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Perspectives of River Ecology Reseach

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ABSTRACT

A river manager cooperates with a researcher, and River Ecology Research Group is established to push forward a general study about the river habits in 1995. And now, this group research a general study of the river environment lively. As an action of the studies for the maintenance of the river environment in Japan, this paper introduces the enforcement situation of River Ecology Research Group and a study example in rivers. There are six rivers becoming the object, and an example of Kizu gawa is introduced. Finally the prospects to the future are introduced.

Keywords: river ecology research, management of rivers, ecological function

1. INTRODUCTION

Our country, Japan, is situated in the Far East of East Asia and occupies an area of 377,837 sq km, which is less than one twenty-fifth of the size of the United States of America or slightly larger than Federal Republic of Germany. The lowlands occupy only about 20 % of national land, and the rest of the country is mountainous and almost entirely covered with forest. The Japanese Archipelago falls within the Asian Monsoon climate zone, one of the few high rainfall regions of the world, blessed with a mean annual precipitation of c.1710 mm, about twice the world average of c.970 mm[1)]. However, because of high population density, per capita precipitation in Japan is about one quarter of the world average and cannot be considered water-rich. Moreover, precipitation fluctuates greatly between seasons, concentrating in the rainy season (June – July) and the typhoon season (August – October). The dividing range runs along the archipelago, producing rugged topography and steep gradients in many rivers. Therefore, floodwaters from heavy rain run off rapidly, increasing the flow rate of rivers enormously at the peak of flooding[2)].

Japan has a population of about 130 million and its GDP exceeds US$42 million, but 51 % of the population and 75 % of the assets are concentrated in the flood-prone regions, about 10 % of the total land area of Japan[3)]. Placed under such severe geographic conditions Japan suffered periodic floods and much damage to the properties during its history. Also, Japan's agricultural system is centred on rice growing and dams have been built for water supply to paddies and waterways since ancient times, the oldest record of dam construction going as far back as 616 AD.

Under such natural and social conditions, Japan has had to manage its rivers since the old days, constructing levees and dams, changing waterways and excavating riverbeds to prevent floods and secure water supply. As a result, the safety of flood control and the stability of water supply have been achieved, enabling economic advancement and safe and rich life style that people of Japan enjoy today. However, straightening of waterways and protection of banks with concrete produced monotony in the riparian landscape, and water

quality has deteriorated with the intake of drainage water. Dam construction caused the intake of drainage water. Dam construction caused interruption of migratory routes of anadromous and catadromous fishes and fragmentation of habitats for land animals besides the loss of the stream environment in watershed areas. It also changed the river environment downstream with reduction and stabilization of flow rate as well as reduction in sediment supply. These are beginning to be recognised as environmental impacts today[4)].

Many environmental scientists and ecologists voiced their view that we should recognise the importance of conserving the natural environment and biodiversity. As exemplified by global warming, we now need to address the environmental issues globally. The government of Japan responded seriously to the cry for the environmental conservation within the country and such trends in the world, and began to examine river management, among other efforts, with a view to preserving the natural environment. In January 1994, the Ministry of Construction (now the Ministry of Land, Infrastructure,Transport and Tourism), which then administered river management in Japan, produced an outline of the environmental policy and adopted the policy of actively introducing nature conservation into river administration. Further, the River Council submitted a report in September 1995, urging the government to positively support "securing of diverse habitats for wildlife", "securing of healthy water circulation", and other measures for protecting the environment.

The River Law was revised in 1997 in response to the social outcry, clearly recognising the "improvement and conservation of the riparian environment" as an objective of river management, in addition to the conventional roles of "flood control" and "water use". Also, in 1997 the "Environmental Impact Assessment Law" was promulgated, stipulating "the execution of environmental impact assessment during the various stages of construction work". Further enactments in 2002 of the Law for the Promotion of Nature Restoration to promote restoration work and in 2004 of the Invasive Alien Species Act to control exotic species of plants and animals and prevent their damaging impacts on the ecosystems, urged the administration to conserve and restore species-rich indigenous ecosystems. Thus environmental management has gained much importance in river management in recent years and further promotion of environment-friendly management of rivers is being encouraged. If we are to achieve such management goals, it is imperative that we obtain and understand ecological information on the river. Unfortunately, we cannot say that we fully understand the functions of the ecosystems involved.

In an effort to overcome these difficulties and promote environmental conservation in river management, researchers and administrators in Japan combined their efforts to establish the River Ecology Research Group in 1995 to conduct integrated research into river ecology. It has been making integrated studies of the river environment of Japan, respectively.

This paper presents the current status of the River Ecology Research Group , a study example in Kizu-river, and reports on the research effort being made towards the conservation of the river environment in Japan.

2. River Ecology Research Group

The purpose of establishing this Research Group is to introduce the ecological viewpoint into the future management of rivers (Figure 1). To achieve the goal, circle of dynamics about how rivers changed their shape, every time a disturbance such as flooding occurred, which in turn altered the flora and fauna and their habitats are to be grasp. This cycle of dynamic relationships is the essential nature of the rivers. We further need to clarify how the biomass of plants and animals changes and what sorts of ecosystems organisms form and how they affect the river environment in general as they respond to the changes of flow rate, water quality and sediment supply, and to the alterations of physical elements such as riffles and pools. It is the intention of this research group to conduct surveys and research on

this principle and examine the methods of river management[5].

To introduce the ecological viewpoint into river management it was necessary for river engineers and ecologists to hold frequent discussions at the same table. They realised that it was important to understand the fundamental nature of rivers, while clarifying the contributions of organisms and ecosystems to the river environment under the fluctuating conditions of rivers. Thus they joined forces in the "River Ecology Research Group" to conduct integrated research into river ecology with an aim of making new contributions to river management in Japan.

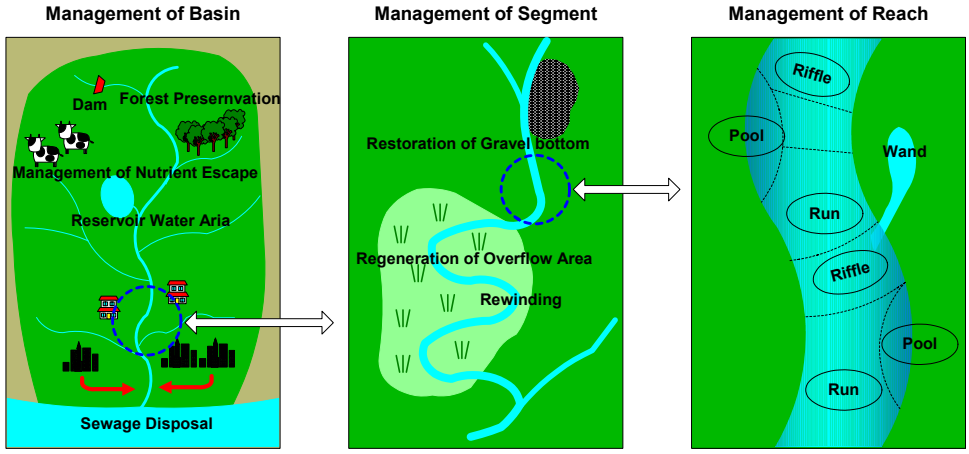


Figure 1. River management from ecological perspective

2.1 Study Rivers

The rivers being studied at present (Figure 2) are: the Tama (in Kanto), the Chikuma (in Hokuriku), the Kizu (in Kinki), the Kita (in Kyushu), the Shibetsu (in Hokkaido) and the Iwaki (in Tohoku). Table 1 summarises the characteristics of the region in which each study area has been selected.

1) The Tama River (Kanto)

The Tama River, situated in Kanto, is a Class A River (controlled by Central Government), flowing 138 km from Yamanashi Prefecture through Tokyo Metropolis and Kanagawa Prefecture into Tokyo Bay. It is one of the few metropolitan rivers in Japan, with a population of 4.25 million in its drainage basin of 1,240 km^2. The middle reaches of the Tama have gravel beds and support an endangered endemic composite species, the riverbed aster (*Aster kantoensis*). In recent years spreading of exotic trees, such as black acacia, is conspicuous. The Tama is the first river to be studied by the group in 1996.

2) The Chikuma River (Hokuriku)

The Chikuma River, situated in Hokuriku, is surrounded by high mountains. Flowing through Nagano Prefecture it changes its name to "the Shinano River" where it enters Niigata Prefecture. The Shinano River is the longest river in Japan, with the total length of 367 km, of which 210 km belongs to the Chikuma and 150 km the Shinano proper. The drainage basin of the Chikuma has 7,163 km^2, supporting 1.5 million people.

3) The Kizu River (Kinki)

The Kizu River, situated in Kansai, is a Class A River, flowing through Mie and

Kyoto Prefectures and merging with the Uji and the Katsura Rivers to form the Yodo River. Its total length is 147 km and basin area 1,596 km^2. The Kizu is a sandy river due to the wind-eroded granite in the basin and is characterized by the development of alternating sand bars in the riverbed. The study was initiated in 1998 in Kyotanabe District (2.5 km) with an aim of understanding the ecosystem of a violently fluctuating sandy river. We will introduce Kizu River later.

4) The Kita River (Kyushu)

The Kita River, situated in Kyushu, is a primary tributary of the Gokase River flowing through the northern part of Miyazaki Prefecture. Its length is 50.9 km, basin area 587 km^2 and basin population 18,000. It is rich in natural features, with many continuous riparian forests, well-developed riffles and pools, and wetlands in lower reaches. A disaster struck in September 1997 when the typhoon No. 19 caused extensive flooding, inundating 1894 residences above the floor level. In response to this disaster the study was initiated along the section (16 km) from Kumata District to the mouth of the river to follow up the effect of restoration work on the ecosystem.

5) The Shibetsu River (Hokkaido)

The Shibetsu River flows in the eastern part of Hokkaido and enters the Sea of Okhotsk. It is a Class B River (controlled by Prefectures Government), basin area 671 km^2 and basin population 25,000. Prior to the 1940s the Shibetsu was a highly meandering river with rich wetlands, but waterways have been straightened to prevent flooding in the 1960s. In the river restoration work started in 2000, meandering was restored experimentally in Kyosei District. There is no other example of large-scale restoration to recover meandering in Japan.

6) The Iwaki River (Tohoku)

The Iwaki River is situated in the western part of Aomori Prefecture and forms headwaters in World Heritage Shirakami Mountains. It is a Class A River flowing through Tsugaru Plains and entering the Sea of Japan via the brackish lake (Lake Jusan) at the mouth. Its length is 102 km and basin area 2,540 km^2. Participation of the Research Group in this project was prompted in 2006 for the purpose of investigating the formation of the ecosystems of the brackish lake and the extensive reed field.

Table 1. Characteristics of study areas

	Name of Research Area	Characteristics of the Area
Tama River	Nagata District	Constant flow-rate maintained by dam
	Tama-Ohashi District	Impact with input of treated sewage
Chikuma River	Nezumibashi District	Gravel beds with riffles and pools typical of middle reaches of the Chikuma
	Awasabashi District	Experimental excavation of waterways
Kizu River	Kyotanabe District	Alternating sandbars, typical of the Kizu
Kita River	River mouth - Kumata District	Prompt restoration work after flooding
Shibetsu River	River mouth - Kyosei District	Restoration of meandering as national work
Iwaki River	The Lake of Jusan - Takeda District, Shariki District	Estuary with brackish lake and extensive reed field

7) Synthesis Team

The Synthesis Team was established in 2005 to integrate and evaluate the outcome of research for every river. It aims to synthesis the river ecology research by comparing the study methods and physical and ecosystem characteristics of respective study rivers, and deriving similarities and differences from this exercise.

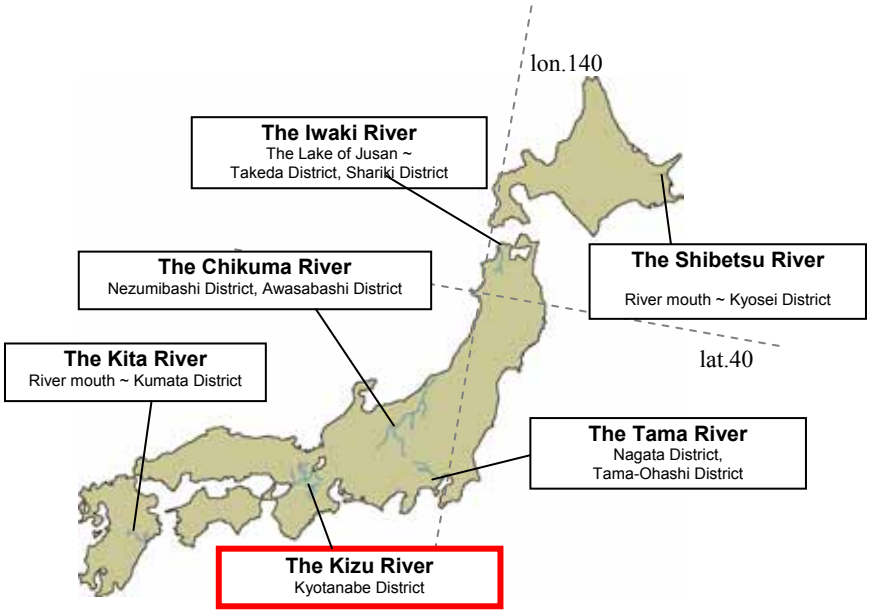


Figure 2. The rivers under study

2.2 Research Framework

The Research Group conducts research cooperatively among research scientists of universities (river engineers, biologists), National Institute for Land and Infrastructure Management of the Ministry of Land, Infrastructure , Transport and Tourism (mainly river engineers) and Public Works Research Institute of Independent Administrative Foundation (mainly river engineers). Its office is run by the administrative river controllers of the study rivers and Technology Research Center for Riverfront Development. The officers are responsible for the management of conferences and synthesis of research outcomes as well as conducting publicity work and various activities of coordination for the River Ecology Research Group.

1) Researchers of universities, etc.

University researchers form a core of the Research Group and represent many different fields. Among the ecologists there are specialists on birds, fishes, benthic organisms, plants, insects, mammals and algae, whereas specialties of engineers include river engineering, civil engineering, erosion control, hydraulics and matter circulation. They usually belong to the universities close to the study river as it is an advantage to have an easy access to the field site. Graduate students in Masters and Doctors courses and other young researchers also take part in the projects, as this system of the Research Group contributes much to the training of research scientists.

2) Research organisations of the government

Members of National Institute for Land and Infrastructure Management and Public Works Research Institute also belong to the Research Group. The Ministry of Land, Infrastructure Transport and Tourism is responsible for managing the social capital for the use, development and conservation of land and for the promotion of transport policy, whereas National Institute for Land and Infrastructure Management within it is a research organisation concerned with the development of surveys and research planned by the Ministry. The Public Works Research Institute is another research organisation concerned with research and development of civil engineering technology. Both research institutes have teams pursuing surveys and research on rivers, and researchers mainly in the field of river engineering belong to the River Ecology Research Group.

3) River managers (Administration)

The staff of the Ministry of Land, Infrastructure Transport and Tourism manages the rivers under study. On the ground they are responsible for the management of river infrastructure for flood control and water use, and conduct measurement of water levels and discharge, maintenance and inspection of rivers, and various other tasks concerned with the management of rivers. They also collect and collate water level and discharge data and aerial photographs, and provide general support to researchers, together with Technology Research Center for Riverfront Development, as an agent for River Ecology Research Group. They distribute a variety of information to the researchers, organize conferences, procure research funds, help with collation of research results and engage in publicity work for the Research Group.

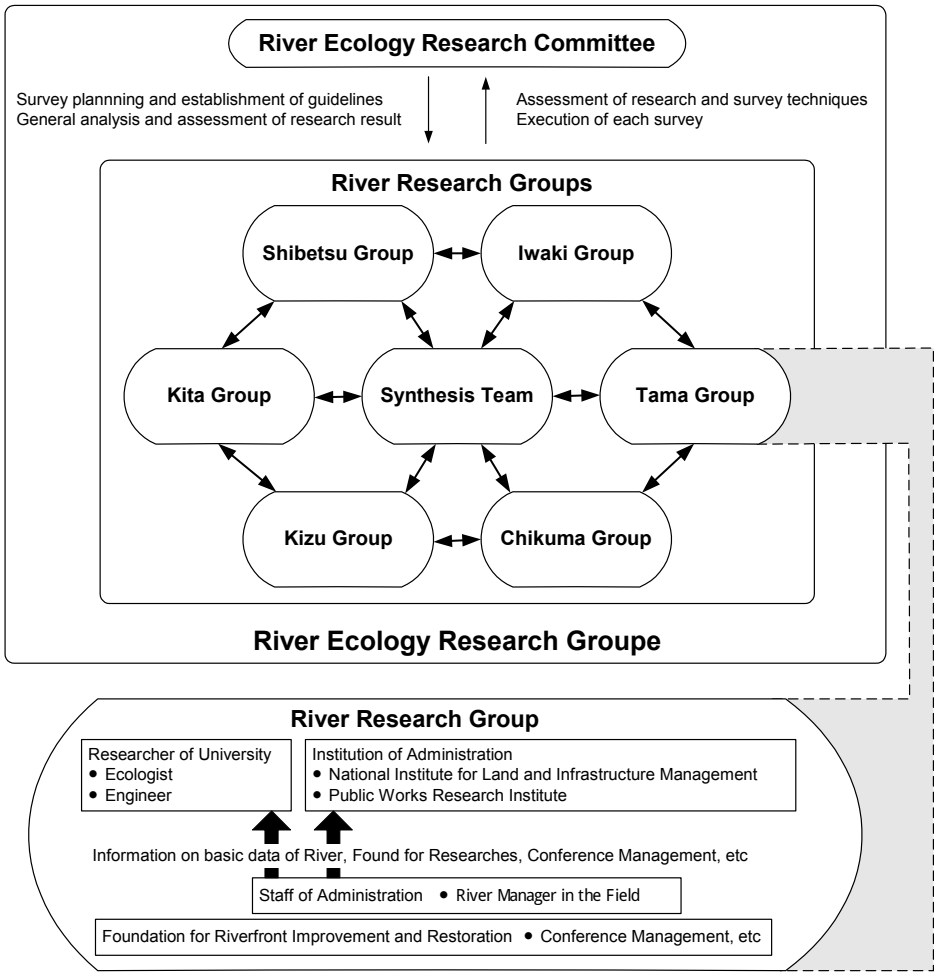


Figure 3. Research organisation chart

2.3 Operation of the Research Groups

As shown in the previous section, a research group is formed for each study river, consisting of researchers from universities and government research institutions. Each research group meets three to four times a year to discuss its operations and report on its findings. At the meeting researchers discuss what to focus their efforts on, how to form a study team, how frequently they should survey, and so on, and they proceed accordingly to conduct surveys and research. The study period is about 4 to 5 years to reach its conclusion.

In addition, the representatives of respective river study groups meet twice a year, in spring and autumn, to report on the research methods and findings to their parent committee. At the spring meeting the committee inspects the study area and collects information regarding the status of nature restoration and river management. Many government officials attend the meetings of the parent committee and collect useful information for administration

and receive advice directly from the researchers at the meeting.

Researchers working on different rivers can also glean information on research results from other members at a meeting held in December each year in Tokyo, where a large hall with a capacity of several hundreds is hired for the presentation to be given to the combined conference of research groups. This combined research conference is having its 9th meeting this year. The participants have opportunities to compare their own studies with those of other rivers and take part in active discussion.

3. Introducing Research

We introduce one of study case instituted in Kizu-river from six investigation object areas. This river is branch of Yodo-river reaching Osaka-bay from Lake Biwa.

Kizu-river joins in Uji river and Katsura-river and becomes Yodo-river. The basin has much weathering granite zones. The most of the basins consist of weathering granite. An alternate bars is formed in the down stream of this river. This is the river where a characteristic as a sand river is remarkable.

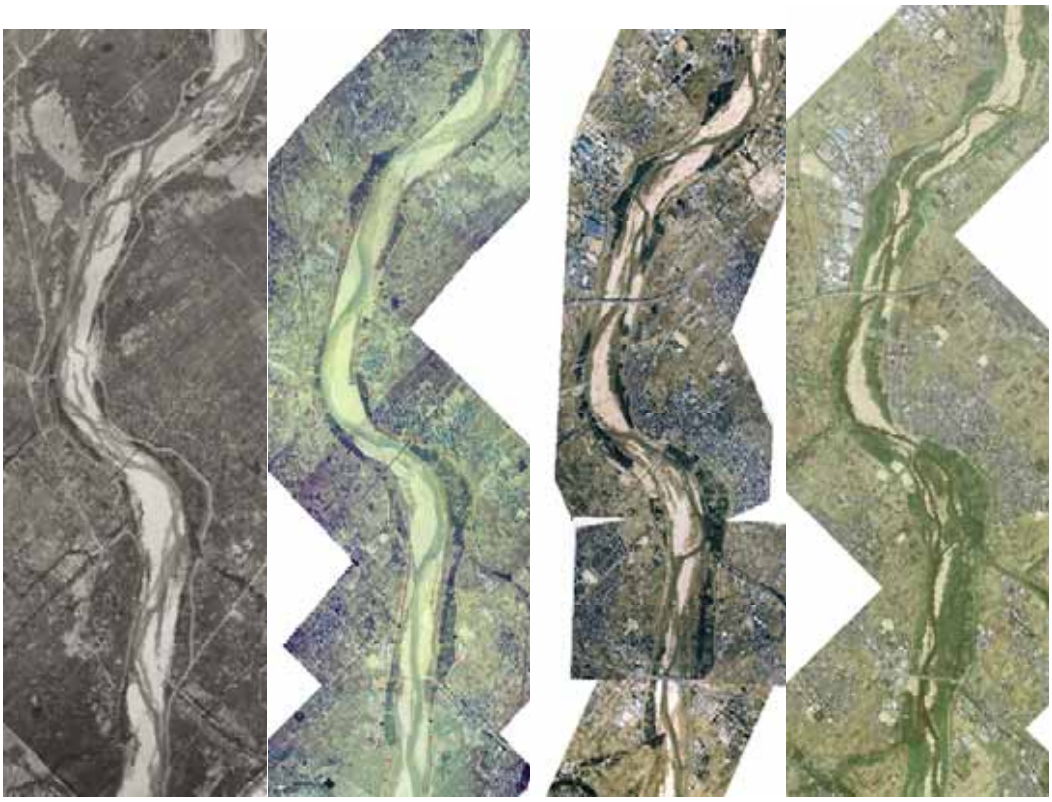
In the first phase of research, Kizu-river research group selected the middle-class district Kyotanabe for a research area. Kyotanabe district is section of about 2,500m extension to be located in the border of Joyo-city and Kyotanabe-city. It has executed the research and the investigation of the habitat conditions and the physical formation mechanism of the native habitat to understand the clarification of the ecosystem of the sandy river. And, it arranged these study results as "Integrated research on Kizu-gawa (December, 2003)".

In the first phase of research, on the basis of the study of the first phase, it was begun a study of the evaluation of two kinds of functions to make use in the river management. The first one is a function as the habitation ground of various creatures, and the second is material conversion and a water purification function. We researched a detailed micro-landscape (waterside, main stream, ripples, deep pool, grassland, woods zone, gravel area in bare bar, bare area in sand bar) in Kizu-river. And, it have clarified the role of each detailed micro-landscape. Many studies have been performed, but introduce two studies here.

3.1 Change of the vegetation area in the sandbar

At first, we introduce a study ,as an example about the change of the physics ground, about the change of the vegetation area in the sandbar. Two types of sandbars coexist in the middle-class department of the study district. There is the sandbar where vegetation (isolation vegetation) growing thick apart from a vegetation zone to be located in in the vicinity of a dike develops. The second does not have vegetation zone, and there is the sandbar which the bare land occupies. Why would such a difference appear in the same object district? The following things assumed it a transition process of the vegetation in the sandy river on examining the coexistence reason. It is it with an important key of the vegetation area expansion from the water's edge whether a herb of the water's edge it is destroyed frequently, and to play changes to the shrub stock.

At first this study examined a secular variation of a vegetation cover rate on the sandbar which calculated the time when vegetation developed in detail from an aerial photograph. It became clear by this study to have enlarged the isolation vegetation area from the water's edge from the latter half of 1970's to the latter half of 1980's. With this result, this study considered flow regime and a vegetation transition process on a sand floor and analyzed a flow on a sandbar in Kizu-gawa. Furthermore, it calculated attractive force and examined a destruction opportunity of the vegetation area. As a result, It is decided whether herb stock at the water's edge was easy to be disheveled in 1970's by a medium size or small size flood of flow quantity 500m3/s degree, nude place sandbar is kept or herb stock changes to the shrub stock and spreads for isolation vegetation.



Picture 1　the state of the change of the Kizu river
(　1953, 1974, 1997, 2006　)

By a characteristic of the vegetation transition of the sandy river mentioned above, the sandbar which isolation vegetation extended occurred in the lower part of Kizu-river. In addition, as a result of having performed similar examination, it was in a situation that bare area sandbar of the down stream sandbar is easy to be disturbed at the time of a flood by existence of the isolation vegetation. In such place, it became clear now that the state that a bare area is maintained in the down stream side of the vegetation sandbar continued.

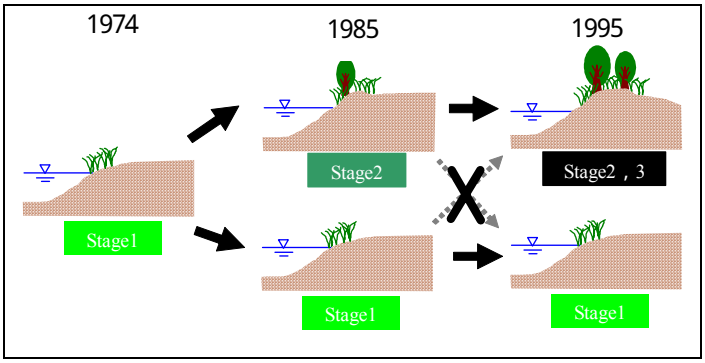


Figure 4　The stage change of bare area sandbar and the vegetation sandbar

3.2 Physics ground and the nest building environment of the plover

As a study example about the role in a small landscape, I introduce physics ground and a study example about the nest building environment of the plover next. This study paid its attention to grit size on the sandbar and tried comparison between quantitative kinds about the nesting ground which did a choice enthusiast of plovers. It conducted an investigation into nest building environment of plovers for two sandbars from 2000 to 2006. According to this

findings, 84 little ringed plover nests, 26 masked long-billed plover nests, 43 kentish plover nests were confirmed, and the total of the nest became 153. And, as for the nest building, all was almost performed in bare area without the vegetation. It developed that plovers chose different ground substance size by a kind and built a nest when I analyzed findings. In addition, a meaningful difference is recognized to the spot size of three kinds of eggs. It is guessed that this act expects a concealment effect by colors and design of the plover egg. The first effect is that it is not preyed because an egg is mistaken for a stone. The second effect's also not preyed because a predator cannot distinguish the design of egg and the bare area.

species	sand and gravel size class						Sum
	1	1+2	2	1+3	2+3	3	
Little Ringed Plover	1	11	24	3	41	4	84
Long-billed Plover	0	2	5	3	9	7	26
Kentish Plover	5	32	5	1	0	0	43

Figure 5 Egg of plover

3.3 The study of the integration

The ecosystem conservation of river environment is the key for land mangement. Through cooperated research among river hydraulics, ecology and limnology more than ten years, we have accumulated a lot of fragmentary information. These results indicate the ecological functions of respective micro-landscapes. Now, it associates a typical micro-landscape constituting a sandbar with these results of research and performs the usability test of the sandbar. The integration may suggest which bar is preferentially conserved among many bars in a segment.

At first, Kizu Group unified a concept of the structure of river called ,"Structure", "Texture" and "Duration" aim to integrate into some studies. "Structure" is physics structure prescribed to bed slope, bed load, width and depth of a river of the flood once in ten years to one year. "Texture" is the various typical micro-landscape which an individual sandbar has. Typical micro-landscape means water route, riffles, flat shallow, deep water spot, temporary water area (creek, side pool, secondary stream). Each "Structure" and "Texture" have their lifetime ,which is expressed by the word "Duration", and it pays attention to the scale during that time. Based on these, this study can do scoring of a function of the ecosystem such as habitation ground and the hydrological cycle and the matter cycle that accepted Texture. The role by the each landscape can evaluate this scoring technique and can evaluate importance of the sandbar whole more. Furthermore, predict the evolution of the sandbar can evaluate the importance of the sandbar in the future.

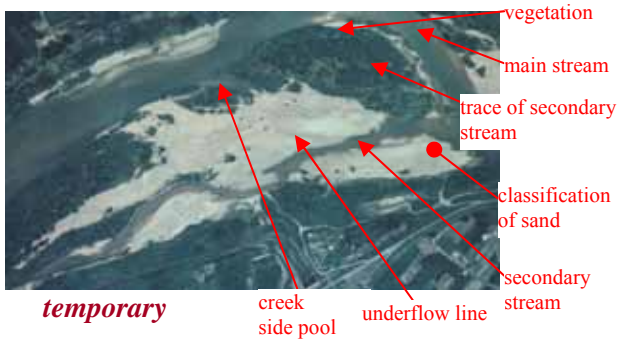


Figure 6 **Various topography elements of the sandbar topography** = Habitation ground

Because the sandbar has various functions, it is not clear which sandbar there is a problem on, neither what kind of measures are urgently pressed for, when we manage Kizu-river. By this study, it develops that any sandbar is important and can extract a problem facing. As a result, this result leads a clue examining the maintenance measures of the sandbar strategically .

4. Future Perspective

The Tama River Research Group is trying to restore the gravel riverbed where the flood plains are forested today as a result of large-scale gravel mining and sediment reduction due to upstream infrastructure for flood control and water supply. The Chikuma River Research Group is searching for the ecosystem-friendly way to excavate waterways by examining the restoration process following the experimental excavation carried out by the government for the purpose of improving the flow rate. However, there are still very few examples of making or trying the transfer of research results to actual river management as being attempted in the Tama and the Chikuma Rivers. From the executive point of view we must promote further discussion and cooperation between the researchers and administrators to achieve this in the future.

As stated earlier, a total of 6 rivers have been surveyed and studied for 10 years, during which time much ecological information has been accumulated on each river. It will be necessary in future to compare and evaluate the enormous amount of data accumulated for different rivers. In fact, the Synthesis Team was established in 2005 and started to compare the individual results across different rivers. The Synthesis Team is planning to analyse the basic data, such as climatic conditions of individual rivers, in relation to the increased local precipitation in recent years accompanying global warming. In so doing, we hope to clarify the issues relating to the survey and research that have escaped attention in the previous discussions on each river, and to improve methods and hence further expand the work of the River Ecology Research Group.

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