



## Evaluation of Ecological Function of Chiwa Wetland, Haizuka Dam

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### ABSTRACT

In Chiwa wetland created above the impoundment of Haizuka dam (Miyoshi City, Hiroshima, Japan) constructed in Satoyama environment, we conducted water quality and biological investigations. Then, we evaluated these results from the aspect of water storage to the impoundments and creation of the wetland. We confirmed that creating the wetland within the secondary dam had positive effects on the followings: (1) preventing the devastation of flood control area; (2) purification of water quality; (3) creating a new habitat for fishes, birds and insects; (4) opportunities for local residents to be involved in environmental activities. We need to continue follow-up investigations and cooperate with local residents for the appropriate management in Chiwa wetland towards the future.

*Keywords: Artificial Wetland, Community Participation, Ecological Evaluation, Riparian Ecosystem, Water Quality,*

### 1. INTRODUCTION

The Haizuka dam is a multi-purpose dam, which is planned by Ministry of Land, Infrastructure, Transport and Tourism (former Ministry of Construction), for flood control, stabilization of vested water intake, and environmental protection of the Gounokawa river (194km river extension and 3,900 km<sup>2</sup> catchment area), and water supply to the Shobara city and the Miyoshi city. The Haizuka dam is completed construction in March 2007, managed since April 2007. Since the Haizuka dam was built in the valley surrounded by woodlands, not in a steep mountainous area, it is characterized by having a shallow depth and large reservoir area (Fig. 1, Table1).

Chiwa wetland, constructed above the secondary dam as a flood control area of the Haizuka dam, is located along the Jogegawa river which flows into the reservoir of the Haizuka dam. Because of this location, the vast flood control area as wide as 70 hectares is usually exposed at normal water levels. It is only covered with water during

the flood period. It was concerned that the area would be a devastated dry land, since the frequency of flood is once per five years in relatively low land areas, and once per twenty years in upstream areas located in high ground. Therefore, according to the guidance and advise from scholars, a wetland (marsh as a habitat of creatures), which is highly demanded worldwide, was developed by the local government and Ministry of Land, Infrastructure, Transport and Tourism (Fig.2).

Chiwa wetland consists of open water, marshland, littoral zone, etc., and is intended to be a riparian environment which, in turn, will provide a new habitat for a variety of wildlife. Also, it is expected that the wetland is utilized for purification of water quality by aquatic plants and hygrophytes, and subsidence or clearing of suspensoids (particles floating in water) by retaining the flow of the river with Chiwa secondary dam. In addition, it is also expected that the wetland is utilized for environmental education, biological observation, and experiences in nature by the public such as elementary and junior high school students and local residents.

Investigations in Chiwa wetland were carried out from the aspect of forming a new marsh environment. In this report, we present the overview and status of forming marsh environment, and consider the problems and the solutions of the operation and maintenance of the wetland.

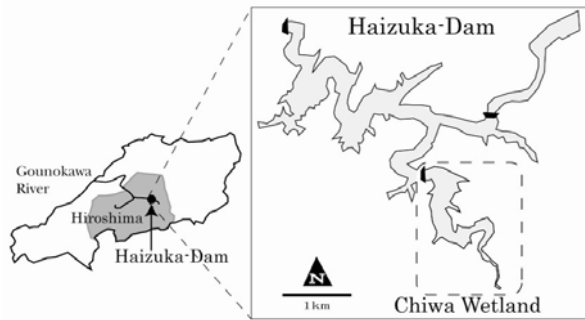


Fig. 1. Locations of Haizuka dam and Chiwa wetland

Name of Basin	Gouonokawa River Basin: Class A Rives (managed by National government)
Completion year	2007
Catchment area	217km <sup>2</sup>
Storage area	3.54km <sup>2</sup>
Gross Storage Capacity	52,100,000m <sup>3</sup>
Effective Storage Capacity	47,700,000m <sup>3</sup>
Maximum water level (At the time of usual)	EL.231.2m
Maximum water level (At the time of flood)	EL.247.3m

Table 1. Specifications of Haizuka dam

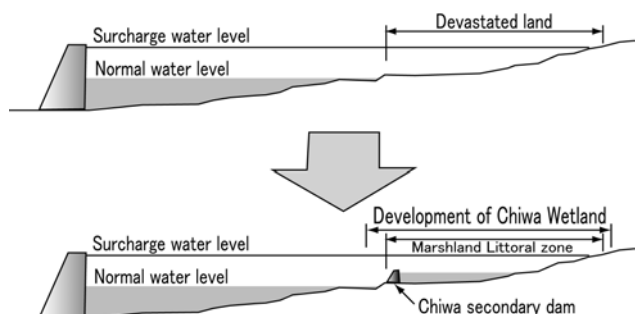


Fig. 2. Creation of wetland by Chiwa secondary dam

## 2. OUTLINE OF THE DEVELOPMENT OF CHIWA WETLAND

The goals of the development of Chiwa wetland is described as follow (2.1-2.4).

### 2.1. Prevention of the devastation of the flood control area by the development of the wetland

The vast flood control area in Chiwa was devastated, and alien plants such as *Solidago altissima*, and the plant community of *Miscanthus sinensis*, *Miscanthus sacchariflorus* etc. dominated the area before the development of the wetland, because the long time has been passed since the farming of the area had stopped. Even after completion of the Haizuka dam, the progression of degraded lands and the deterioration of landscapes were concerned in the areas which was rarely flooded.

Also, it is strongly desired by the local residents that the area has a good landscape, and should be a functionally valuable land. According to these opinions, we prevent the devastation of the flood control area by creating water surface with the establishment of Chiwa secondary dam, and forming a wetland with water flowing from the upstream.

### 2.2. Purification of water that flows into dam using aquatic plants and hygrophytes

The water quality of Jogegawa river has a problem that high concentrations of nutrient salts causes eutrophication of the dam. In the development of the wetland, we flow a part of Jogegawa river into the wetland, retain the water, and then flow it out into downstream. By doing so, the quality of the water that flows into the dam will be improved using the purification function of aquatic plants (e.g. *Phragmites australis*, *Zizania latifolia*.) and hygrophytes (e.g. *Carexes*, *Persicaria thunbergii*).

### 2.3. Creation of new riparian ecosystems by developing the wetland

### 2.3.1. Creation of habitats for diverse wildlife

With due consideration to a wide variety of environment, such as forests, upstream of river, agricultural land, and water surface newly created in the dam, we create new habitats of diverse wildlife that ecosystem working can be kept and biodiversity can be improved.

### 2.3.2. Contribution to make international habitat networks

In consideration of waterfowls flying from the Korean Peninsula, we enrich the habitat of them in western Japan. By doing so, we contribute to make habitat networks in eastern Asia.

## 2.4. Development of the wetland and local revitalization with the participation of residents

It is expected that the wetland will be a new local resource as the recreation area for feeling rich natural environment. In addition, we utilize the wetland for activity of making wetland and protecting the nature by local residents. Thus, the main purposes of the creation of the wetland can be described as follows:

- (1) Providing opportunities for the development of a region
- (2) Utilizing as materials of environmental education and nourishing minds of children

We evaluated these development goals from results of the researches from 2007 to 2010.

## 3. EVALUATION OF ECOLOGICAL FUNCTION WITH THE DEVELOPMENT OF CHIWA WETLAND

A new marsh environment was created by the development of Chiwa wetland. We evaluated the ecological function of the wetland, since it was revealed that diverse wildlife inhabited and new ecosystem was being formed in the wetland.

### 3.1. Prevention of the devastation of the flood control area with the development of wetland

We set up 5 fixed observation points around Chiwa wetland (Fig. 3), and observed the changing landscape by photography from the fixed points in every season. Also, we observed the succession of vegetation by aerial photography.

Water surface was formed by setting Chiwa secondary dam, and the dry waste land has changed to the marsh. As a result, an alien plant *Solidago altissima* was restrained from spreading its population within the area, and plants that inhabit in marsh areas were increased. We consider that the vegetation communities may function to prevent the devastation of flood control area, even though the communities are still in succession.

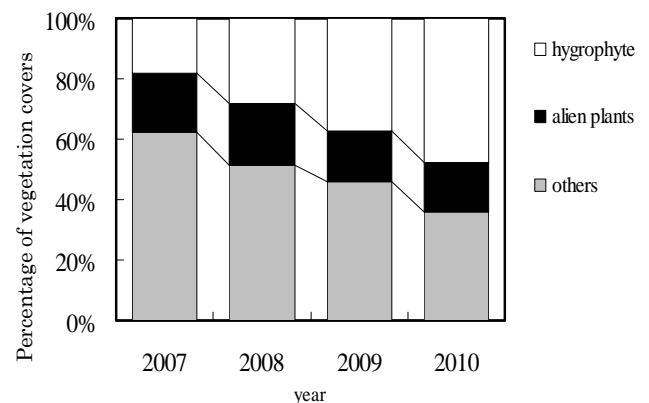


Fig. 4. Vegetation changes in Chiwa marsh areas

### 3.2. Purification of influent water into the dam by aquatic plants and hydrophyte

We conducted monthly water quality surveys (water temperature, ph, BOD, COD, N, P, etc.) at points that water flow into Chiwa marsh areas, a center of the marsh areas, and points that water flow out from the marsh areas (Fig. 3).

A part of Jogegawa river, which flows into Haizuka dam, is conveyed to Chiwa wetland. Since the water flowing into Haizuka dam has high phosphorus concentration, it is important to reduce eutrophication in the impoundment.

The result reveals that the level of PO<sub>4</sub>-P at outflow

areas in Chiwa marsh reduced than it at inflow areas, from spring to summer that increases the activity of plants (Fig. 5). This could imply that the water quality is improved by the plants, even though the result varies in every year.

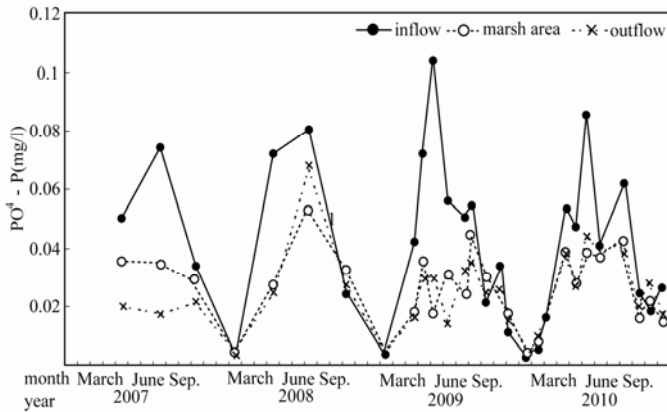


Fig. 5. PO<sup>4</sup>-P concentration changes in Chiwa wetland

### 3.3. Creation of new riparian ecosystems by the development of wetland

We investigated the number of species of fish, bird and terrestrial insect living in the new marsh environments. The results are shown below.

#### 3.3.1. Fishes

The research was carried out by capturing fishes with casting nets and landing nets in spring, summer, and autumn from 2007 to 2010 (Fig. 3).

In marsh areas of Chiwa wetland, the still water inhabitants such as *Oryzias latipes* and *Gnathopogon elongatus elongatus* were dominated (Fig.6). This indicates that the formation of a new riparian ecosystems at the area may create a suitable habitat for these fishes.

On the other hand, invasive alien species such as *Micropterus salmoides* and *Lepomis macrochirus* were also found. The effect of these species on the local fish community should be concerned.

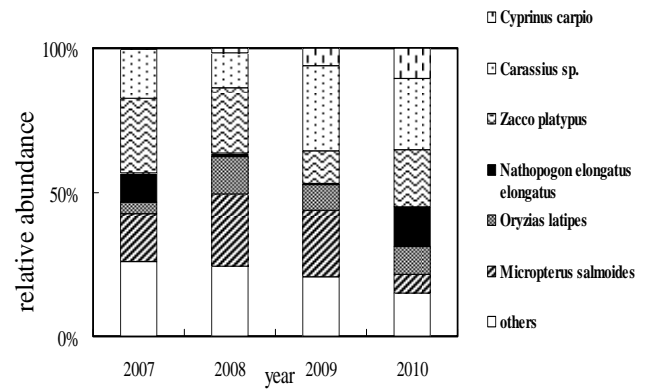


Fig. 6. Changes of relative abundance of fishes in Chiwa marsh areas

#### 3.3.2. Birds

The investigation was carried out by fixed point observation during the bird migration period from 2007 to 2010 (Fig. 3).

We found that many birds, especially, winter resident such as waterfowls (e.g. *Anas platyrhynchos* and *Anas penelope*), visited Chiwa wetland (Fig. 7). Also, we constantly found wetland inhabitants such as *Porzana fusca* and *Pandion haliaetus*. These results indicate that Chiwa wetland may work as a bird habitat.

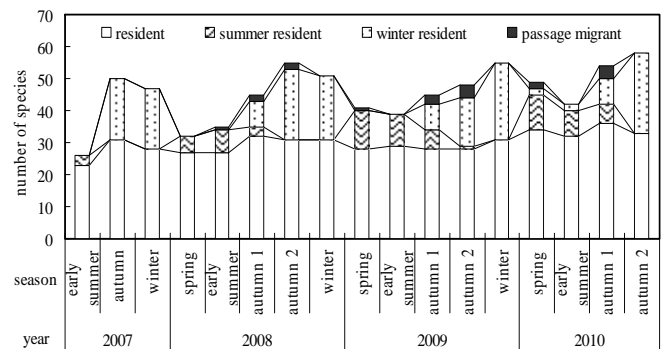


Fig. 7. The fluctuation of number of bird species in the wetland

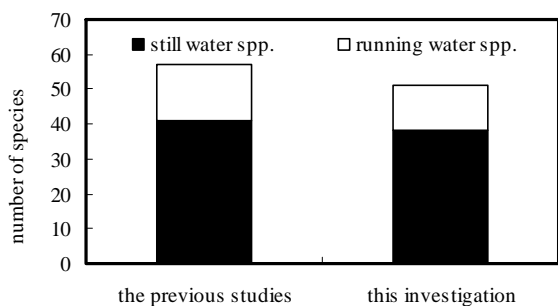
#### 3.3.3. Terrestrial insects (Odonata)

The investigation was carried out by capturing Odonata at each site in Chiwa wetland in spring, summer, and autumn from 2007 to 2010 (Fig. 3).

According to the literature (MLIT., 2010) many Odonata species inhabited in this area when the area had been agricultural land once before the construction of the Haizuka dam. After the dam construction, the devastated land had become dry land resulting in the degradation of

Odonata habitat (Fig. 2). It is assumed that the devastated land would be dry land without the development of Chiwa wetland.

The comparison between the previous studies in the literature and this investigation result shows that about 85 percent of still water species, listed in the previous studies, are found in this investigation (Fig.8). This means that a suitable Odonata habitat, which is comparable to it before the development of Chiwa wetland, may be formed.

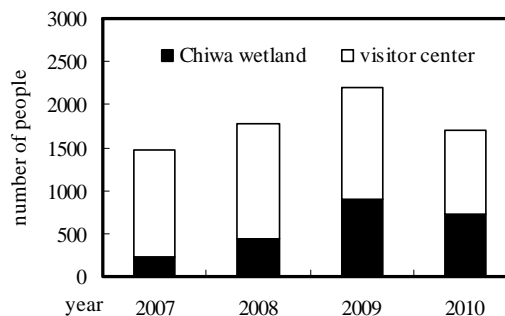


**Fig. 8.** A Comparison of the number of Odonata species between the previous studies(MLIT, 2010) and this investigation.

### 3.4. Development of the wetland and local revitalization with the participation of residents

In order to estimate the relationship between the Chiwa wetland development and local revitalization, we sorted out the number of visitors in Chiwa wetland and at the visitor centre, as well as the contents of events held at these places.

The number of visitors increased after the Chiwa wetland development (Fig.9). Most of these visitors were local residents and neighbour school students. The wetland provided environmental activities including environmental education, bird watching and events held by local residents.



**Fig. 9.** Number of visitors in Chiwa wetland and the Chiwa visitor centre

## 4. CONSIDERATION OF FUTURE MAINTENANCE

We confirmed that Chiwa wetland fulfilled the following four functions: (1) Prevention of the devastation of flood control area; (2) Purification of water quality by hydrophytes; (3) Creation of new riparian ecosystem; (4) Development of local revitalization with the participation of residents.

The following efforts are important to maintain appropriate natural environments continuously in Chiwa wetland.

### 4.1. Follow-up Research

#### 4.1.1. Continuous research

In 2012, almost five years will be passed since the wetland has started for use. Since the habitat environment is expected to change in the future, it is necessary to conduct appropriate follow-up investigations to create the environment that accords with the aim of management. The Haizuka dam administration office plans to conduct biological surveys and water quality surveys regularly. In addition to these surveys, we recommend to investigate appropriate environmental surveys according to need, if any changes of the marsh environment are found.

#### 4.1.2. Investigations that cooperate with local residents

Chiwa wetland is vast (70ha), therefore, it is difficult to maintain only by the dam administration. Local residents in the area have formed "Wetland team". The team is

constructed by people who interested in nature, and they conduct environmental education and activities cooperated with the dam administration. In the future, we expect that the team will play an important role in the wetland environmental investigations together with the dam administration.

## 4.2. Appropriate management for protection of the marsh environment

### 4.2.1. Vegetation management

Plants, as they grow, absorb phosphorus resulting in the purification of water. However once the plants are withered, nutrient salts (e.g. phosphorus) kept in the plants will be released in the water again. Thus, proper plant managements such as regular trimming of over-grown plants will be required in order for the water quality to be kept at the appropriate level.

### 4.2.2. Extermination of alien fishes

A large number of *Micropterus salmoides* and *Lepomis macrochirus* were found in Chiwa wetland. They are assumed to have a large influence on the existence of native species. Although the capturing extermination of alien species has been conducted in the area, it seems to be ineffective. It is important to develop the effective extermination methods of alien species suitable for Chiwa wetland.

## 4.3. Management of wetland cooperation with local community

With the Wetland team described before in this paper at the head of the list, the local community is highly interested in Chiwa wetland. Since it is difficult to maintain vast Chiwa wetland only by the administrator itself, we expect that biological investigations, vegetation management and extermination of alien species will be conducted in cooperation with local residents.

## 5. SUMMARY

This investigation revealed that the development of Chiwa wetland has achieved its primary goals. The

summary of findings is as follow:

(1) Regarding the prevention of degradation in the flood control area, a newly formed wetland was found and the wetland seemed to prevent alien plants to be spread within the area;

(2) Water quality in Chiwa wetland could be improved by the increase of hygrophytes within the area, which was verified as the reduction of phosphorus concentration;

(3) It appeared that a good riparian ecosystem has been formed within the wetland, and the area acted as a stopover for migratory birds as well as fish habitat. On the other hand, it is necessary to take measures of effects on native species by alien species;

(4) The wetland was utilized by local residents and elementary schools for environmental education. This might result in local revitalization with the participation of residents.

Chiwa wetland is still in succession. To maintain the environment of Chiwa wetland properly, it is important to carry on the water quality and biological investigations in the area. Also, it is necessary to manage Chiwa wetland in cooperation with local residents, local communities and scholars.

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