration, 30 years have passed. Till now, the River Law has sustained the river administration, and under it, River Bureau has led or achieved many projects which composed of flood mitigation, water resources development, river environment improvement and others in contributing to the national development and the betterment of life of the people.

Today, the River Law is appreciated as one of the most efficient law, because it has the consistent philosophy and controls river water well. In this paper, the writer introduces various aspects including its philosophy which should be held by any river engineer, so as to make it easy to understand the essence of Japan's river administration system.

Finally, it would be gratifying, if this paper will be of some use to those with interest in the river administration of Japan.

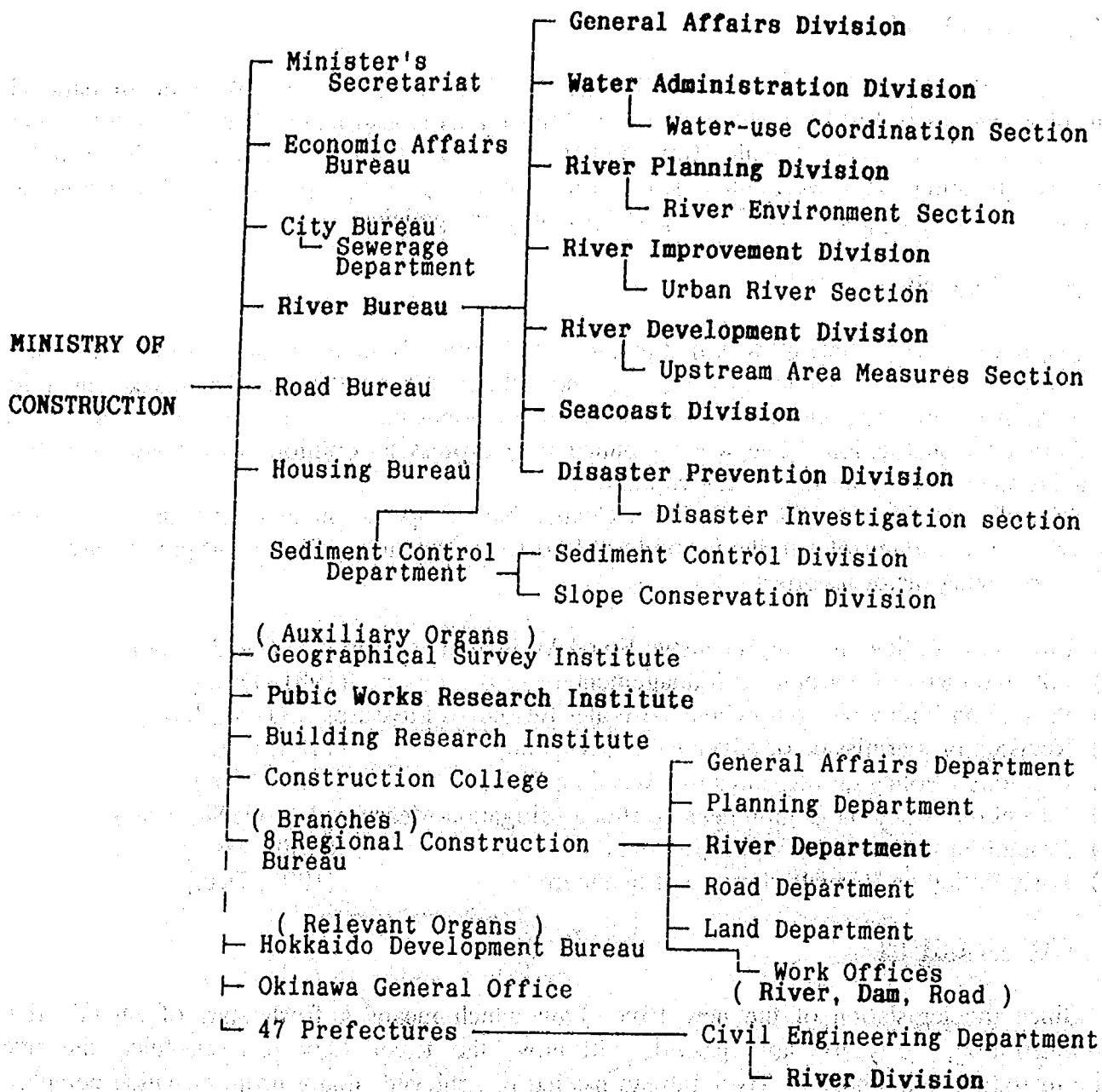


Figure 1 Organization of Ministry Of Construction

COMPREHENSIVE RIVER BASIN MANAGEMENT IN JAPAN

Akira Terakawa

Senior Officer for Regional Planning and Project Coordination

Construction and Development Coordination Division

Economic Affairs Bureau

Ministry of Construction, JAPAN

ABSTRACT

A river basin can be taken as a basic unit for national land management, because the upper basin and the lower basin are closely interdependent through river, which makes the mutual understanding and cooperation indispensable. For the effective river management, we should not limit our eyes to river itself, but should take the whole basin into consideration. In this paper, Japanese national land planning policy after the Second World War is briefly reviewed from the viewpoint of river basin management. Then the comprehensive flood disaster prevention and the comprehensive reservoir area promotion are introduced as recent administrative subjects encountered in the river basin management in Japan.

INTRODUCTION

About two thirds of Japanese total land area is mountainous, which makes the rivers be generally short and have steep channel slopes. This common characteristics of Japanese rivers, along with relatively abundant precipitation (1800mm/y in average), causes flood runoff occur very quickly and annual flow variation (ratio of flood discharge in the wet season to drought discharge in the dry season) be large.

Because of limited flat land area and a consequent high population density, about 50% of the population and about 75% of the properties are concentrated in the flood plain, about one third of the flat land area, which suffers great damage once flood disaster occurs.

On the other hand, a large amount of water is to be stored preparing for a dry season, to stably supply drinking water, industrial water and irrigation water, especially to irrigate rice fields during the growing period from May through September. Therefore, how to control floods and utilize water resources effectively have long been quite important subjects for the adequate national land planning.

In this paper, at first, the history of the Japanese national land development policy after the Second World War is briefly outlined, focusing on the river, which is followed by the introduction, in more detail, of the comprehensive flood disaster prevention policy and the comprehensive reservoir area promotion policy as two of the most important subjects encountered in the recent comprehensive river basin management.

NATIONAL LAND DEVELOPMENT AND RIVER BASIN MANAGEMENT

National Land Development Law

It was after the Second World War that a river basin was recognized as a basic unit for the national development. In 1950, Comprehensive National Land Development Law was enacted, the purpose of which was to improve public welfare through comprehensive utilization, development and conservation of the national land and adequate promotion of industries.

Japan, at that time, was in great disorder after the War and was suffered from a rapid increase of population and a lack of food and energy. Therefore, the urgent goal was set to be the comprehensive national land development to promote food production, coal mining, and hydroelectric power generation etc. TVA, the comprehensive river basin development projects started in 1933 in USA which was to achieve multiple goals including flood control, water resources development, and power generation etc., was taken as a good example.

In the late 1950's, Japanese economy took off from the reconstruction stage to the expansion stage. According with the new establishment of production facilities of private corporations, a huge amount of money was intensively invested for the industrial infrastructure mainly in the existing industrial area along the Pacific Coast, which made it possible to achieve a high economic growth rate. (Average annual GNP growth rate from 1956 to 1960 was 9.3 %) However, in the early 1960's, the expansion of a gap between the rich and the poor regions has come to be recognized as a serious problem. In order to cope with this situation, Comprehensive National Development Plan was settled in October 1962.

The Plan's basic objective was to prevent excessive expansion of big cities and to reduce the regional difference by means of the balanced regional development all over Japan through the effective utilization of natural resources. Each company, as a result of its

rational decision-making to maximize the benefit, had a tendency to locate their plants in the existing industrial area around the big cities. So, "strategic footholds" were set up in various parts of Japan, where the infrastructure, such as roads, ports, levees and dams, was intensively constructed to promote transferring the factories from the overpopulated urban area to less populated rural area abundant with land and water resources, and each foothold was organically connected by transportation and communication facilities.

For the well-balanced Regional Development

Till late 1960's, Japanese economy has enlarged its scale with background of the urbanization, the internationalization and the arrival of the information-oriented society, national land utilization system with the infrastructure basically built up in Meiji era, the formative period of Japan as she developed into a modern nation, could not keep up with times, which deepened the seriousness of the problems of both the overpopulated area and depopulated area.

Under these circumstances, the Second Comprehensive National Development Plan was settled in May 1969, which mainly aimed at drastically reorganizing the national land utilization through large scale development projects and formation of the new transportation/communication networks. Comprehensive river development project, of which large dam construction formed the core, had been continually promoted in this time period to control and to utilize water resources.

However, since the projects are usually more beneficial for the people living in the lower basin, than those in the upper basin affected by the submergence of land, the gap between the regions was amplified, which became the obstacle to the smooth dam construction. In order to relieve serious antagonism between the upper and the lower basin regions, Law on Special Measures for Reservoir Area Promotion was enforced in 1974, which prescribes that the Prime Minister authorizes, with cooperation of the related Ministers, the master plan of reservoir area promotion, where large dam accompanying substantial submergence of houses and farm lands would be constructed.

Since 1975, Foundation for Reservoir Area Promotion has been established for each of the principal river systems, which enabled the lower basin region to directly provide fund necessary for promoting the upper basin region.

In November 1977, the Third Comprehensive National Development Plan was settled, which mainly aimed at improving the total livability of each region based on its own historical and traditional background. The concept of "Settled Habitation Area" was introduced as a unit area of human habitation for making it possible to settle down comfortably in each region, which might prevent the concentration of people and industries to big cities. River basin was considered to be one of the most important unit to establish the

Plan, which inevitably closed up the importance of the comprehensive river basin management.

For the Effective Flood Disaster Prevention

One of the most important subject to be solved for managing river basin, at that time, was the frequent occurrence of natural disasters, such as floods and landslides etc., which arose from the unbalance between the land use rapidly changing by the progress of urbanization and the natural disaster protection measures.

It was in October 1976 that the Minister of Construction inquired the River Council on the guidelines of the comprehensive flood disaster prevention measures focusing on the way to cope with the difficulties caused by the urbanization. After the intensive study in the subcommittee of the Council, the interim report was submitted to the Minister in June 1977, which marked the historical change of flood prevention policy from that of taking only the conventional in-channel measures including the river improvement and dam construction to that of adding non-conventional measures in the basin, such as maintaining water retention or retarding function of the basin. Ministry of Construction, in response to this recommendation, started the Comprehensive Flood Disaster Prevention Project in 1979, which has been strongly pushed forward to date.

COMPREHENSIVE FLOOD DISASTER PREVENTION MEASURES

Influence of the urbanization on the urban rivers

From 1960's, Japan experienced a rapid urbanization especially around the major three city areas (Tokyo, Nagoya and Osaka). This Urbanization, which is still going on, put a heavy burden on the urban rivers. Fig. 1 shows a rapid enlargement of the urbanized area in Tsurumi River basin, which gives us a typical example of the urban river basin. Fig. 2 shows the change of a flood hydrograph in accordance with the basin development. In this case, urbanization of 60% of the basin raised the peak discharge from $600\text{m}^3/\text{s}$ to $1000\text{m}^3/\text{s}$ and also shortened the flood concentration time about 1hr. These are mainly caused by the increasing non-permeable areas and the efficient drainage system. The changes of the hydrological cycle, along with the increase of damage potential because of the increasing population and properties in the flood plain, brought aggravated flood damage in urban areas.

The interim report, mentioned in the previous section, pointed out the necessity of promoting the comprehensive measures, emphasizing to make the utmost effort, in addition to the adequate flood control facilities, to decrease flood discharge and sediment transport by conserving the water retaining and retarding functions of the river basin. In response to this

recommendation, the Ministry of Construction started the Comprehensive flood Disaster Prevention Project in 1979, the urgent goal of which was to secure the safety of the basin against the target rainfall of 50mm/hr.

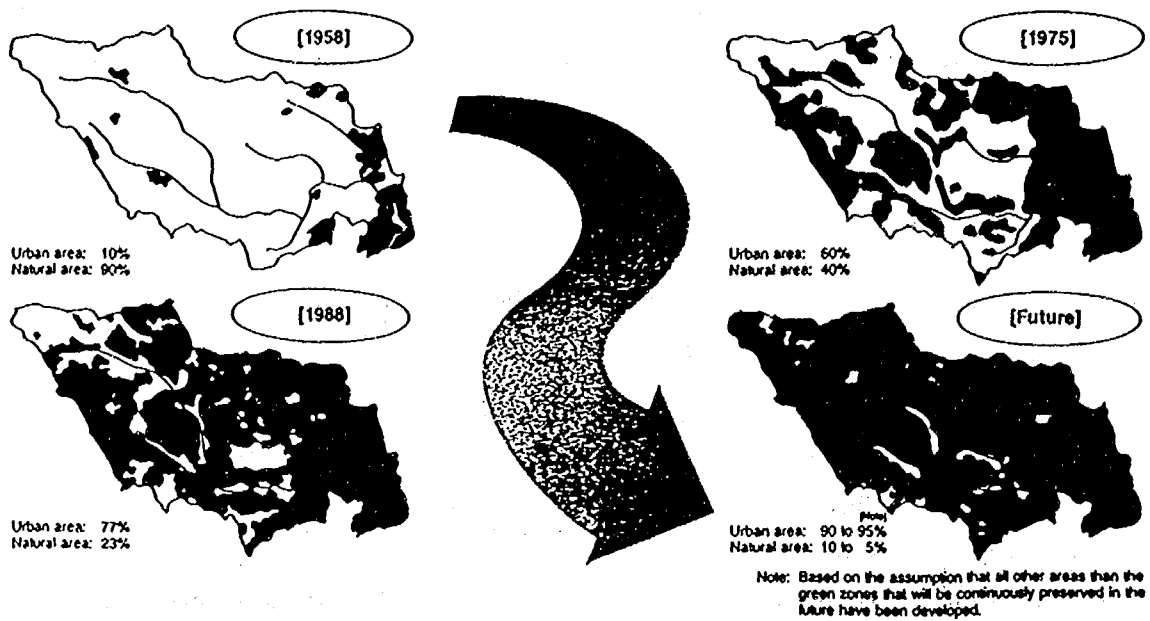


Fig. 1 Changes of Land Use in Tsurumi River Basin

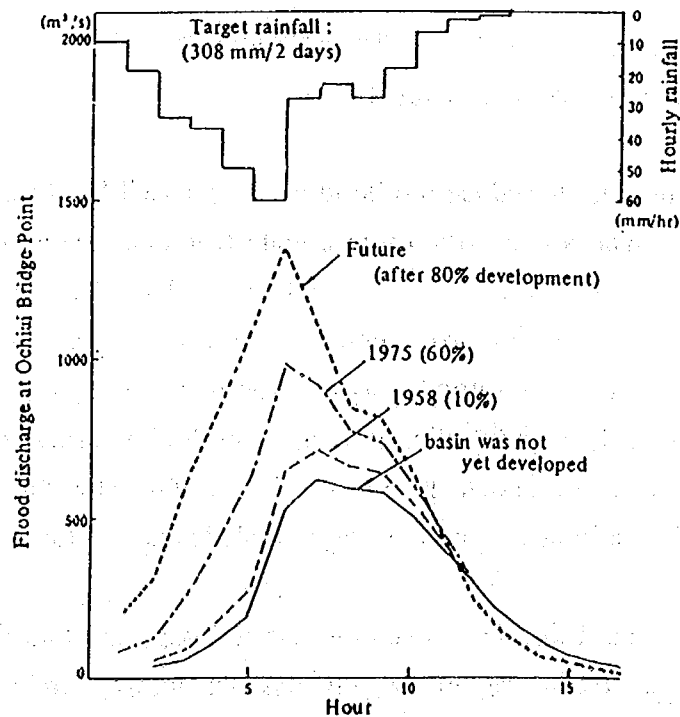


Fig. 2 Change of Flood Discharge due to Urbanization in Tsurumi River Basin

The Concept of the Comprehensive Flood Disaster Prevention Measures

Flood disaster prevention measures can be roughly classified into structural and non-structural measures. The former one is to control floods by means of levees, dams, retarding basins, river improvement etc., and the latter is to reduce flood damage by land use control, flood proofing structures, flood insurance, flood fighting, etc. They are systematically shown in Fig. 3, which are, as a whole, bundled under a concept of "the Comprehensive Flood Disaster Prevention Measures".

Non-structural measures are mainly for reducing fragility against disasters and are regarded as complementary to the structural measures. However, because of the increasing cost and time necessary for coordinating the concerned people's interest of the conventional structural measures, the importance of non-structural measures is increasing more and more in recent years.

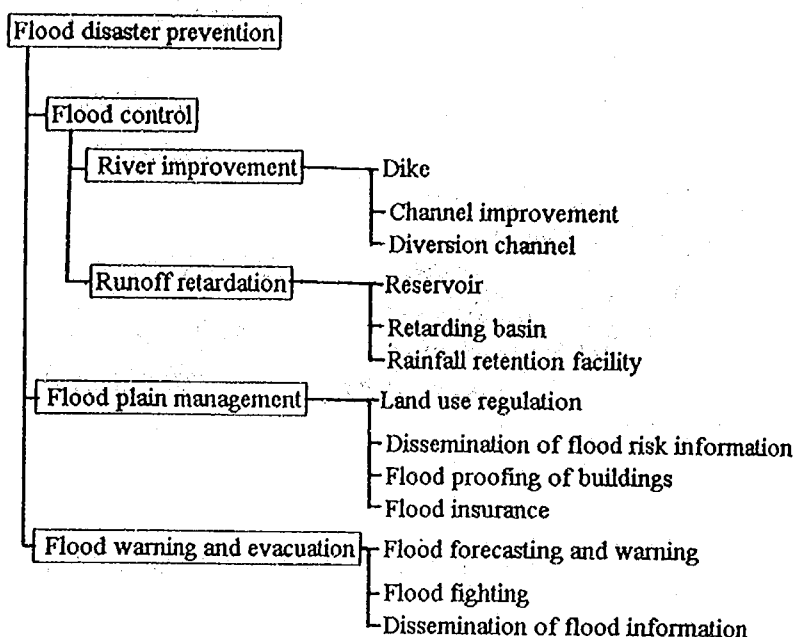


Fig. 3 Comprehensive flood disaster prevention measures

Some of the non-structural measures are to be briefly explained below.

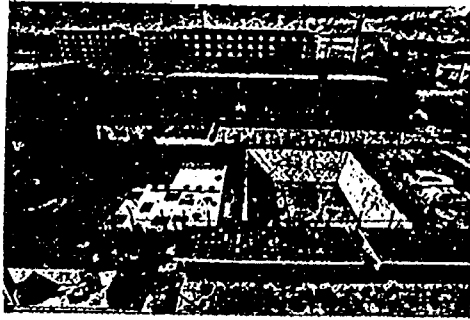
Runoff reduction facilities

Runoff reduction is a measure to reduce the flood discharge itself by storing or infiltrating the rain water in a basin, which are classified into on-site type and off-site type. It plays a role to recover storage and infiltration capacity of soil, which have been lost by pavement and drainage system in the process of urbanization. There are several types of facilities including a retarding basin, a detention pond (might be used for multiple-purpose as a park, a parking lot and a play ground), an infiltration trench, an infiltration pond, and a permeable pavement etc., some of which are shown in Fig. 4. Fig. 5 illustrates the combination of rainwater infiltration facilities adopted in the housing complex area development.

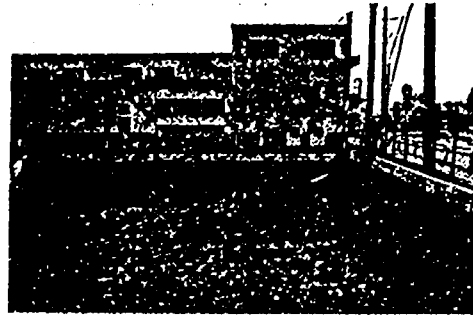
Land use regulation

Land use regulation for flood disaster prevention has two aspects. One is to restrict the development of the upper basin region, which has an impact on the hydrological environment and might decrease the safety of lower basin region. The other is to curb further concentration of population and properties in flood plain areas, where safety against

flood disaster has already considerably decreased.



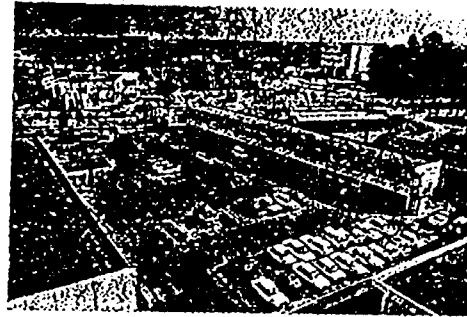
● Reserve + filtration
The reserving function of the adjusting pond and the filtering well plays two roles of executing the outflow control and drainage processing.



● Adjusting Pond
The adjusting pond cuts a part of the flood water without directly letting the rain water flow into the river and drainage pipes.



● Park Reserve
The park is dug one step deeper than the surrounding land. Normally, it can be used as a park but when a typhoon comes etc., it can serve as a temporary rain water reserve.



● Water Filtering Pavement
Where the traffic is scarce such as in a parking lot, the water filtering pavement can be used.

Fig. 4 Several types of Runoff Reduction Facility

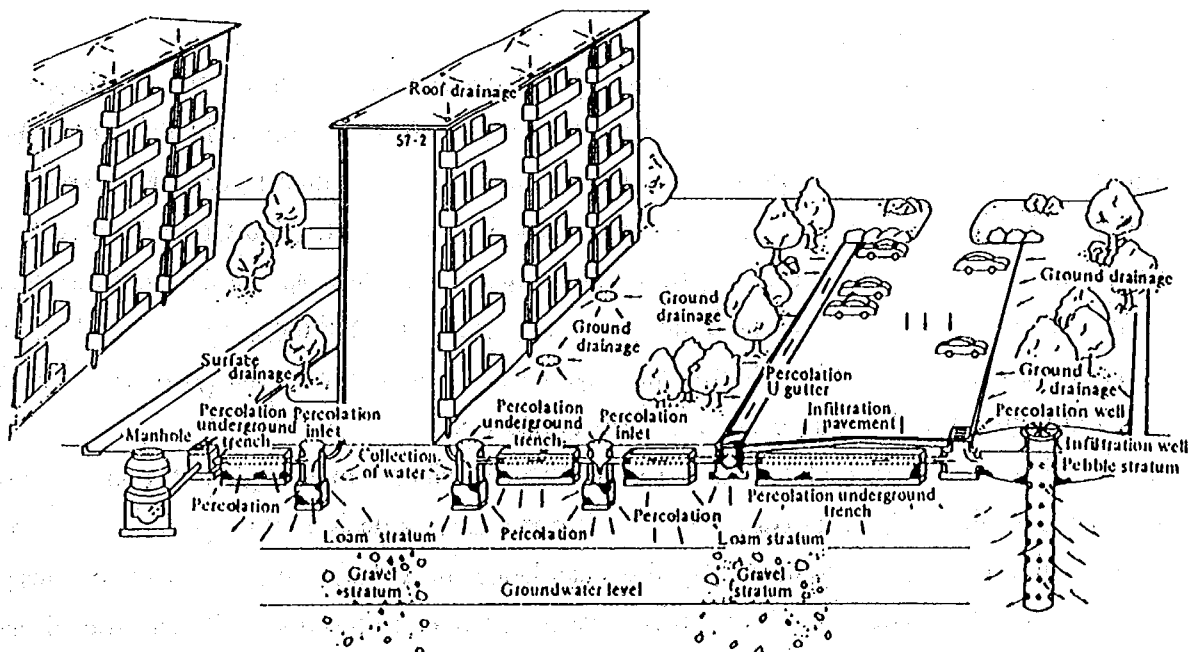


Fig. 5 Combination of Rainwater Infiltration Facilities

There are two approaches to achieve the above goal : to restrict or guide the location of houses and factories themselves ; and to impose the obligation to the locating bodies not to reduce their own or other's safety against flood. The Building Standard Law, the National Land Planning Law and the City Planning Law are the examples of laws which are effective to limit the rights of private land owners for this purpose.

Administrative guidelines for housing land development are also an effective means, though they have no legal power. It is used for promoting systematic city planning by applying it when issuing governor's development permission under the City Planning Law, which is required to develop land more than 0.1ha in urban area. As for flood disaster prevention, it often includes the obligation to construct runoff regulating facilities, such as shown in the previous section, to prevent the increase of peak discharge caused by the development.

Dissemination of flood risk information

For the appropriate flood fighting activities in case of disaster and the establishment of evacuation arrangement, the local residents should be aware of the risk of inundation of their living area. Public announcement of expected inundation areas is made for this purpose, which is to inform the public of the past records of flooding, the accompanying inundation and the relations between the rainfall intensity and inundation areas and the level of inundation under the current flood control capacity. In Japan, to date, past inundation record of 448 rivers (as of December 1991) have been published and also flood risk maps based on hydrological and geomorphologic studies have been published since March 1987.

The Basin Conservation Plan

Comprehensive flood disaster prevention should be achieved based on the consensus of the Ministry of Construction, local government bodies, private sectors, and residents. For this purpose, a River Basin Council has been set up for each of the selected urban rivers to facilitate coordination of interests and implementation of a project. The Council consists of the Regional Construction Bureau of the Ministry of Construction and prefectural and local governments. With diverse participants from city planning, building, river and drainage agencies of prefectural and local municipalities, these councils are in charge of formulating the related projects with a support of residents concerned.

Each Council is to formulate a Basin Conservation Plan, a master plan to control flood water and to drain landside storm water. To frame a plan, a design return period of flood is first determined, which is followed by the calculation of a design discharge in the design period, taking the effect of future urbanization into consideration. Then, the design discharge distribution for river and basins is determined, considering an appropriate balance between them. Fig 6 shows an example of discharge distribution set to each of the divided

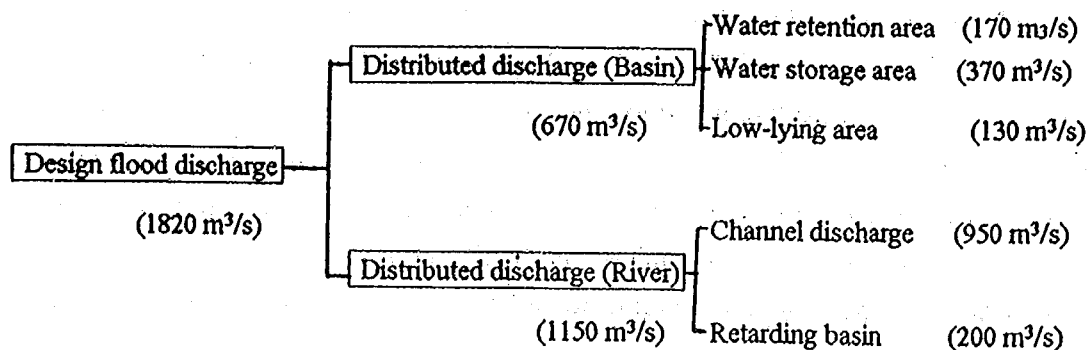


Fig. 6 An Example of Discharge Distribution Plan

area according to its characteristics, which include the following : water retention area - mainly hilly lands, terraced and mountainous districts, where runoff retaining capacity should be maintained or increased ; water storage area - lowlands where the natural storage function should be maintained ; low-lying area - lowlands to be protected against flooding.

COMPREHENSIVE RESERVOIR AREA PROMOTION MEASURES

Necessity of Reservoir Area Promotion Measures

Large dam construction, for achieving flood control, water resources development and/or power generation, inevitably causes large scale submergence of land and houses, which might possibly destroy the village community around the reservoir. Therefore, its impact is not limited only to the people who lose their houses and/or farm lands by submergence, but also to the regional community itself. It can be also pointed out, as a local condition of the region where dam construction takes place, that it suffers from depopulation and aging.

In order to promote dam constructions under such conditions, it is necessary not only to support the reconstruction of each person's life who is directly affected by submergence, but also to get rid of the complaint and worry of the people belonging to the community, by taking the comprehensive measures to overcome the minus impact of the dam construction and to promote the region.

Law on Special Measure for Reservoir Area Promotion

In accordance with the growing concern for establishing the measures to relieve the impact of dam construction on the surrounding region's community, Law on Special Measures for Reservoir Area Promotion was enforced in 1974.

The Prime Minister, according to the Law, authorize the master plan of comprehensive measures of reservoir area promotion, based on the demands of the regional community, for the dams accompanying considerable submergence of houses or farm lands. The master plan consists of wide range of public works, which include farm land improvement, road construction, sewage works, provision of public facilities for education, public health and recreation etc. Ministries in charge of each public works incorporated in the master plan, are to take cooperatively the concrete action to achieve the scheduled and concentrated promotion of the reservoir area.

Since the enforcement of the Law, 80 dams were specified as satisfying the conditions to apply the Law, among which the master plans were actually authorized for 62 dams and have been carried out.

Foundation for Reservoir Area Promotion

Since 1975, Foundation for Reservoir Area Promotion has been established for each of the principal river systems, which include Tone River, Ara River, Kiso River, Yodo River, Yoshino River, Chikugo River, Kino River, Toyo River, and Yahagi River, and have been functioning actively. Each Foundation consists of local governments of both the reservoir area (upper basin) and the beneficiary area by dam construction (lower basin).

The basic role of the Foundation is to supplement the measures based on the Law and to return the benefit from dam construction which belongs to the lower basin region to the upper basin region in the form of supporting the regional promotion, which would contribute to smoothen the dam construction project and also to achieve the well-balanced river basin development.

To Activate the Community of Reservoir Area

In order to promote the reservoir area, where depopulation and aging are going on, the important point is how to increase the chance for communal exchange with the cities in the lower basin, which would bring a great impact for activating the regional community, and also would contribute to conserve catchment basin through supporting the afforestation activities. People living in the big cities have a tendency to long for the abundant natural environment and the beautiful natural view of the reservoir area, while, on the other hand, those in the village of the reservoir area are to be attracted by the city life with a plenty of shopping stores and amusement facilities.

Therefore, it should be positively pushed forward to make use of dams and reservoirs as valuable resources and develop recreational facilities around them to attract people living in the city area in the lower basin, which would contribute to the economic development of the region with increasing employment opportunities and income.

To promote the utilization of dam and reservoir for recreational purpose, several problems are to be solved by creative idea and technical development. The problems include: how to conserve the lake water quality; how to secure the safety of the users of lakes; how to cope with the seasonal change of lake water level caused by lake water management operations, etc.

For the effective reservoir area promotion, it is needless to say that municipal authorities, prefectural governments and federal government have to recognize their own role and to closely cooperate each other. And the most important point is that the people in the upper basin region and those in the lower basin region should recognize each other the importance and difficulty of both the water resources development and reservoir area promotion, as they are sharing the fate in the same vessel : a river basin.

CONCLUSION

In Japan, due to a rapid urbanization, low land has become more prone to flood disaster, while the execution of conventional flood control measures such as dam construction and river improvement work, has come to require so much time and cost. So, it is important to bear the storm water not only by conventional measures, but also by various types of storm water detention and infiltration facilities dispersedly located in a basin, and by the effort to lesson the flood loss by soft measures, such as land use regulation and flood warning system. This is the concept of the comprehensive flood disaster prevention policy.

On the other hand, in order to smoothly promote dam construction projects, mutual understanding, or recognizing of the partnership, between the people in the lower basin and those in the upper basin from the standpoint of well-balanced total river basin management, is indispensable. We have to make much effort to strengthen the measures for promoting the reservoir area community trying to activate communal exchange between the upper and the lower basin, as it is called the comprehensive reservoir area promotion policy.

It should be emphasized that, for a better management of rivers including flood control and water resources development and also river water quality improvement (which is increasing the importance these days in order to create an attractive river environment, though not discussed in this paper.), we should not limit our eyes to river area in a narrow sense, but should have a wide viewpoint how to manage the whole basin effectively. The responsibility of river administrations should spread all over the river basins.

River Environment Administration and New Trial in Japan

Yukihiro Shimatani

River Environment Division, River Department, Public Works Research
Institute, Ministry of Construction, Japan

1. PROFILE OF RIVER IN JAPAN

Japan is mainly composed of 4 major islands, and its area is 374,341 km². These islands extend over 2,000km in total length, but only about 300 km, at maximum, in width. The land of Japan is mostly mountainous, about 75%. Long mountain ranges run along the center of the islands. The Japan Alps which include mountains of 3,000m class and lie in the central area of Honshu. Plains are relatively narrow and formed by river sedimentation. Rivers are short and generally form steep channeled slope in general.

According to the census of 1985, the population of Japan is 121,049 thousand(persons), the seventh in the world. With a population density of 320 persons/km², Japan is one of the most densely population in the world. The Population is mostly concentrated in urban areas in plains.

Japan is located at the northeast end of Monsoon Zone that includes Korea, China, India, and Southeast Asian countries.

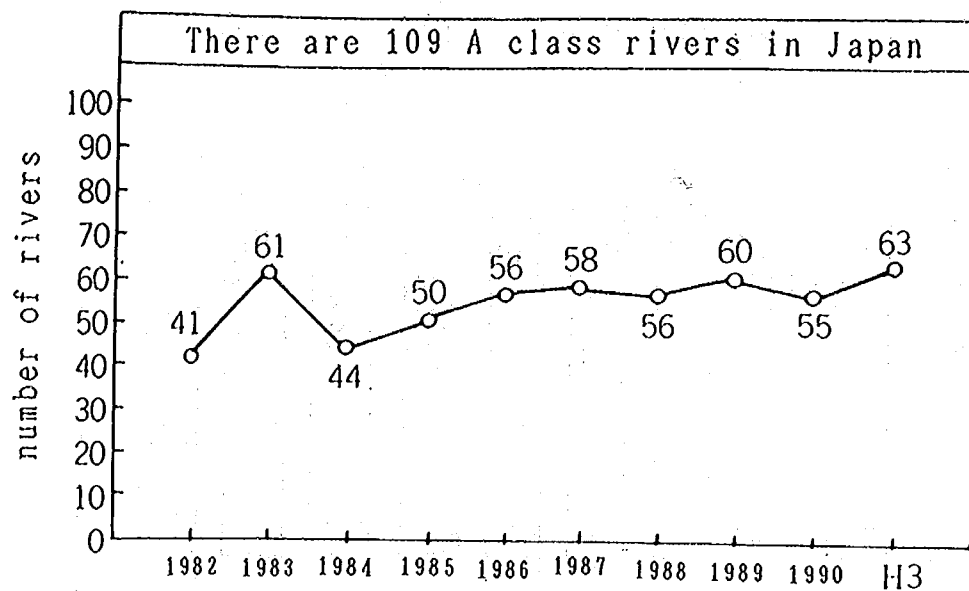
In Japan, there are 4 seasons including 3 wet periods. In winter, there are heavy snow falls on the Japanese Sea side, in particular in the northern part, but fine weather continues on the Pacific Ocean side. The second wet period, observed in June and July is called "Tsuyu" brings continuous heavy rains. During the third wet period in September and October, typhoons born in the southern oceans attach Japan and cause stormy weather. Because of these 3 wet periods, the annual precipitation in Japan is 1,800 mm, and one of the highest per km² in the world, which has a global average of 800mm

2. GENERAL

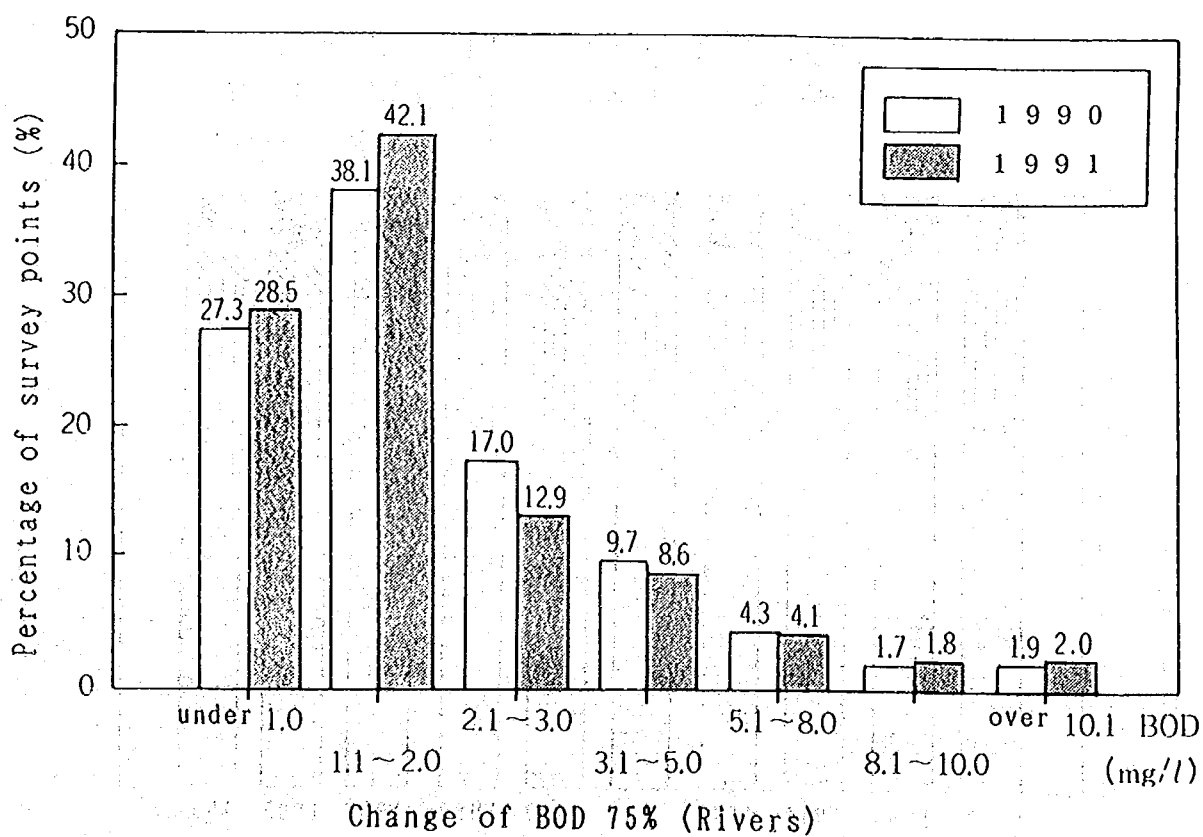
As a result of the progress of urbanization in river basins in recent years, the river environments have changed, water quality has worsened and hydraulic properties fallen. Public demand for the improvement of water quality, and preservation of natural environment has risen.

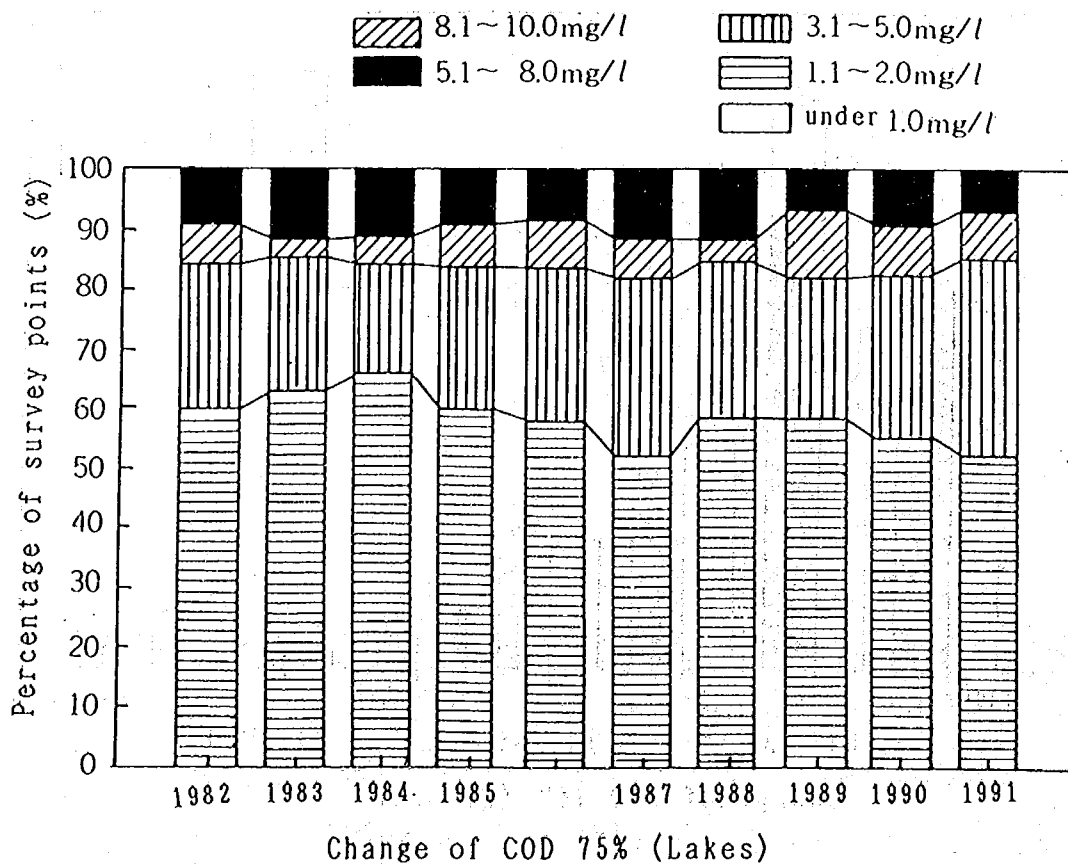
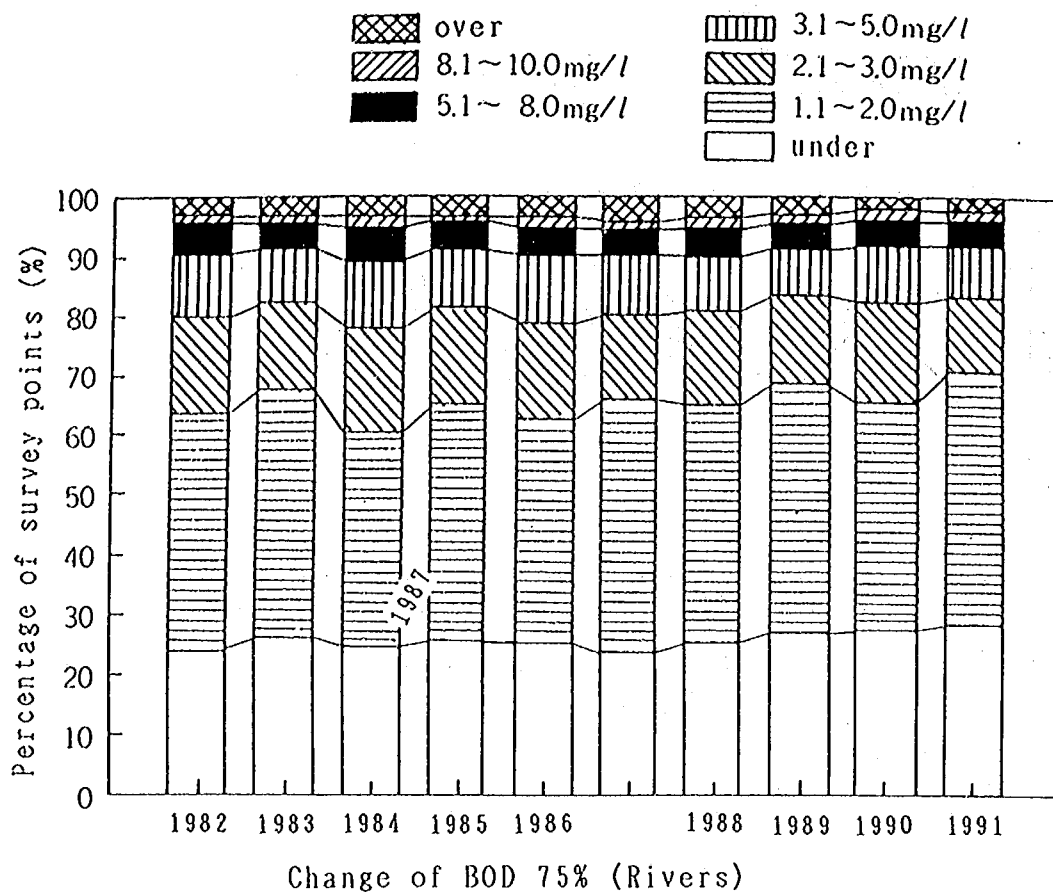
Watersides are considered valuable open spaces, and support natural conservation, disaster prevention and recreation. The role of such spaces in the formation of regional environment is being re-evaluated.

For instance, according to the national census on River Environment by the Ministry of Construction in fiscal 1990 to 1991, about 130 million people visited the 109 most important rivers in Japan. This means that each citizen visits a river about once a year for walking, fishing or sports, and this condition illustrates the recreational role of rivers.



Change of river number which every survey points satisfied with water quality standards





130 million people visit the river every year.

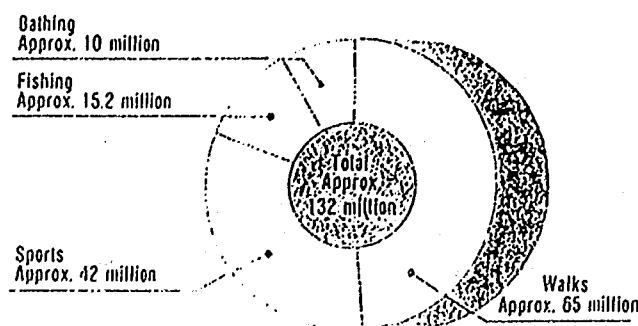


Fig.1 River users between summer 1990 and spring 1991¹⁾

3. Policies

Principal policies on river environment taken by the ministry of construction are as follows;

3.1 National Census On River Environments

This is a survey on inhabitation by fish, birds, insects, small animals and plants in rivers, and on utilization of river space. The nationwide survey is carried out periodically for rivers under ministerial jurisdiction, and in the future will also be conducted for rivers managed by prefectural governments. This is one of the basic surveys used to know the actual situation of rivers, and the results are reflected on various plans.

3.2 River Management Basic Plan

Recommendations entitled "Approach to River Environment Management" was submitted by the River Council in December 1981, which noted that "river management is extremely important for the people's daily lives, together with floods control and water use management.

In response to this, the Ministry of Construction intends to formulate a master plan for river management carrying out comprehensive policies on conservation and creation, by coordinating and harmonizing the flood control and water use plans and local characteristics, based on the long-term, broad-based perspectives.

River spatial environment management plans for rivers have been completed, and water environment management plans are now being formulated.

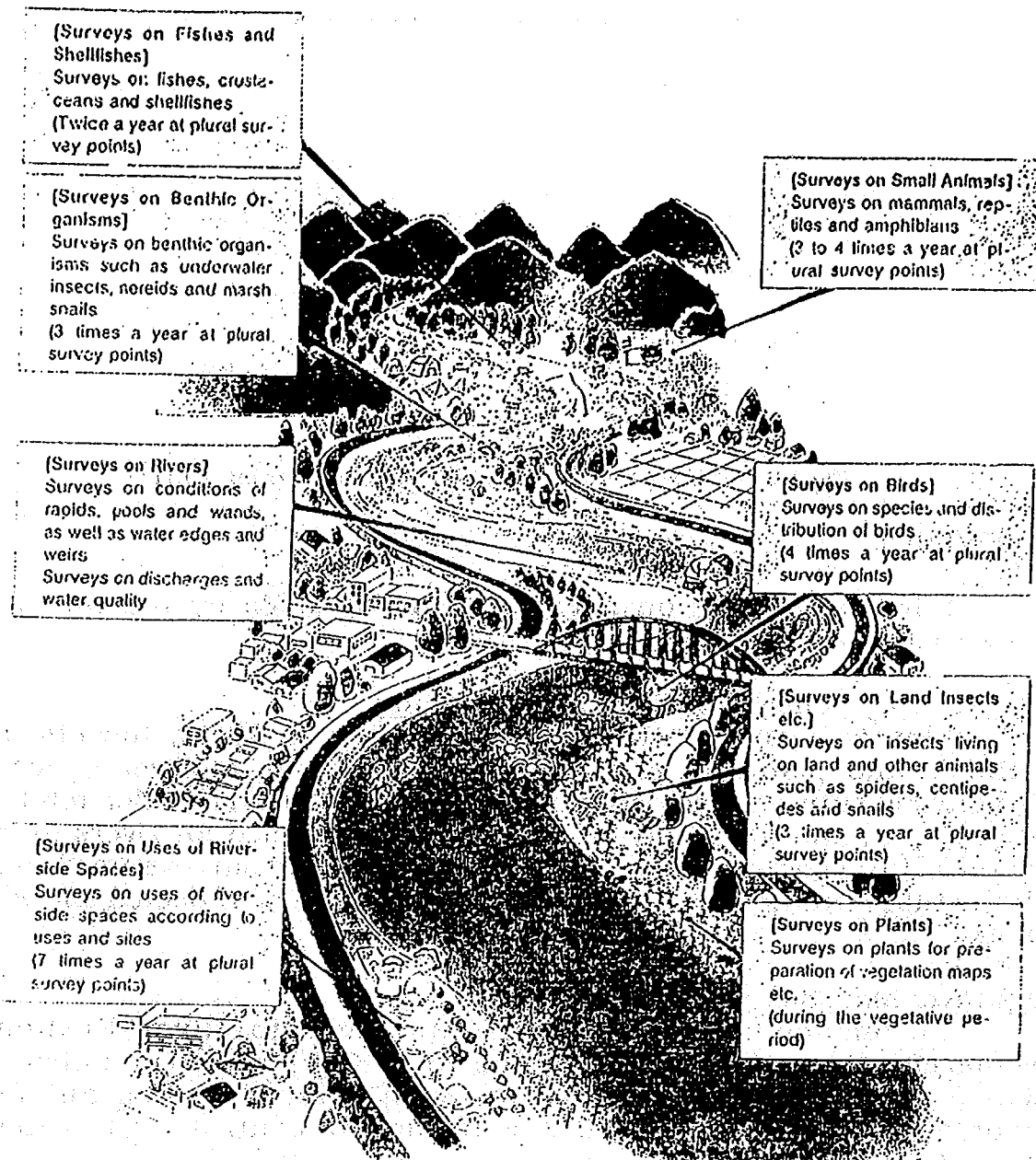


Fig.2 Situation of National Census¹⁾

In order to conserve natural habitats, basic information relating to rivers are collected on sections of rivers directly administered by the Ministry of Construction on a total 109 river systems in Japan

Nature, nature use and development zones will be created under the river space layout plans. Each of these zones will have the following characteristics.

[Nature Zone]

The natural environment and scenery peculiar to rivers will be conserved and artificial alterations will be avoided in principle except for purpose of flood control and water use. In these areas people come into contact with nature as it is.



Skunk cabbage along Ishikari River at Yausuba (Hokkaido)

[Nature Use Zone]

The natural environment and scenery peculiar to rivers are made use of to create quasi-natural environments such as areas for nature observation, fields of wild grass and agricultural fields, providing spaces for walks and other nature-oriented recreation.



Mamigasaki River (Yamagata Prefecture)

[Development Zones]

Multi-purpose plazas, parks, sports grounds, and stepped and gently-gradient revetments are created on the flood channels and river banks to provide space for various recreational and sports activities, and for watching the fireworks, shoryo-nagashi (floating of straw boats for ancestral spirits), canoe races and regattas.



Hyogojima, Tama River (Tokyo Metropolitan District)

Fig.3 Nature, nature use and development zones will be created under spatial environment management¹⁾

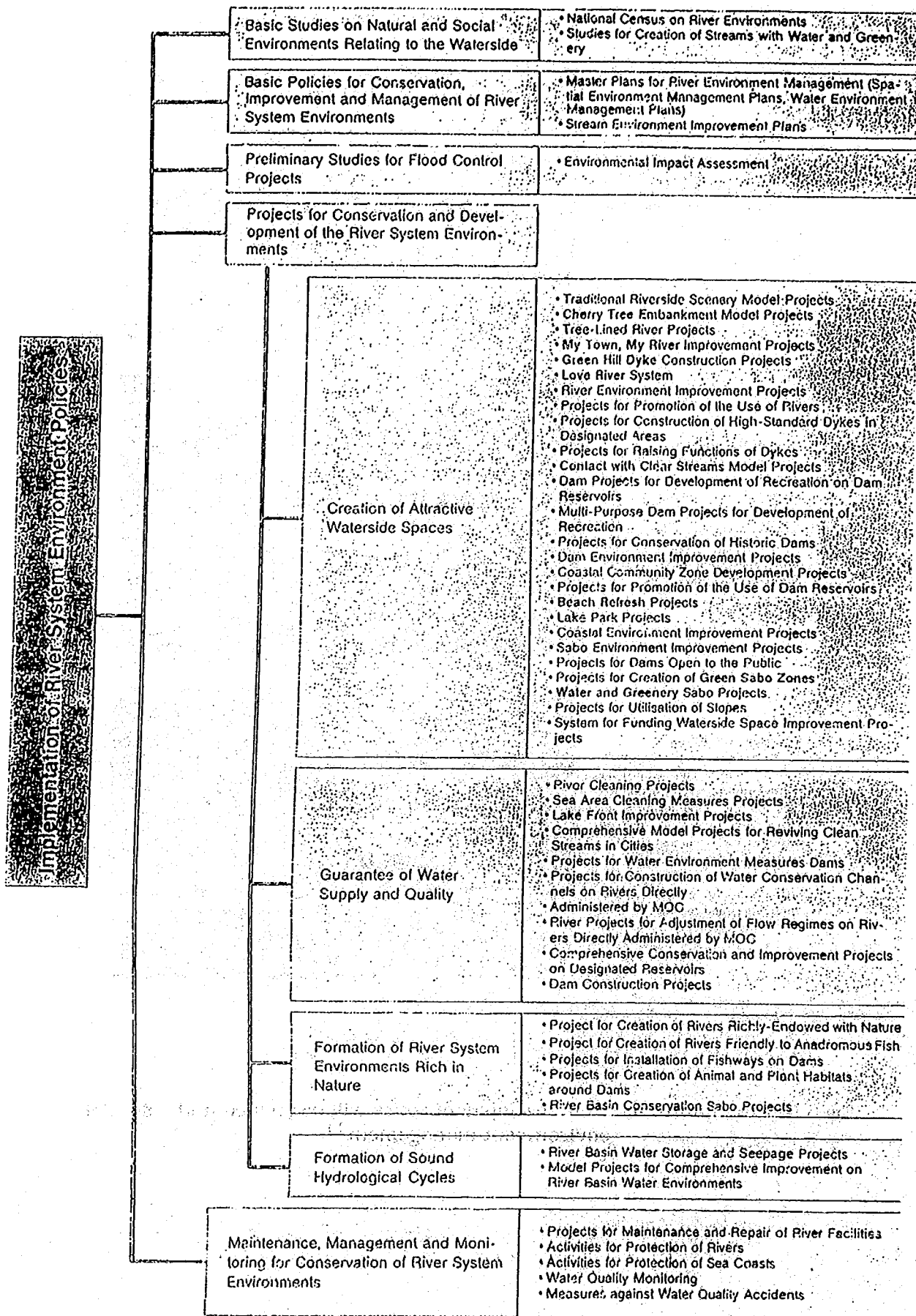


Fig.4 Implementation which realize river environmental Policies¹⁾

3.3 Environmentally-sensitive River Works

(1) River improvement projects

Various works are being carried out, such as the conservation and creation of scenery, conservation of natural environment and various projects are being undertaken to enhance hydraulic properties.

These include the creation of multiple-nature rivers, natural hilly levees and rivers where fish can swim upstream, as well as home town river model projects and model project for levees planted with cherry trees.

Porous materials are used for river banks, shoals and pools. Installation and improvement of fish channels, installation of levees with gentle slopes and undulations, expansion of levees, planting cherry trees, river work which is coordinated with town planning.

(2) River purification projects

Dredging of deposited sludge is being carried out in rivers, lakes and swamps.

Introduction of purified water is performed by taking in fresh water from other rivers to a river where water quality is poor. This was done in many rivers such as the Uchi River in Wakayama City and the Furu River in Neyagawa City.

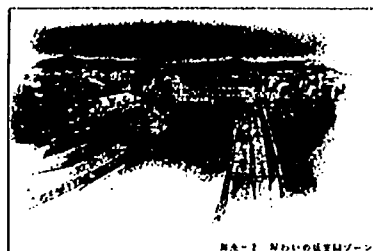
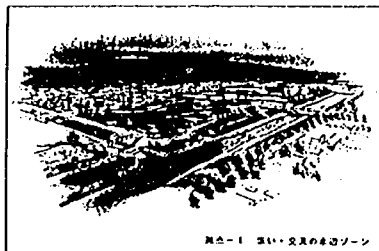
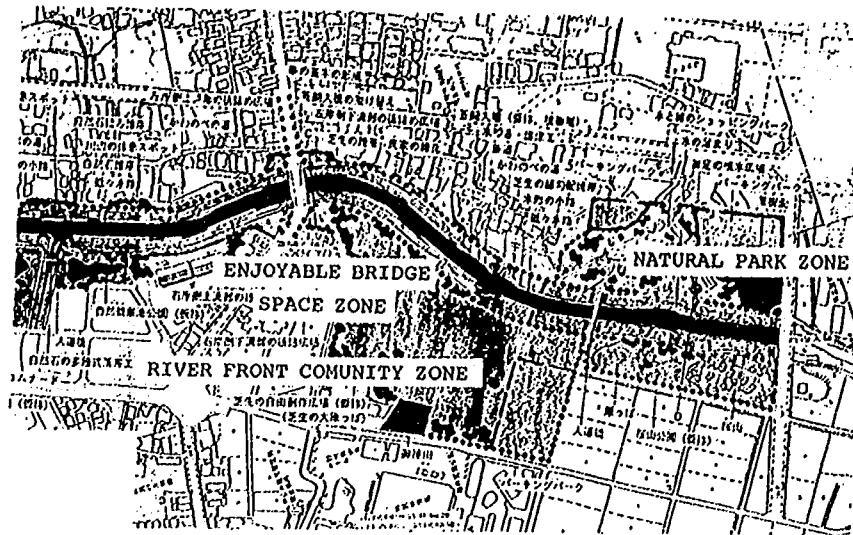
In addition river purification can be performed by direct purification such as inter gravel contact oxidation, where river water is taken into a gravel tank, and pollutants are absorbed, settled and oxidized by gravel and organic matter on the gravel.

Purifying facilities described above were installed at inlets to the Tama River, and water was taken in from its tributaries, the No and Hirase Rivers.

Cherry tree embankment

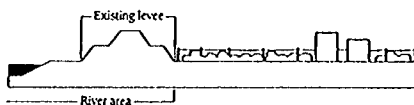


Home town river project

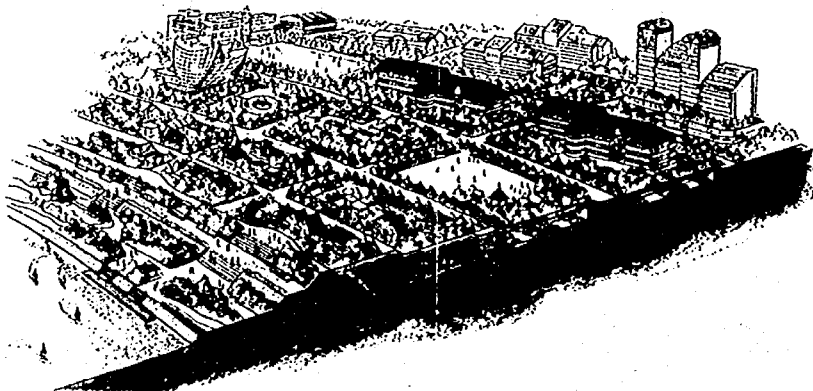
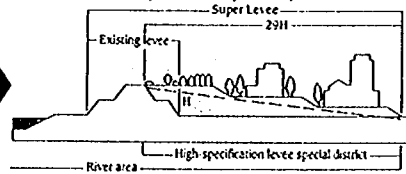


The Super Levee

• Before Improvement by the Super Levee



• After Improvement by the Super Levee



Floods are no longer terrifying

A fine new town built up
from the foundations

A community brimming over
with sunshine and greenery!

4. NEW TOPICS OF TECHNOLOGICAL ISSUES REGARDING ENVIRONMENTAL TECHNOLOGY

4.1 Naturally Diverse River Construction Method

River improvements are apt to damage the natural environment, which means that they decrease the fish habitats, riffles and pools, stone beds and aquatic plants stripe. Riffles are used for spawning by some fish species during spring and summer, and in winter large carps move to pools to avoid low water temperature. Another important habitat is cobble which is in unsunken stone stripe and can provide shelter for fish. This is most important during storm events, especially for these fish with limited ability to swim in fast flow. Fish are considered an important component in preserving the diversity of natural river environment.

Naturally diverse river construction methods include the installation of riffles, pools, creeks, ponds which are connected to water flow, unsunken stone stripe, aquatic plant stripe and fish shelter.

During 1992 these methods were carried out at 606 sites throughout Japan, and 971 sites in 1993. Our division proposed and installed some original construction methods based on our researches.

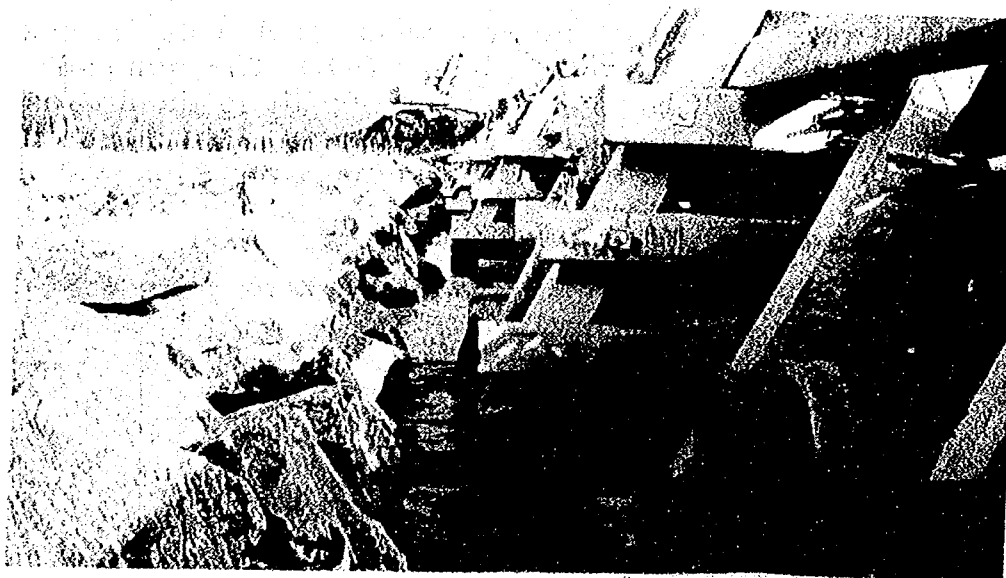


Fig.5 Example of Naturally Diverse Construction Method in Midori River.

In order to make aquatic plant and fish shelter, using willow and concrete pipe.

4.2 River Water Purification Method

Many methods of water purification are used in combination with physical and chemical purification. Physical purification is the method in which we use sedimentation, filtration, adsorption and so on. Chemical purification is the method in which we use oxygenate of aerobic micro-organisms, the effect of coagulation by eco-system and so on.

In this section, we introduce new researches or works which are recently carried out in Japan.

(1) Contact Oxidation Systems

Two methods have been developed by which river water is taken into a materials tank, and as a result coagulation and filtration by contact with materials occurs. Micro-organisms incorporate the organic matter and form inorganic materials. One of these methods uses gravel and another uses charcoal.

a) Contact oxidation system using gravel

Using this method, we have river water percolate through a materials tank. Inorganic matter such as sand or mud which is a kind of polluted materials in river is removed. Organic matter is reduced by the biological effect after it is trapped in the spaces between gravel by physical effect.

This method accomplishes two objects; one is the maintenance of the capacity to reserve trapped inorganic matter, another is the supply of enough oxygen to oxygenize organic matter. Many works of this type have been carried out in Japan.

b) Purification System using charcoal

In this method, we let river water percolate into a charcoal layer. The mechanism is same as oxidation system using gravel. The feature of this system is that the area of this facility is smaller than using gravel and that we can set it on river bed.

This system is applied to the area where BOD value is below the value between 10~20, which is relatively low BOD. The removal ratio is 80% at ss value, 70% at BOD value, and the velocity in the area is about 2~4cm/minute. As one of the effects of this system, we are expecting the removal of smell. In Tenryuu River and Uzuma River, This system were installed and now working.

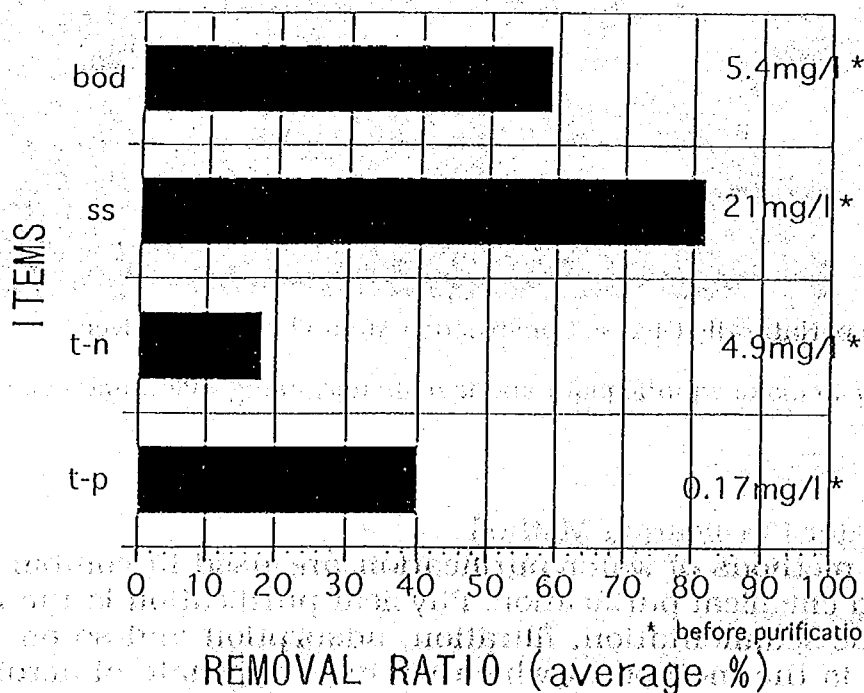


Fig.6 Effect of purification system using charcoal 1)

(2) Purification System Using Natural Biological System

In this method, we use the eco-system in order to remove polluted materials. Polluted materials are reduced by plants and animals in the eco-system. We are uncertain about many aspects of how the biological system performs the function of purification, so we are planning to expand this area of research. Three environments for this research include ponds, creeks and reed stripes along rivers.

a) Pond

This is the method in which polluted water is reserved in pond for some period and eco-system in the pond dissolve them. In this method, diffusion and transportation of polluted water are expected to occur as a result of uptake by the food chain from the micro-organisms and algae to fish and bird communities in the pond.

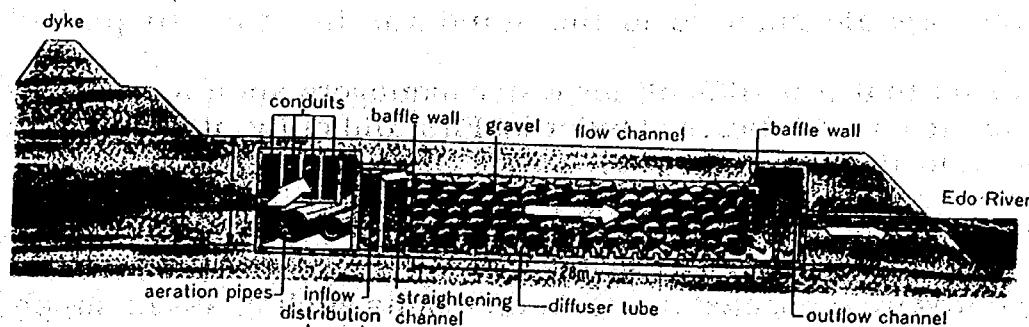
The critical aspect of this method is how we keep the efficiency of eco-system circulation. Especially, referring to the uptake of polluted materials based on organic matter, materials which flow from outside of eco-system.

b) Creek

This is the method in which we combine Soil Percolation Method and Oxidation Pond. We make creek on flood plain or other spaces and let river water flow in the creek. In this process, the purification by the eco-system of the creek and by percolation into soil are expected. One of the points is maintenance of the eco-system in creek, and another is how river water are percolated into the soil. It is difficult how to design pressure head, coefficient of permeability, and the area of percolation.

c) Water Quality Purification System using reed stripes

This method has same idea of oxidation pond that polluted materials are removed by using the eco-system of reed stripes. Moreover we are also expecting the effect of sedimentation and adsorption. It is very important how to evaluate the maximal amount of polluted materials which flow into reed stripes. The features of this system is that if the amount of flowing into reed stripes increases more than the maximal value, the effect cannot be expected efficiently. organic matter and that organic matter is dissolved fast in reed stripes.



Cross-Section of Kogasaki Purification Works (Chiba Prefecture)

The processes of contaminant removal by aquatic marsh plants are summed up in the following 3 points:

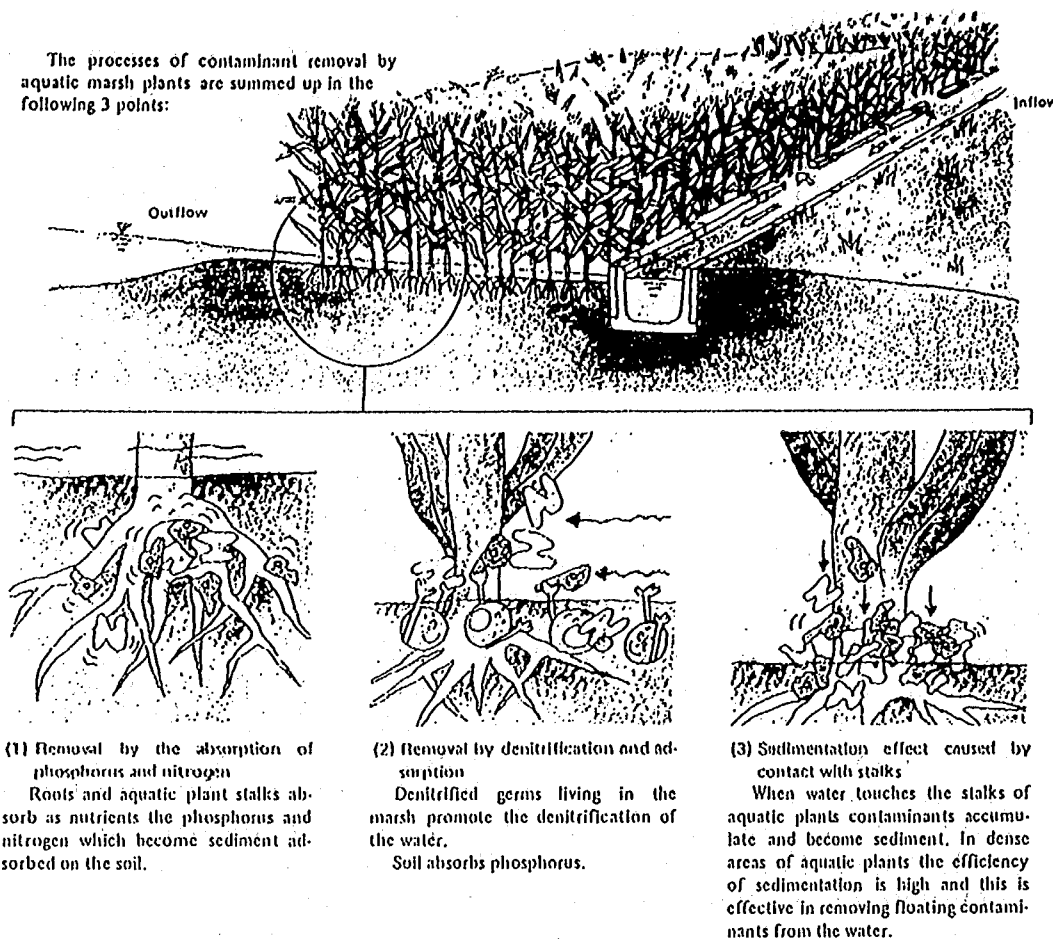


Fig.7 Mechanisms of water quality purification system using reed stripe²⁾

4.3 New Standards Of Water Quality

In Japan, there is a environmental water quality standards relating to pollution in public waters, which were made by Environment Agency to protect human health and to conserve the environment of human life. And in 1993/3, Environment Agency added new items such as agricultural chemicals and organic chlorine to the standards in order to protect human health.

But it is said that it is difficult for water managers such as Ministry of Construction to control theses standards. First difficulty, it is needs of much budget and time to analyze all items. Considering this situation, some researcher are recreating new methods that is synthetically vaulting and easy operating such as Rec-assay and biosensor.

Second difficulty is related to evaluation of environment of human life. The standards were enacted based on the points such as water supply and agricultural or fishery productivity and these points do not include human feelings which are very important in evaluating the quality of human life. So PWRI is investigating new standards which include items of human feelings toward their quality of life such as landscape, recreational use and the health of the eco-system which surrounds them.

Table.1 Environment quality standards relating to protection of human health

items	standards mg/l
cadmium	under 0.01
cyanide	no detect
lead	under 0.01
chromium	under 0.05
arsenic	under 0.01
mercury	under 0.0005
alkyl mercury	no detect
PCB	no detect
dichloromethane [*]	under 0.02
carbon tetrachloride [*]	under 0.002
1,2-dichloroethane [*]	under 0.004
1,1-dichloroethylene [*]	under 0.02
cis-1,2-dichloroethylene [*]	under 0.04
1,1,1-trichloroethane [*]	under 1
1,1,2-trichloroethane [*]	under 0.006
trichloroethylen [*]	under 0.03
tetrachloroethylene [*]	under 0.01
1,3-dichloropropene [*]	under 0.002
TMTD [*]	under 0.006
CAT [*]	under 0.003
benthiocarb [*]	under 0.02
benzen [*]	under 0.01
selenium [*] (x new items)	under 0.01

Table.2 Environment quality standards relating to conservation of living environment

	pH	BOD mg/l	SS mg/l	DO mg/l	COLIFORM GROUP
AA	over 6.5 under 8.5	under 1	under 25	over 7.5	under 50MPN/100ml
A	over 6.5 under 8.5	under 2	under 25	over 7.5	under 1000MPN/100ml
B	over 6.5 under 8.5	under 3	under 25	over 5	under 5000MPN/100ml
C	over 6.5 under 8.5	under 5	under 50	over 5	
D	over 6.0 under 8.5	under 8	under 100	over 2	
E	over 6.0 under 8.5	under 10	no dust	over 2	

5. REFERENCES

- 1) Prepared by Technology Reserach Center for River Development
- 2) Prepared by Kasumigaura Construction Office, Ministry of Construction