

**ENVIRONMENT PROTECTION AT DAM RESERVOIRS
IN OKINAWA MAIN ISLAND**

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1. INTRODUCTION

Located at the southern end of Japan and belonging to the subtropical climate zone the Okinawa Main Island, the largest (1,300Km²) of the Okinawa Islands, is a slender island extending from northeast to southwest. Annual precipitation of 2,300 mm is more than Japan's annual average of 1,800 mm, but rainwater runs off quickly because of short, fast-flowing rivers. The island, therefore, is prone to flush floods, which have frequently caused considerable damage to the communities along the rivers. Wild fluctuations of stream flow made it difficult for Okinawans relying on rains for most of their domestic water needs to utilize river water stably during the dry season.

Under these circumstances, a number of dams have been built to secure such purposes as flood control, minimum stream flows, water supply stabilization (drinking, industrial and irrigation purposes) and environment protection, and their reservoirs have been interconnected in order to make effective use of stored water. Since Okinawa Main Island is blessed with nature, it is inhabited by many endangered plant and animal species peculiar to Okinawa Prefecture. In connection with dam construction, therefore, efforts have been made to protect the natural environment and water environment concerning dam reservoirs.

This paper describes on some measures being taken to protect the natural environment and water environment concerning dams and reservoirs in Okinawa Main Island [1], [2].

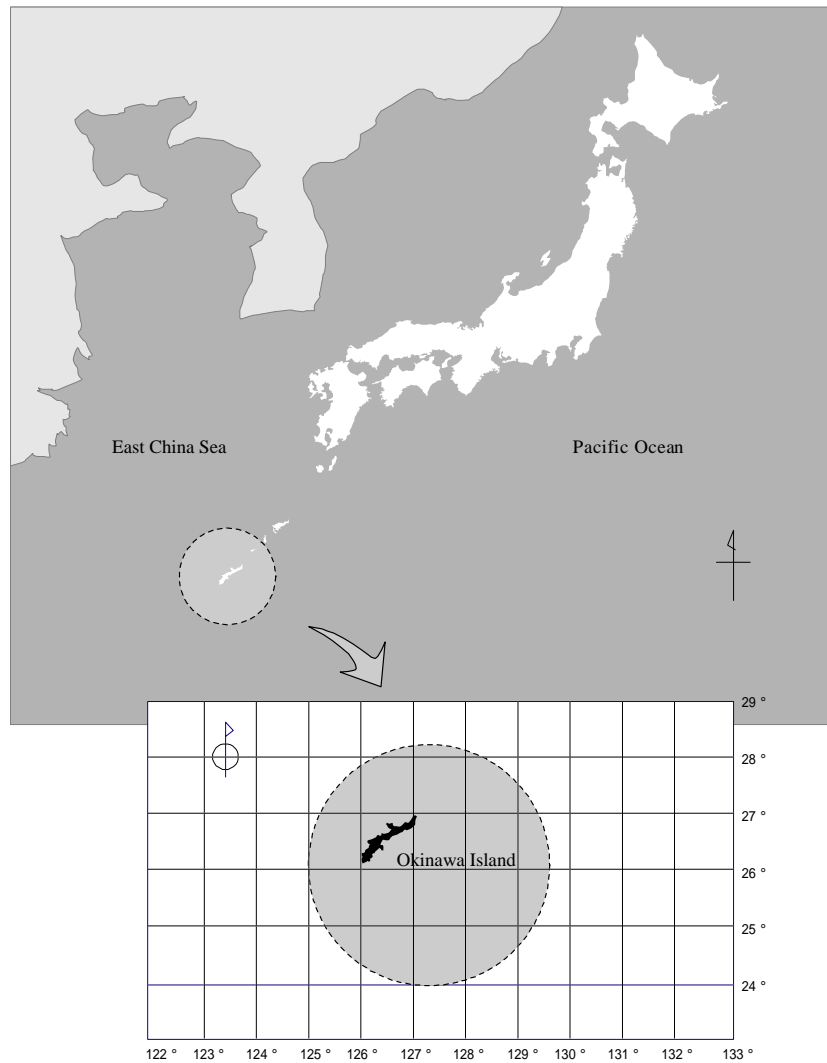
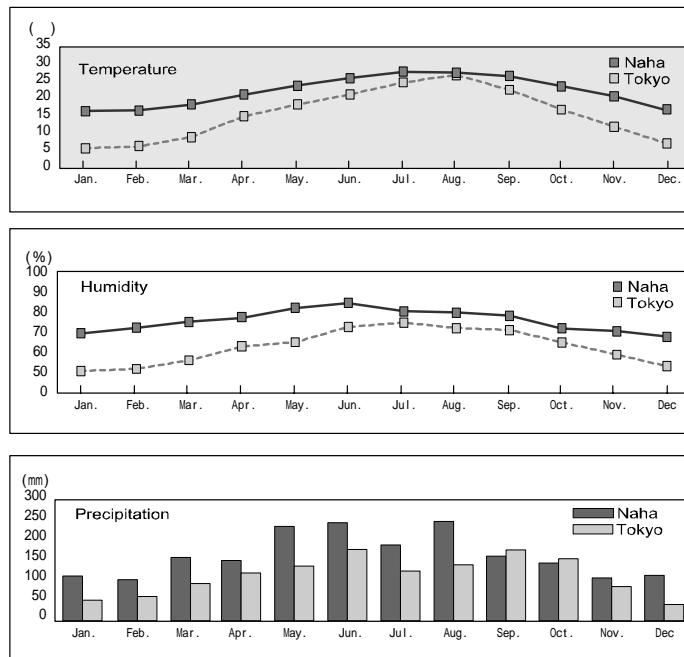


Fig. 1
 Location of Okinawa Main Island
 Emplacements de l'île principale Okinawa

2. GENERAL INFORMATION OF OKINAWA

2.1 Geographical Location

As shown in Fig. 1, the Okinawa Main Island is located roughly at the center of the Ryukyu Islands, a north-south chain of islands 135 km long and 28 km wide located at lat. 24 ° to 27 ° N and at long. 122 ° to 131 ° E. The northern part of the Okinawa Main Island consists mainly of the Kunigami Mountains and marine terraces, and the central and southern regions are formed mainly by raised reef. The highest peak on the island is Mt. Yonaha of the Kunigami Mountains.



Note 1. Source: Climate Table of Japan, Japan Meteorological Agency

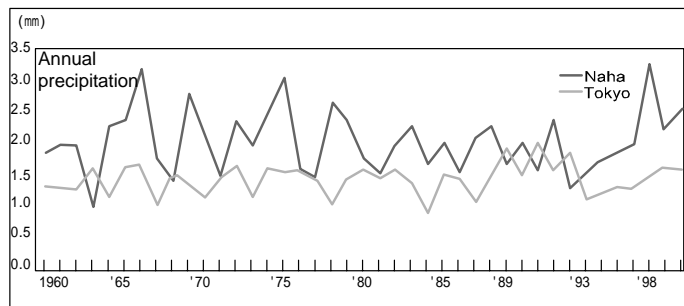


Fig. 2

Climate of Naha City, Okinawa Main Island and Tokyo
Climats de la ville de Naha (province d'Okinawa) et de Tokyo

2.2 Climate of Okinawa Main Island

The Okinawa Main Island belongs to the subtropical climate zone, being surrounded by a warm current and covered by Siberian cold air mass in winter season. Annual mean temperature (Naha City) is about 22 °C, monthly mean temperatures range from 10 to 30 °C, and the mean humidity is about 76 percent.

Annual mean precipitation is 2,000 mm in Naha City and around 2,200 mm in Nago City. Thus, they have much rain in the northern mountainous region compared with the southern region. Annual precipitation in the Okinawa Main Island is characterized by considerable year-to-year variations [3].

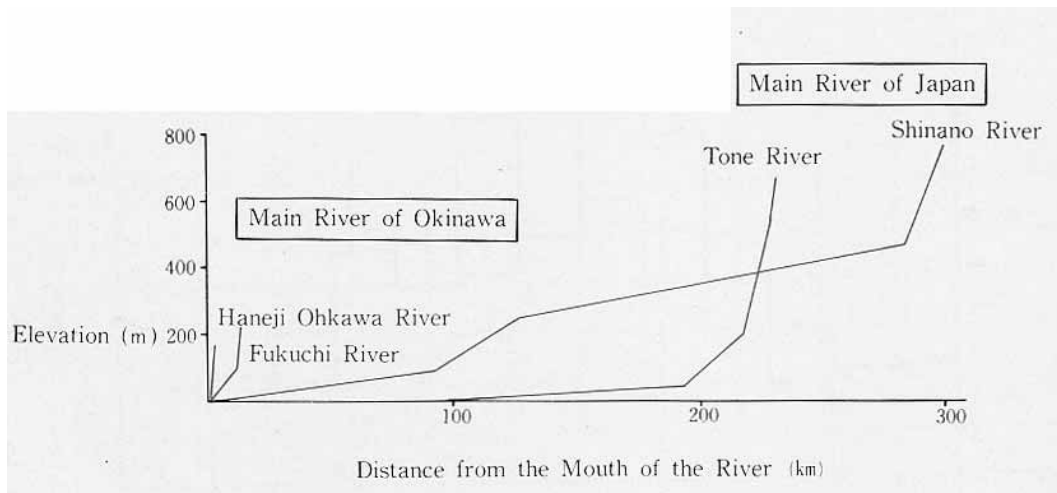


Fig. 3

Comparison of slopes of main rivers in Okinawa Main Island and Honshu Island
 Comparaison des pentes du fond des cours d'eau en île principale Okinawa et en île Honshu

Nearly 54 percent of annual precipitation occurs during the rainy season (May and June) and the typhoon season (August and September), and there are considerable seasonal variations (see Fig. 2).

2.3 Rivers in Okinawa Main Island

There are more than 300 rivers on Okinawa Main Island. Of these rivers, 74 rivers in 50 river systems are under the jurisdiction of the prefectural government.

Compared with rivers in Honshu Island, the main island of Japan, rivers in the Okinawa Main Island are characterized by short and steep channels. Flooding after rainfall tends to be faster than in the Honshu Island. Since river basins are relatively small, the amount of flowing water during ordinary times is very small. Because of these characteristics of rivers and seasonal variations in precipitation, river flows are very instable.

2.4 Examples of Endangered Animals in Okinawa Main Island

Various forms of living beings inhabiting the Okinawa Islands have evolved under the influence of the geological history of the islands, isolation imposed by the surrounding sea, and the subtropical and maritime climates. Consequently, the islands are inhabited by diverse forms of living beings many of

which are biogeographically endangered, including *Ryukyu ayu* (Ryukyu sweetfish, *Plecoglossus altivelis ryukyuensis*), *Ryukyu woodpecker* (*Sapheopio noguchii*), *Okinawa rail* (*Rallus okinawae*) and *iriomete yamaneko* (iriomete wildcat, *Felis iriomotensis*) .



Photo 1
Ryukyu ayu (Ryukyu sweetfish,
Plecoglossus altivelis ryukyuensis)
Ryukyu ayu (saumon de Ryukyu,
Plecoglossus altivelis ryukyuensis)



Photo 2
Ryukyu woodpecker (*Sapheopio
noguchii*)
Pic de ryukyu (*Sapheopipo noguchii*)



Photo 3
Okinawa rail (*Rallus okinawae*)
roi des cailles d'Okinawa (*Rallus okinawae*)



Photo 4
Iriomote yamaneko (Iriomote wildcat,
Felis iriomotensis)
Iriomote yamaneko (chat sauvage
d'Iriomote, *Felis iriomotensis*)

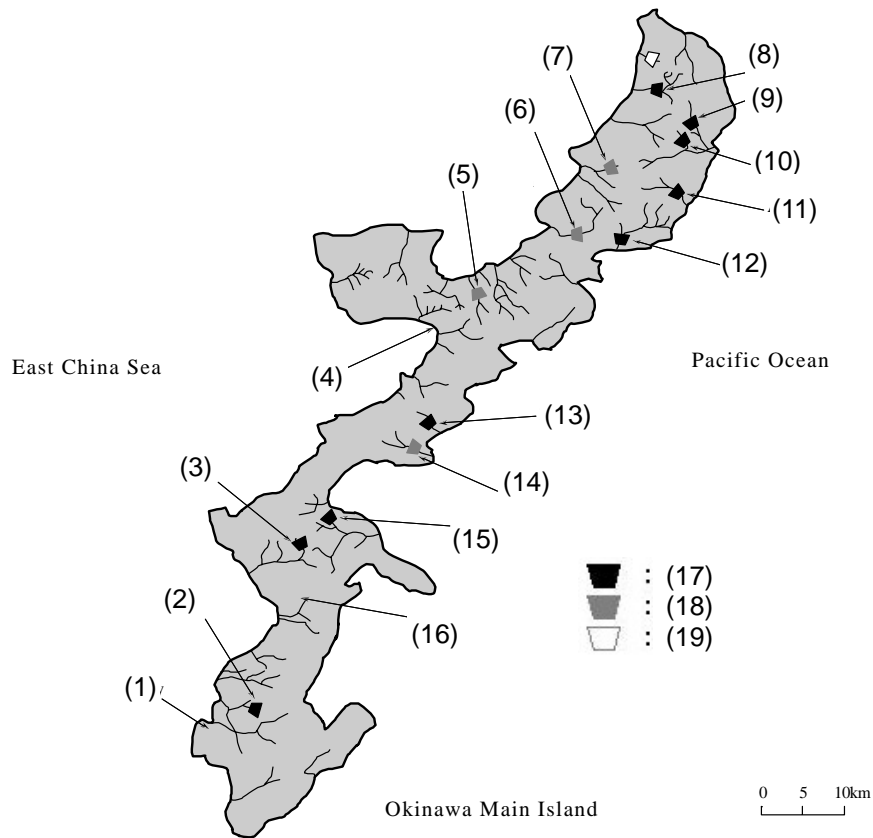


Fig. 4
Locations of multi-purpose dams in Okinawa Main Island
Emplacements des barrages à buts multiples de l'île principale Okinawa

(1) Naha City	(11) Arakawa Dam	(1) Ville de Naha	(11) Barrage Arakawa
(2) Kinjou Dam	(12) Fukuchi Dam	(2) Barrage Kinjou	(12) Barrage Fukuchi
(3) Kurashiki Dam	(13) Kanna Dam	(3) Barrage Kurashiki	(13) Barrage Kanna
(4) Nago City	(14) Okukubi Dam (re-development of Kimu Dam)	(4) Ville de Nago	(14) Barrage Okukubi (remise à neuf du Barrage Kimu)
(5) Haneji Dam	(15) Yamashiro Dam	(5) Barrage Haneji	(15) Barrage Yamashiro
(6) Taiho Dam	(16) Okinawa City	(6) Barrage Taiho	(16) Ville d'Okinawa
(7) Okuma Dam	(17) Dams in operation	(7) Barrage Okuma	(17) Barrages en service
(8) Benoki Dam	(18) Dams under construction	(8) Barrage Benoki	(18) Barrages en construction
(9) Fungawa Dam	(19) Dams under feasibility study	(9) Barrage Fungawa	(19) Barrages en étude de faisabilité
(10) Aha Dam		(10) Barrage Aha	

3. Dams in Okinawa Main Island

There are a total of 10 dams in Okinawa Main Island: six dams under the jurisdiction of the Cabinet Office, Okinawa General Bureau (Fukuchi, Arakawa, Aha, Fungawa, Benoki, Kanna), four dams under the jurisdiction of the Okinawa prefectural government (Kinjou, Kurashiki, Yamashiro, Kimu). The locations of these dams are shown in Fig. 4.

4. ENVIRONMENTAL PROTECTION MEASURES TAKEN AT DAM RESERVOIRS

4.1 Protection of Natural Environment

This section reports on some of the environmental protection measures implemented in connection with aquatic life species, mangroves, Ryukyu ayu (*Plecoglossus altivelis ryukyuensis*), Ryukyu woodpecker (*Sapheopipo noguchii*) and bats.

(1) Fishway

On the Okinawa Main Island, dams are often built at locations relatively close to river mouths as possible so as to maximize storage capacity. Consequently, the distance from the river mouth to the dam tends to be short and migratory behavior of anadromous and catadromous species of wildlife such as gobies, shrimps and crabs may be hampered. To mitigate such adverse effects, the first high-dam fishway in Japan was installed (see Photo 5 and Fig. 5).



Photo 5
Fishway at Kanna Dam
Coupe de la passe à poissons
du barrage Kanna

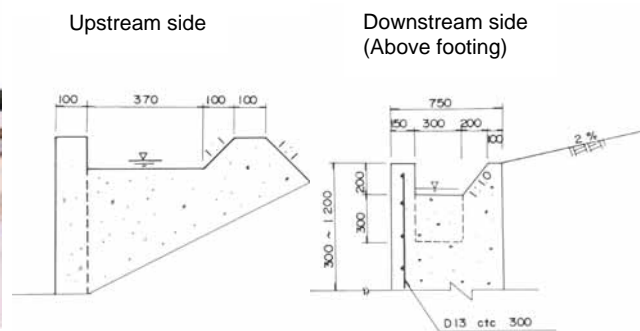


Fig. 5
Cross section of fishway at Kanna Dam
Coupe de la passe à poissons du barrage Kanna

In a survey conducted after the fishway went into service, migratory fish species such as *bozu haze* (monk goby, *Sicyopterus japonicus*), *gokuraku haze* (paradise goby, *Rhinogobius giurinus*) and *kuroyoshinobori* (dark-colored goby) were identified in large numbers, along with migratory crustaceans such as *yamato numaebe* (*Caridina japonica*), *tsunonaga numaebe* (*Caridina longirostris*) and *togenashi numaebe* (*Caridina typus*).

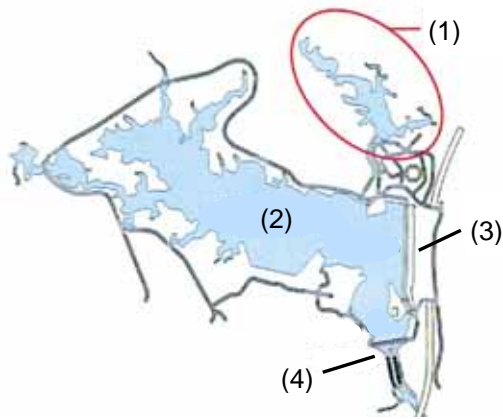
This indicates that the fishway is being used by many migratory species

as a migration path.

(2) Improvement of wetland habitat

At Kanna Dam, efforts were made to provide diverse habitats for species that prefer damp areas. A wetland that existed before the beginning of the project was dammed to create a secondary reservoir (see Fig.6). Then, the normal water level was raised to the high water level of the reservoir to enlarge the water area, and observation stations and nature-watching trails were built (see Photos 6,7).

The species found in the biotope after the improvement are listed in Table 1. A wide variety of wetland plants, insects and birds have been found.



- (1) Secondary reservoir
- (2) Reservoir (Kanna Reservoir)
- (3) Saddle dam
- (4) Main dam

- (1) Réservoir secondaire
- (2) Réservoir (Réservoir Kanna)
- (3) Barrage de col
- (4) Barrage principal

Fig. 6

Biotope location (Second Reservoir)
Situation des Biotopes (réservoir secondaire)



Photo 6
Area before the improvement of the biotope
Avant l'aménagement du biotope



Photo 7
Biotope after the improvement
Après l'aménagement du biotope

Table 1 Species found in the biotope

Classification		Number of species	
Wetland plants		15 families	33 species
Insects	Aquatic	41 families	144 species
	Terrestrial	60 families	174 species
Fish		6 families	10 species
Crustacea		1 family	1 species
Riparian birds		9 families	21 species

Source: Investigations in 1993 through 1995

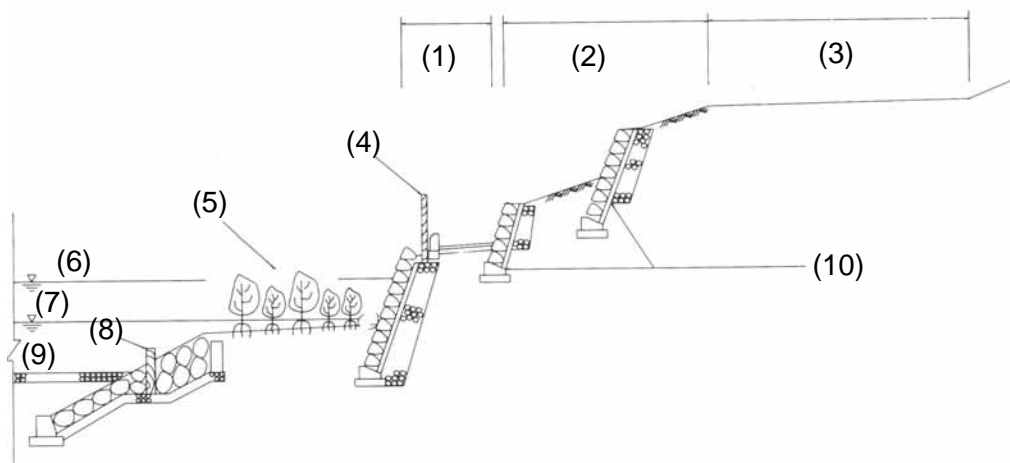


Fig. 7

Typical cross section of downstream river channel of Kanna Dam
Coupe transversale typique du lit en aval du Barrage Kanna

- | | |
|----------------------------------|---|
| (1) Walkway | (1) Allée |
| (2) Planting zone (Beach plants) | (2) Zone de végétalisation |
| (3) Maintenance road | (3) Voie de services pour entretien |
| (4) Imitation wood fence | (4) Clôture en similibois |
| (5) Planted mangroves | (5) Mangroves plantées |
| (6) High water level | (6) Niveau de crue |
| (7) Mean high water level | (7) Hautes eaux moyennes |
| (8) Pine stakes | (8) Pieux de pin |
| (9) Planned riverbed level | (9) Niveau du lit prévu |
| (10) Masonry retaining wall | (10) Mur de soutènement en maçonnerie de pierre de taille |

(3) Restoration of mangroves

Before Kanna Dam was constructed, the site was covered with mangroves up to just above where the crest of the dam is located now. It was decided, therefore, to restore mangroves, which can be considered a symbol of lower rivers and estuaries in the Okinawa Main Island.



Photo 8

Mangroves downstream of Kanna Dam
Des mangroves en aval du Barrage Kanna

As shown in Fig. 7, spaces for planting mangroves were secured by building masonry retaining walls and setting back sections of the levee so that there would be no obstruction to flood flows. Judging from the conditions of the mangroves remaining in the estuary area, *mehirugi* (*Kandelia candel*) was chosen as the primary mangrove species to be planted, and a total of 6,200 trees consisting of *ohirugi* (*Bruguiera gymnorhiza*) and *yaeyamahirugi* (*Rhizophara mucronata*) as well as *mehirugi* were planted.

As shown in Photo 8, the mangroves thus formed provide habitats for diverse species of living beings. At low tide, crabs and gobies can be seen under mangroves; as tide comes in, small fishes and shrimps come in from the sea.

(4) Restoration of Ryukyu ayu

Ryukyu ayu (*Plecoglossus altivelis ryukyuensis*) is a subspecies endemic to the Okinawa Islands. The last identification of Ryukyu ayu occurred in around 1980, and it is now believed that Ryukyu ayu has gone extinct in Okinawa Main Island and can be found only on nearby Amami Oshima Island, the largest of the Amami Islands.

Ayu (sweetfish) are migratory fish species that migrate between rivers and the sea, as shown in Fig. 8. Ayu's lifecycle is completed in a year, but it has been found that there are cases where ayu for some reason become land-locked (i.e., form the habit of completing their lifecycles migrating between lakes and influent streams).

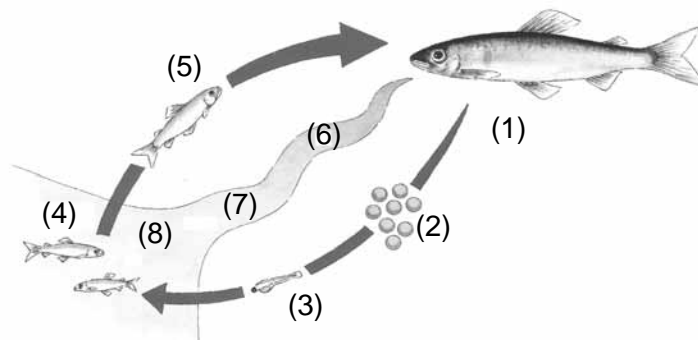


Fig. 8
 Lifecycle of Ryukyu ayu
 Cycle de vie de Saumon de Ryukyu

- | | |
|---|---|
| (1) Inhabit rocky or stone-covered areas in middle reaches and feed on attached algae. | (1) Ils habitent dans des zones où le lit est rocheux ou caillouteux du cours moyen et s'alimentent des algues attachées à leur surface. |
| (2) The spawning season is mid-November to early February. Lay eggs on shallow gravel beds in shallow water 1 to 2 km from the river mouth. Eggs are 0.9 to 1.0 mm in diameter. | (2) La saison du frai correspond à la période de mi-novembre à début février. Ils pondent des œufs sur un lit en gravier dans un cours d'eau peu profond à une distance de 1 à 2 km de l'embouchure du fleuve. Le diamètre des œufs est de 0,90 à 1,0 mm. |
| (3) Hatched fry migrate downriver to the sea. | (3) Les alevins descendent le fleuve vers la mer. |
| (4) Fry feed on zooplankton in coastal waters. | (4) Les alevins grandissent en se nourrissant des zooplanctons près des côtes. |
| (5) Migrate upriver in March to June. | (5) Remonte des poissons migrateurs de mars à juin |
| (6) River | (6) Fleuve |
| (7) Estuary | (7) Estuaire |
| (8) Sea | (8) Mer |

The restoration plan is sought to utilize Ryukyu ayu's behavioral characteristics (i.e., the ability to become land-locked). The plan aimed to establish the subspecies in a river system by releasing ayu in a stream flowing into a dam reservoir.

In 1992 and 1993, 380 and 1,200 of Ryukyu ayu were released at Fukuchi Dam as shown in Fig.9, respectively. In 1994 to 2000, about 4,000 to 15,000 Ryukyu ayu were observed every year. Since then, Ryukyu ayu were successfully made land-locked at Aha Dam and Benoki Dam, as well as at Fukuchi Dam. So far, a total of around 6,000 Ryukyu ayu have been identified.

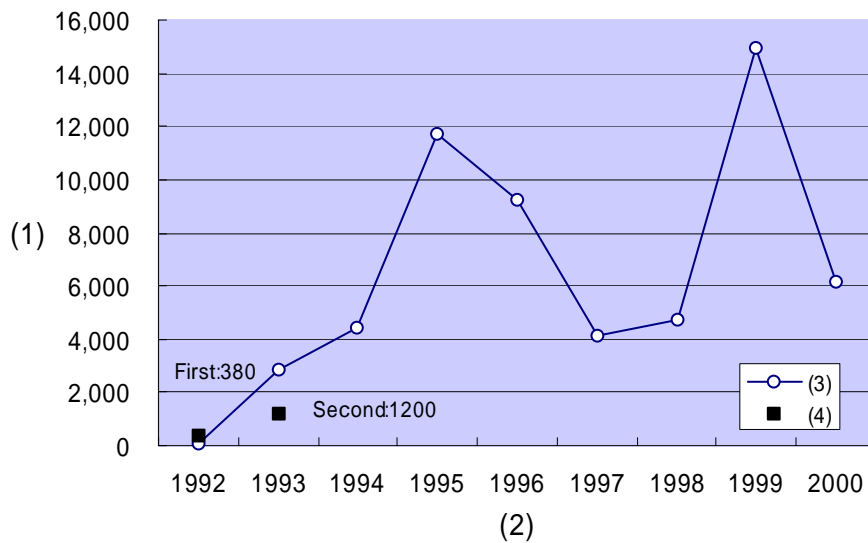


Fig. 9

Changes in number of Ryukyu ayu at Fukuchi Dam
 Changements de population des saumons de Ryukyu
 observés au niveau du Barrage Fukuchi

- | | |
|----------------------------|-----------------------------------|
| (1) Number of individuals* | (1) Nombre d'individus* |
| (2) Year | (2) Année |
| (3) No. of fish identified | (3) Nombre de poissons identifiés |
| (4) No. of fish released | (4) Nombre d'alevins lâchés |

* Since the first release of Ryukyu ayu, field surveys have been conducted every month. The number indicated for each year is the greatest number of Ryukyu ayu individuals found in that year.

*Depuis le premier lâcher des saumons de Ryukyu, des enquêtes sur les lieux sont menées mensuellement. Le nombre indiqué pour chaque année correspond au plus grand nombre des saumons de Ryukyu constaté au cours de l'année.

(5) Protection of Ryukyu woodpecker

As mentioned earlier, Ryukyu woodpecker (*Sapheopio noguchii*) is a species of the picidae family found only in a mountainous area in the northern part of the Okinawa Main Island. A Ryukyu woodpecker is now on the brink of extinction because of its small area of distribution, felling of natural forests and forestry road



Photo 9
 Nesting tree of Ryukyu woodpecker
 Un arbre avec un nid de pic de Ryukyu

construction, and has been nationally designated as a special natural monument.

The catchment area of Taiho Dam, which is under construction in the northern part of the Okinawa Main Island, is said to be the southern end of the distribution area of Ryukyu woodpeckers. As shown in Photo 9, an environmental study conducted by North Dams Office confirmed that the area is indeed inhabited by Ryukyu woodpeckers.

In view of the circumstances described above, North Dams Office has drawn up basic plans for protecting this endangered species and have been performing various measures accordingly. Some of the protection measures implemented to date are described in the followings.

(a) Installation of artificial nesting trees

In order for a Ryukyu woodpecker to nest, there must be a large-diameter tree whose interior has rotten to become corky. In the case of *itajii* (*Castanopsis cuspidata*), the interior of a growing tree rots as it is invaded by fungi. Because of this characteristic, itajii trees account for a large percentage of Ryukyu woodpecker's nesting trees. In view of this fact, it was decided to use itajii to make artificial nesting trees. The artificial nesting tree shown in Photo 10 was made by splitting an itajii log, carving out the interior of the log and filling the reassembled halves with balsa or other material. To lure nesting birds, a hole was drilled in each of the artificial nesting trees installed.

Since 1989, a total of 40 artificial nesting trees have been installed to date. So far, mating pairs of Ryukyu woodpeckers have been seen to bring food into three of the nesting trees, as shown in Photo 11, and a total of five young birds have been seen to fledge.



Photo 10
Artificial nesting tree
Un arbre aménagé
permettant aux pics de
nicher



Photo 11
Ryukyu woodpecker on
artificial nesting tree
Un pic de Ryukyu sur le
tronc d'arbre aménagé pour
y nicher

(b) Creation of habitats in vicinity of large-diameter trees

It is generally said that Ryukyu woodpeckers tend to shy away from large-diameter trees surrounded by leafy branches because the entrance to the nest would be difficult to reach for nesting birds and easy to reach for predators such as snakes.

Therefore, in areas where potential nesting trees have not been nested despite their apparent attractiveness to Ryukyu woodpeckers from the standpoint of the age of trees, leafy branches have been removed from a considerable number of nesting trees so increase the number of available nesting trees.

(c) Installation of feeder boxes

Larvae of coleopterans that inhabit rotten or dead trees in forests and crickets and other insects that like to hide under or behind rotten or dead trees are important food for Ryukyu woodpeckers.



Photo 12
Shelter for animals
Un abri pour des animaux

In an attempt to make up for the feeding environment lost as a result of dam projects, trees felled in connection with dam projects were used to create shelters for animals by, for example, placing them against standing trees and stacking them up (see Photo 12). These shelters for animals were installed at Benoki, Taiho, Kanna and Kurashiki Dams. So far, it is recognized at Benoki Dam that some remains of insects are fed on by Ryukyu woodpeckers.

(6) Substitute caves for bats

At Haneji Dam site, many cave-inhabiting species of bats including *Okinawa kokikugashira koumori* (*Rhinolophus pumilus*) were found in the area to be submerged under water as a result of the dam project.

As a means of mitigating the adverse effects resulting from the loss of the habitat, an artificial cave as shown in Photo 13 was constructed. The artificial cave, which is about 30 m deep, was designed to mimick natural caves by providing a water channel to reproduce humidity and other microenvironmental conditions.



Photo 13
Substitute cave buried in spoil bank at
Haneji Dam
Une cave de substitution aménagée sur un
talus du Barrage Haneji

As a result, between 1998 and 2001, it was confirmed that the artificial cave was inhabited by one Okinawa kokikugashira koumori. However, the number of individuals inhabiting the cave can be expected to grow as the cave matures as a habitat.

4.2 Protection of Water Environment

(1) Erosion control

In view of the fact that red surface soil eroded and washed away from development project sites was contaminating the scenic coral reef and rivers to affect adversely the living beings inhabiting those waters, the Okinawa Prefectural Government enacted "The Surface Soil Erosion Prevention Ordinance" (October 1995).

The term "red surface soil" here does not refer to any specific type of soil; it is a generic term referring to any soil that has become red as the iron contained in parent rock was oxidized through weathering and the oxidized iron was released into the surrounding soil. Surface soils on the Okinawa Main Island are broadly classified into red-colored soils and gray-colored soils. These red-colored soils are the so-called "red surface soils" that account for about 80 percent of all soils found on the Okinawa Main Island.

This section introduces the measures taken during the construction of Haneji Dam, whose impoundment began in July 2000 [4].

(a) Settling basin

In the Haneji Dam construction area, a 84,000 m³ settling basin was constructed, as shown in Fig. 10, to handle stormwater flowing into the area of the dam under construction. The minimum settling basin capacity required by Okinawa prefectural ordinance is 70,050 m³.

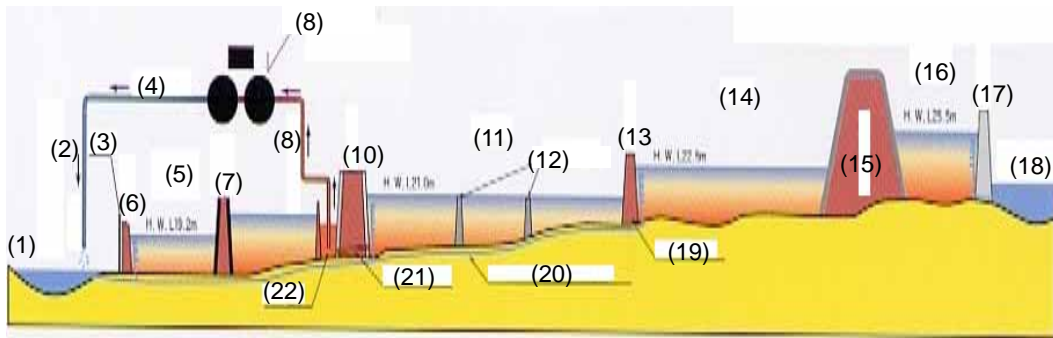


Fig. 10

Turbid water treatment system
Système de traitement des eaux bourbeuses

- | | |
|--|---|
| (1) Haneji-Ohkawa River | (1) Rivière Haneji-Ohkawa |
| (2) Release | (2) Lâcher |
| (3) Steel sheet piling | (3) Mise en place des palplanches d'acier |
| (4) Treated water (PPM) | (4) Eaux traitées (PPM) |
| (5) Settling basin D | (5) Bassin de décantation D |
| (6) Weir 5 | (6) Déversoir 5 |
| (7) Weir 4 | (7) Déversoir 4 |
| (8) Turbid water (raw water) | (8) Eaux bourbeuses (eaux non traitées) |
| (9) Turbid water treatment plant | (9) Station de traitement des eaux bourbeuses |
| (10) Weir 3 | (10) Déversoir 3 |
| (11) Settling basin C | (11) Bassin de décantation C |
| (12) Filter weir | (12) Déversoir avec filtre |
| (13) Weir 2 | (13) Déversoir 2 |
| (14) Settling basin B | (14) Bassin de décantation B |
| (15) Cofferdam | (15) Batardeau |
| (16) Settling basin A | (16) Bassin de décantation A |
| (17) Weir 1 | (17) Déversoir 1 |
| (18) Haneji-Ohkawa River | (18) Rivière Haneji-Ohkawa |
| (19) Turbid water pipe, 400 mm dia. | (19) Conduite des eaux bourbeuses d'un diamètre de 400 mm |
| (20) Upstream conveyance pipe, 400 mm dia. | (20) Conduite de transport vers l'amont d'un diamètre de 400 mm |
| (21) Turbid water pipe, 400 mm dia. | (21) Tuyau d'eaux bourbeuses d'un diamètre de 400 mm |
| (22) Pump pit | (22) Puisard |

(b) Water treatment facilities

Common practice in dam construction is to install a plant for treating highly alkaline cement-contaminated water produced through foundation grouting

or other cement-related work.

At the Haneji Dam site, it was decided to use a single plant not only for treating water contaminated through construction work but also as a means of preventing soil runoff. As shown in Fig. 10, red-soil-contaminated water stored in the settling basin was also treated with the same plant. In the treatment process, the red soil content was firstly reduced with the settling basin, and the water with a reduced soil content was secondarily treated just before it was released downstream.

(2) Intermittent aeration system

At Kanna Dam, two thermocline-lowering type cylindrical surface-layer circulators were installed to reduce the troublesome eutrophication of reservoir water.



Photo 14
Intermittent aeration system
Un système d'aération intermittente



Photo 15
Gravel contact oxidation system
with aerator
Système d'oxydation avec graviers
en contact, muni d'un aérateur

As a result, the quality of reservoir water at Kanna Dam has improved in recent years. So far, the degree of eutrophication has decreased to a medium level (see Photo 14).

(3) Treatment of water from influent stream (installation of river water treatment system)

At Kanna Dam, a bypass channel and water treatment system (dilution tank, gravel contact oxidation tank with aeration system) were installed to prevent further deterioration of reservoir water quality due to wastewater from the piggery operations upstream.

As a result, BOD of 5 mg/L or less was achieved, and the suspended solids of 2 mg/L was substantially achieved (see Photo 15).

5. CONCLUSIONS

The environment protection measures implemented on the Okinawa Main Island that have been introduced in this report are currently reviewed to verify their effectiveness and identify improvement needs under the Follow-up System For Management of Dams and Related Structures by Ministry of Land, Infrastructure and Transportation.

Since the establishment of the Follow-up System, “The Environmental Impact Assessment Law” was fully enforced in June 1999 by expanding the range of projects covered and the evaluated items and adding a post-project survey, and has took the place of the former Cabinet approval of assessments.

In August 1999, a post-project evaluation system was added to a series of public works project evaluation system and started to assess the effectiveness of completed public works projects.

The Follow-up System quickly incorporated these concepts to follow-up for dams and related structures and it has been positioned as a procedure for playing a role as an environmental impact assessment and post-project evaluation system.

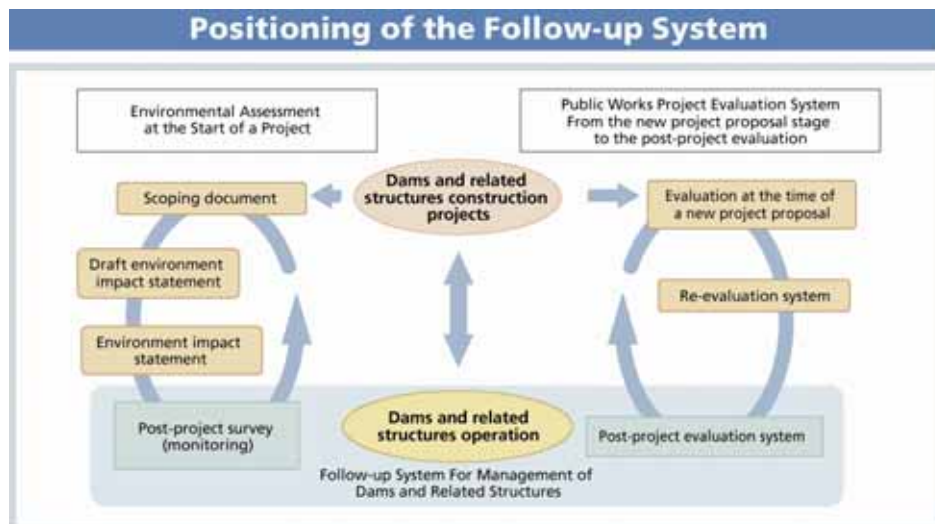


Fig. 11

Positioning of the follow-up system
Détermination de la position d'un système de suivi

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SUMMARY

Located at the southern end of Japan, the Okinawa Main Island, the largest of the Okinawa Islands, is a slender island extending from northeast to southwest. Annual precipitation of 2,300 mm is more than Japan's annual average of 1,800 mm, but rainwater runs off quickly because of many short, fast-flowing rivers. This made it difficult for Okinawans relying on rains for most of their domestic water needs to utilize river water stably during dry season.

Under these circumstances, a number of dams designed mainly for water supply have been built on the Okinawa Main Island, and their reservoirs have been interconnected in order to make effective use of stored water. Since the Okinawa Main Island is blessed with nature, it is inhabited by many endangered subtropical plant and animal species. In connection with dam construction, therefore, effort has been made to protect the natural environment and water environment of dam reservoirs.

This paper describes some of the measures being taken to protect the natural environment and water environment of dams and reservoirs on the Okinawa Main Island, namely, (1) installation of fishway, (2) improvement of wetland environment, (3) restoration of mangrove forest, (4) restoration of Ryukyu ayu (Ryukyu sweetfish), (5) protection of Ryukyu woodpecker and (6) construction of artificial caves for bats (categorized as natural environment protection

measures); and (7) erosion control, (8) installation of intermittent reservoir aeration system and (9) treatment of water from influent stream (installation of river water treatment system) (categorized as water environment protection measures).

RÉSUMÉ

Située à l'extrême sud du Japon, l'île Okinawa, la principale île de l'archipel des Ryukyu, est une île d'un climat subtropical, étirée du nord-est au sud-ouest. Elle reçoit de fortes précipitations (2300 mm en moyenne/an) qui sont supérieures à celles de la moyenne du pays (1800 mm). Cependant à cause de la longueur limitée et de la rapidité de la plupart de ses cours d'eau, le ruissellement était trop importante pour satisfaire d'une manière stable les besoins en eau domestique des habitants qui recouraient aux précipitations, comme principale source d'eau, ce qui les obligeait à réduire leur consommation d'eau pendant la saison sèche.

Étant donné cette situation, plusieurs barrages ont été construits à l'île principale Okinawa principalement pour améliorer les conditions d'utilisation de l'eau, dont les réservoirs sont interconnectés par des canalisations en vue d'une utilisation rationnelle de la retenue. Par ailleurs, l'île Okinawa est un sanctuaire de la nature dont les milieux naturels abritent toujours de nombreuses espèces et des genres rares des zones subtropicales. Compte tenu de cette particularité, lors de la construction d'un barrage, toutes les mesures utiles ont été prises non seulement pour la conservation de la nature aux alentours des sites de barrages, mais aussi pour la protection de l'écosystème dans les réservoirs.

Dans cet exposé seront présentées, à titre d'exemple, quelques mesures prises pour protéger la nature contre les effets de la construction des barrages à l'île Okinawa; soit, 1° la pose des passes à poissons; 2° l'aménagement des marais; 3° la reconstitution des mangroves; 4° la reconstitution de Ryukyu ayu (une espèce de saumon); 5° la protection d'un pic de Ryukyu; 6° la construction des caves artificielles pour les chauves-souris (comme mesures de protection de l'environnement naturel); 7° la prévention de l'érosion du sol en terre rouge; 8° l'installation d'aération par intermittence et; 9° le traitement des eaux apportées

par les affluents (construction des stations de traitement des eaux fluviales)
(comme mesures de protection de l'environnement aquatique).