

# **The Nagaragawa Estuary Barrage**



**Japan Water Agency**

## 1. Background

The estuary area of the river Nagara (Nagaragawa) used to suffer from flood many times. Especially the Ise Bay Typhoon, which hit the Tokai district in September 1959, damaged Gifu, Aichi and Mie Prefectures severely, with fatalities more than 5,000, including the missing. (Fig.1-1) Therefore, to allow volumes of  $7,500\text{m}^3/\text{sec}$  to flow down safely, it is necessary to increase the cross-sectional area of the river.



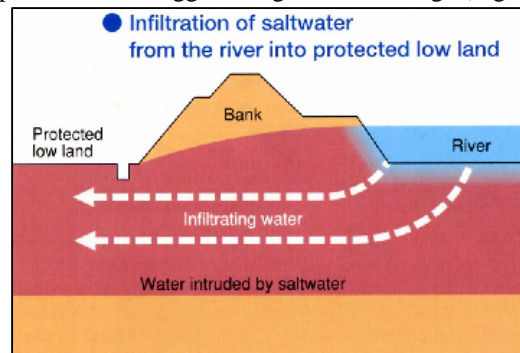
A ruined house (caused by Ise Bay typhoon, Sept. 1959), photo by the "Chunichi" newspaper

(Fig.1-1)

The area along the lower reaches of "the Kiso three rivers"(Fig.1-2:the Kiso, the Nagara, the Ibi) facing Ise Bay have long been invaded by saltwater, and the residents have suffered from salt damage (by salinization) of both river water and ground water used as domestic and agricultural water supplies, and of soils on farmlands. While, to make up for water invaded by saltwater, very large amounts of ground water was drawn. As a result, The ground subsidence caused by drawing ground water led to saltwater intrusion further upstream and to aggravating the salt damage.(Fig.1-3)



(Fig.1-2)



(Fig.1-3)

Before the construction of the barrage and dredging work in the Nagara River, if the flow rate of the river decreased, the reverse flow of the seawater into the river were held back by a relatively high section of the bed known as "mound"(Fig.1-4), which was located about 14 to 18km upstream from the river estuary. But if dredging is carried out for flood control, Saltwater is expected to intrude further upstream about 30km from the river estuary. With Nagaragawa Estuary Barrage serving as a barrier, therefore, it was expected to prevent from salt damage and proceed dredging operations freely (Fig.1-5).



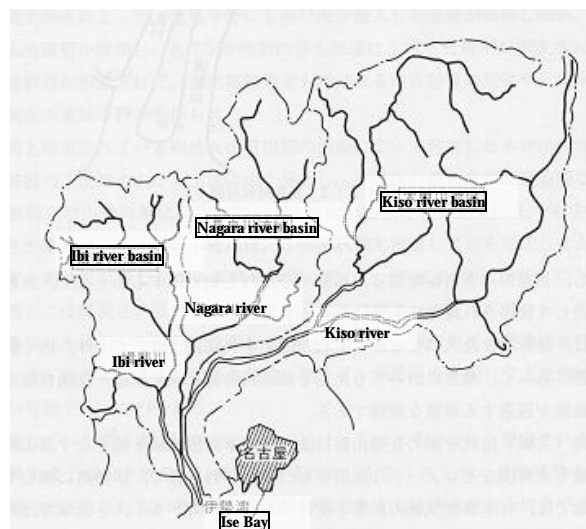
(Fig.1-4)



(Fig.1-5)

## 2. Outline of the Nagara river basin

The river Nagara, which is one of the Kiso River Water System, rises in the Mt. Dainichigadake (1,709m) located northwest of Gifu Prefecture, and flows in parallel with the river Kiso from South of Hashima city, and meets the river Ibi at the mouth of the river Nagara in the Kuwana city, and flows into the Ise Bay. The river basin area is 1,985km<sup>2</sup> and total main river length is 166km (Fig.2).



(Fig.2)

The area, which is located in the estuary area of the river Nagara, is called “Waju” (Fig.1-2). Waju is a communal society bounded by a bank (the ringed bank), built to enclose a community and its cultivated land entirely for the purpose of protecting them from floods. The bank was built by the residents themselves, so the history of the development of Waju is a history about how these communities fought the ever-present threat of floods. In the upstream of Nagara River, there are not many suitable areas for dam construction. For this reason, water volume has to be controlled only by the capacity of river flow. The basic plan for the Kiso River Water System Project involves the adjustment of peak discharge of 8,000m<sup>3</sup>/s (with 500m<sup>3</sup>/s controlled by upstream dams, only 7,500m<sup>3</sup>/s) to flow down safely to the river. River improvement is now in progress based on this plan. To allow flood volumes of 7,500m<sup>3</sup>/s to flow down safely, it is necessary to increase the cross-sectional area of the river.

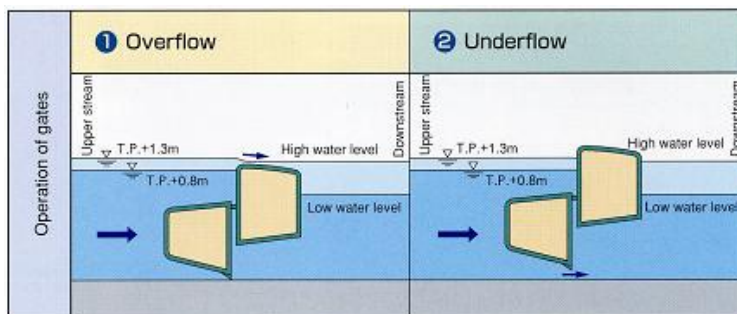
## 3. Outline of the Nagaragawa Estuary Barrage Project

The Nagaragawa Estuary Barrage Project consists of four projects, (1) Nagaragawa Estuary Barrage (2) Bank Reinforcement for Storm Surge Protection (Estuary Section) (3) Countermeasures Against Infiltrating Water (4) The dredging work for increasing the cross-sectional area of the river. Details of four projects are as follows.

**(1)Nagaragawa Estuary Barrage**

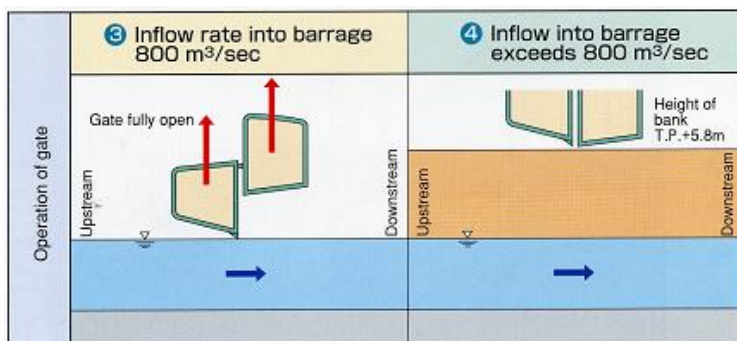
Nagaragawa Estuary Barrage is located from the estuary to about 5.4km upstream. The construction of the main barrage structure began in March,1988. In March,1995, all construction works had been finished. The estuary barrage play roles as flood control, domestic water and industrial water supplies for Aichi Pref, Mie Pref and Nagoya City at rates of up to 22.5m<sup>3</sup>/s by preventing intrusion of saltwater and making extra fresh water.

About the facility of the barrage, it has 10 adjustment gates, all of these are designed to have two-stage structure so as to discharge both overflowing and underflowing in consideration of environment. At ordinary time, basic of the gate operations is carried out so that water level is be controlled within a range from T.P.+0.8m to T.P.+1.3m and the difference in water level between upstream and downstream is reduced as much as possible by lowering the upstream level. (Fig.3-1-1)



**(Fig.3-1-1)**

When the river is flooded (inflow rate into barrage 800 m<sup>3</sup>/sec), all of gates (10 adjustment gates, lock gates and lock-type fishway gates) are raised to a level higher than the top of bank height. (Fig.3-1-2)



**(Fig.3-1-2)**



As an especially advanced technology, fishways are introduced as follows:

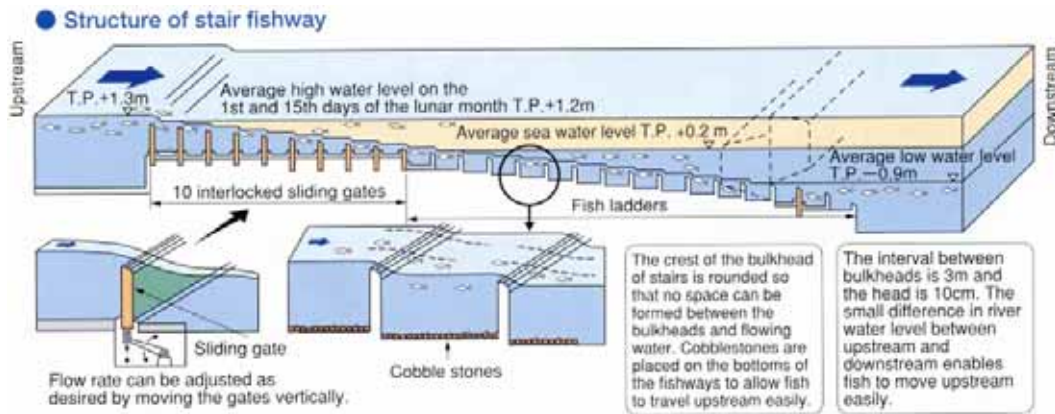
In Nagaragawa Estuary Barrage, several kinds of fishway have been built, e.g. ① Attracting-flow-type Fishway ② Lock-system Fishway ③ Naturally Shaped Fishway.

① Attracting-flow-type Fishway (Fig.3-1-4~5)

The attracting-flow-type fishway consists of attracting flow channels in the center and stair fishways (fish ladder) on both sides. Fish are attracted by the flowing water from the attracting flow channels, and travel upstream via the fish ladders.



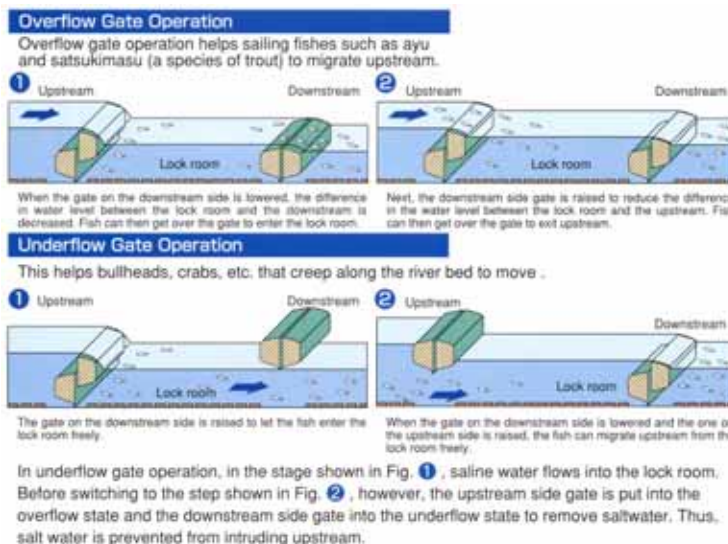
(Fig.3-1-4)



(Fig.3-1-5)

② Lock-system Fishway(Fig.3-1-6)

The lock-system fishway help fish to move through the two stage gates installed on the upstream and downstream sides. As shown below, overflow gate operation and underflow gate operation are repeated in the fishway.



(Fig.3-1-6)

### ③ Naturally Shaped Fishway(Fig.3-1-7)

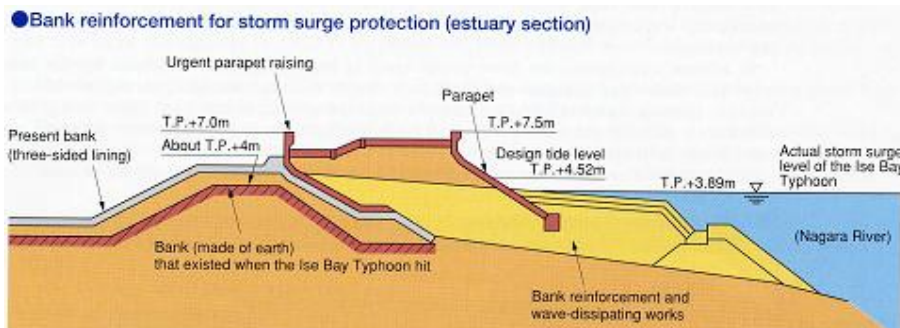
The naturally shaped fishway is about 320m long and 15m wide (including a water surface of 3m in width) provided on the overflow bank on the right bank of the estuary barrage. The fishway resembling a natural stream was created to allow a wide range of fish to travel upstream. The fishway is given a gentle slope, and cobblestones and other natural stones are placed in it. At the exit (upstream end) of the naturally shaped fishway, four roof weirs made of rubber cloth were provided to deal with a change in the water level on the upstream side.



(Fig.3-1-7)

### (2) Bank Reinforcement for Storm Surge Protection (Estuary Section)

The height of storm surge banks, which were built Based on the experience of Ise Bay Typhoon of 1959, was reduced by ground subsidence. Urgent raising of the parapets had been carried out by fiscal 1988. In order to provide more safety against storm surges, The front berms (bank reinforcement and wave-dissipating works) was built in front of the banks. and also the storm surge banks (parapets) was raised.(Fig.3-2)

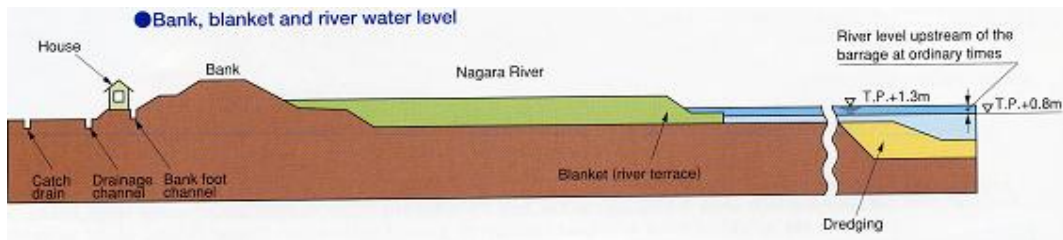


(Fig.3-2)

### (3)Countermeasures Against Infiltrating Water

As a result by construction of the barrage, tidal action does not occur upstream of the barrage, and water level remains at around the high tide level. As a means of infiltrating control, therefore, blanketing (covering the high water channel bed with a 60-centimeter-thick layer of cohesive soil) and planar drainage facilities were provided (Fig.3-3). The blanketing work, about 50 to 70m wide,

was provided over a distance of about 25km upstream of the barrage. Together with the bank foot channel and the catch drain, etc that are built in the protected low land, the blanket reduces water infiltration and prevents the ground water level from rising.



(Fig. 3-3)

#### (4)dredging for increasing the cross-sectional area of the river

As the reason mentioned in Background, Dredging in the mound section of the river began on the day after the operation of the estuary barrage went into operation (Fig.3-4-1:July 6,1995) and was completed in July 1997.(Fig.3-4-2)



The mound section of the Nagara before dredging

(Fig.3-4-1)



The mound section after dredging (photographed in September 2000)

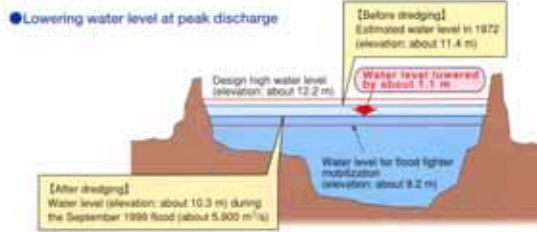
(Fig.3-4-2)

#### 4.Effects of Nagaragawa Esutuary Barrage

As mentioned above, Gate operation was started in July 1995. The dredging in the mound section, which was completed in July 1997, proved effective in mitigating flood damage.

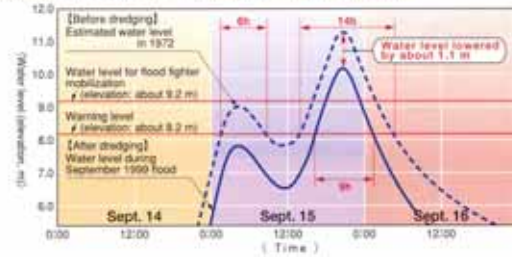
The flood flow caused by the front and Typhoon No.16 of September 14 and 15, 1999, reached a maximum discharge of about  $5,900\text{m}^3/\text{s}$  (estimate) at Sunomata point (39.2km from the river mouth). Though this was the maximum discharge that had occurred since the barrage went into operation, it is estimated that water level was lower than before dredging by about 1.1m (Fig.4-1), and the period of time during which the river water level at Sunomata point stayed above the warning stage was reduced from 20 hours before dredging to 9 hours after dredging.(Fig.4-2)

Lowering flood stage [at Sunomata point (39.2 km from the river mouth)]



(Fig.4-1)

Comparison of flood stage durations before and after dredging

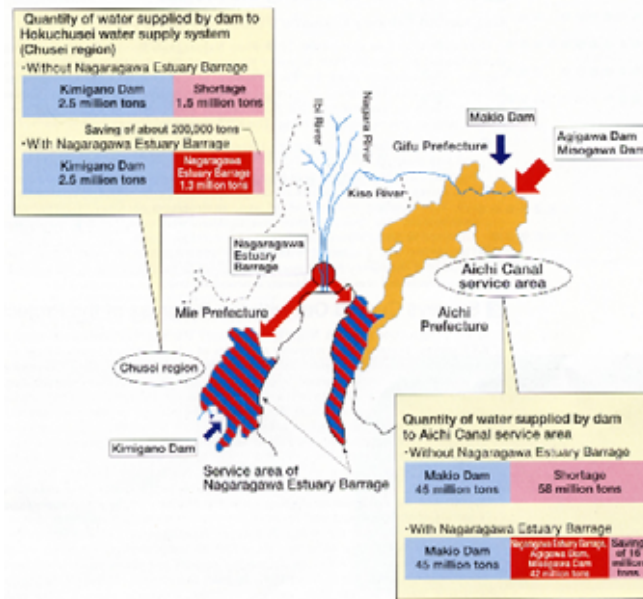


(Fig.4-2)

While the estuary proved effective in water shortage.

Precipitation in July and August, 2000 was only 40 percent of normal rainfall, and a water shortage occurred in the Kiso river system. During this period, however, domestic water from Nagaragawa Estuary Barrage, Agigawa Dam and Misogawa Dam was supplied to the central region of Mie Prefecture and the service area of the Aichi Canal. This prevented serious consequences such as suspension of water supply. Without the water from Nagaragawa Estuary Barrage, water supply would have had to be suspended for about 3 to 8 hours in some of the cities and towns in the Chusei region (about 64,000 households, or 18,000 people).(Fig.4-3)

Contribution to water utilization during the water shortage of 2000



(Fig.4-3)

## 5. Information release and accountability to the people

The Nagaragawa Estuary Barrage was one of the project which was focused on information release and accountability to the people in Japanese public enterprise. Water Resources Development Public Corporation (the present is Japan Water Agency) was accused five times from 1973 to 1994

by fisherman, hotel owner and members related with environmental organization. Because they worried about reduction of fishery and environmental destruction by the barrage construction. WARDEC appealed the necessity of the Nagaragawa Estuary Barrage and took all possible measures for these problems, and finally won all the suits. And also, WARDEC actively disclosed investigation results and made public relations to obtain understanding of the public and mass communication.