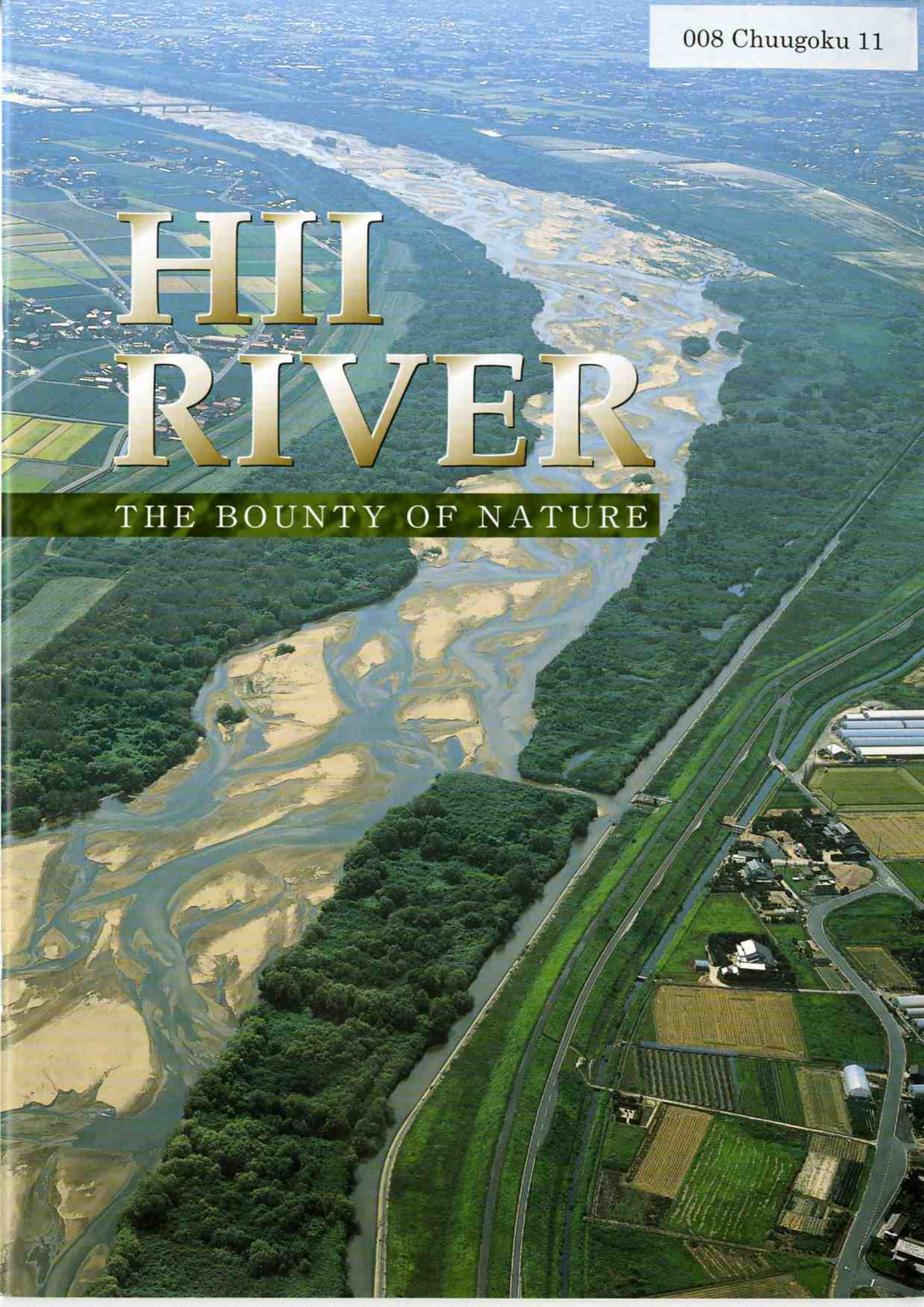


HII RIVER

THE BOUNTY OF NATURE

Hii River has its origin at Mt. Sentsu, western Honshu Island, Japan, meanders through Izumo Plain joining many branch rivers, and reaches the Sea of Japan via Lake Shinji and Lake Namaumi.

Hii River is a noble river characterized with Japanese myths. Many legends originated in the watershed of the River. This area has also been a center of the politics, culture, and economy of the western region of Honshu Island since ancient times.

Hii River, however, has given rise to some environmental problems. A huge amount of the discharged soil has deposited in the riverbed. It has brought about frequent floods in Izumo Plain. Lake Shinji and Lake Nakaumi, brackish lakes that receive Hii River water and are well known as habitats of waterfowls and the fishery resources suffer from the water pollution due to the eutrophication of the lakes.

Though the river gives such threats to human being, it provides us, at the same time, with vast blessings of nature, peace of mind, and support for the daily life. This Guidebook regards both of these two aspects of the Hii River and looks for an image of the future Hii River that is harmonized better with human life and sustainably blesses human being. Thus, the Guidebook will help you understand Hii River.

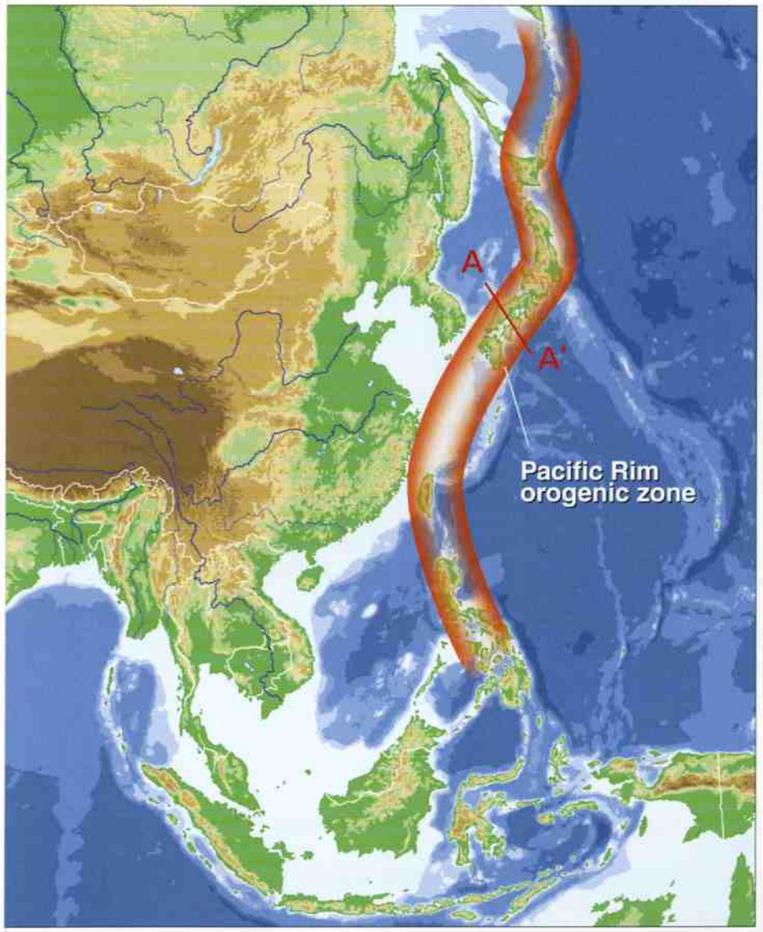
Program

1 Characteristics of the Land of Japan

The Japan Archipelago, Located on the Orogenic Zone of the Pacific Rim

【Long and Narrow Land Area with Steep Topography】

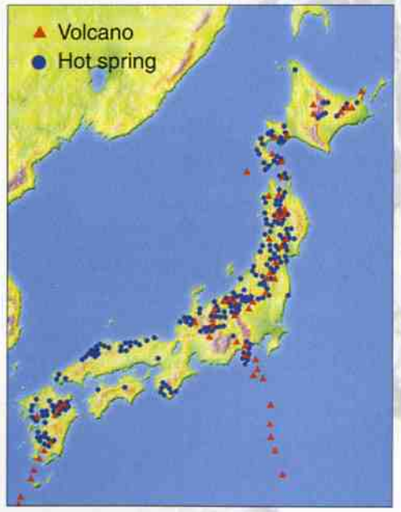
The Japan Archipelago is located on the orogenic zone of the Pacific Rim and stretches out in a narrow arc to the North East and South West direction over a distance of 3,000 km. By contrast, the widest section of the Archipelago is only about 300 km. Steep mountain ranges over 2,000 m extend along the middle of the Archipelago, hence the plain areas constitute only about 10% of the total land area.



【Fragile Geological Structure】

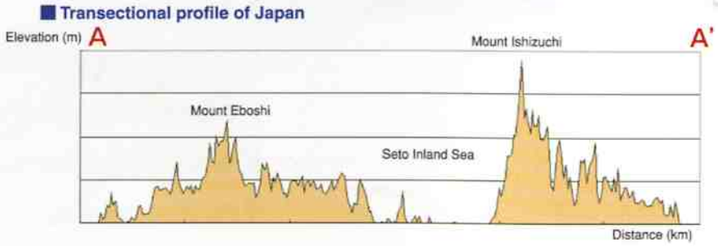
Since the Japan Archipelago has been under the influence of various orogenic and weathering activities, fragile rocks are widely distributed.
Japan locates in a major volcanic region and many active volcanoes and hot springs are found. In these regions, fragile volcanic products and geothermally heated rocks are prominent.

■ Volcanoes and hot springs in Japan



【The orogenic zone of the Pacific Rim】
An active orogenic zone surrounding the Pacific Ocean. It is characterized by steep and high mountains with active seismic and volcanic activity .

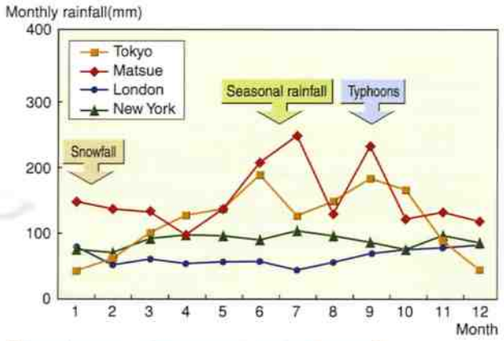
■ Transectional profile of Japan



The Japan Archipelago, Blessed with Abundant Rainfall

The Japan Archipelago lies in the path of low pressure systems and belongs to the monsoon region.

■ Rainfall in Japan and other countries[1]



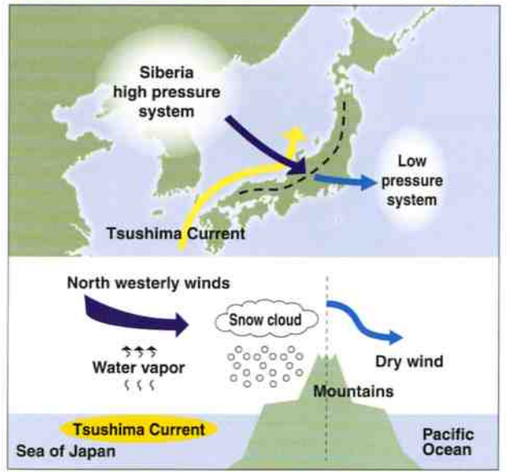
【Stationary Seasonal Rain Front】

During June and July, the Okhotsk high pressure system and Pacific high pressure system collide near the Japan Archipelago and form a front called the "stationary seasonal rain front". This front resides for long periods and often causes intense rain storms.

【Heavy Snowfall in the Sea of Japan Region】

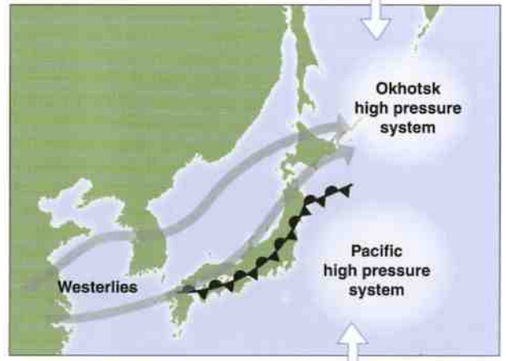
In winter, the Siberia high pressure system resides over the Asian Continent and blows strong winds towards the low pressure system in the Pacific Ocean and north westerly winds become prevalent.
When a north westerly wind crosses the Sea of Japan, it absorbs large amount of water vapor from the warm Tsushima Current and forms snow clouds. When these snow clouds reach the mountain ranges of the Japan Archipelago, they produce heavy snowfall in the Sea of Japan region.

■ Mechanism of the heavy snowfall in the Sea of Japan region[2]



■ Stationary seasonal rain front[2]

The westerlies during spring and summer diverge at the Tibet Plateau and then remerges off the north eastern coast of Japan and form the Okhotsk high pressure system

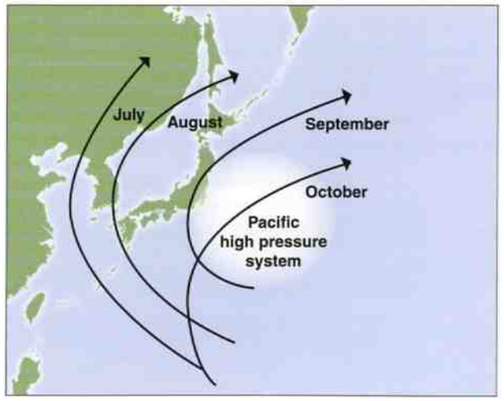


A warm and moist high pressure system develops over the Pacific Ocean and advances towards Japan in summer

【Frequent Passing of Typhoons】

Typhoons are tropical low pressure systems that originate in the tropical regions around the equator in the Pacific Ocean. Every year typhoons approach the Japan Archipelago and cause extensive damage through strong winds and heavy rain.
During summer, typhoons rarely cross Japan, but in autumn when the Pacific high pressure system weakens, typhoons often cross the Japan Archipelago by advancing along the edge of the Pacific high pressure system.

■ Passages of typhoons[2]



Characteristics of Japanese Rivers

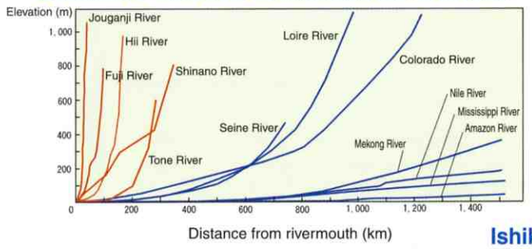
【Short and Steep Rivers of Japan】

Japanese rivers have small catchment areas and short river courses compared to other rivers in the world. Also, since the rivers are short and run along a steep gradient, rainfall is discharged rapidly into the ocean.

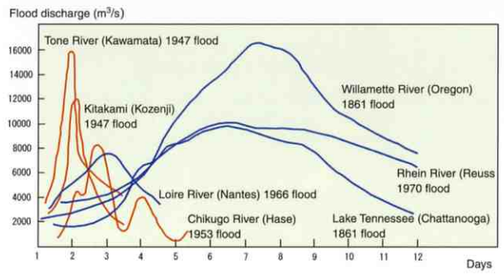
■ **Major rivers in Japan**

Name of River	Catchment area (km²)	Rank	Length of main river course (km)	Rank	Population in the catchment area (thousand)
Ishikari R.	14,330	2	268	3	2,490
Kitakami R.	10,150	4	249	5	1,390
Tone R.	16,840	1	322	2	11,630
Shinano R.	11,900	3	367	1	2,800
Kiso R.	9,100	5	227	8	1,900
Yodo R.	8,240	7	75	67	10,700
Hii R.	2,070	29	153	19	630
Yoshino R.	3,750	17	194	12	640

■ **Distance of rivers from the rivermouth and its elevation** [3]



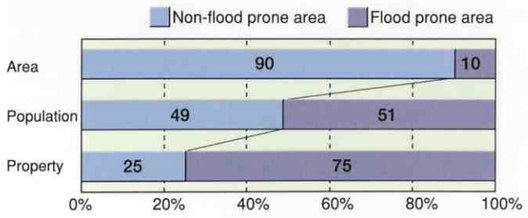
■ **Days required for flood discharge** [4]

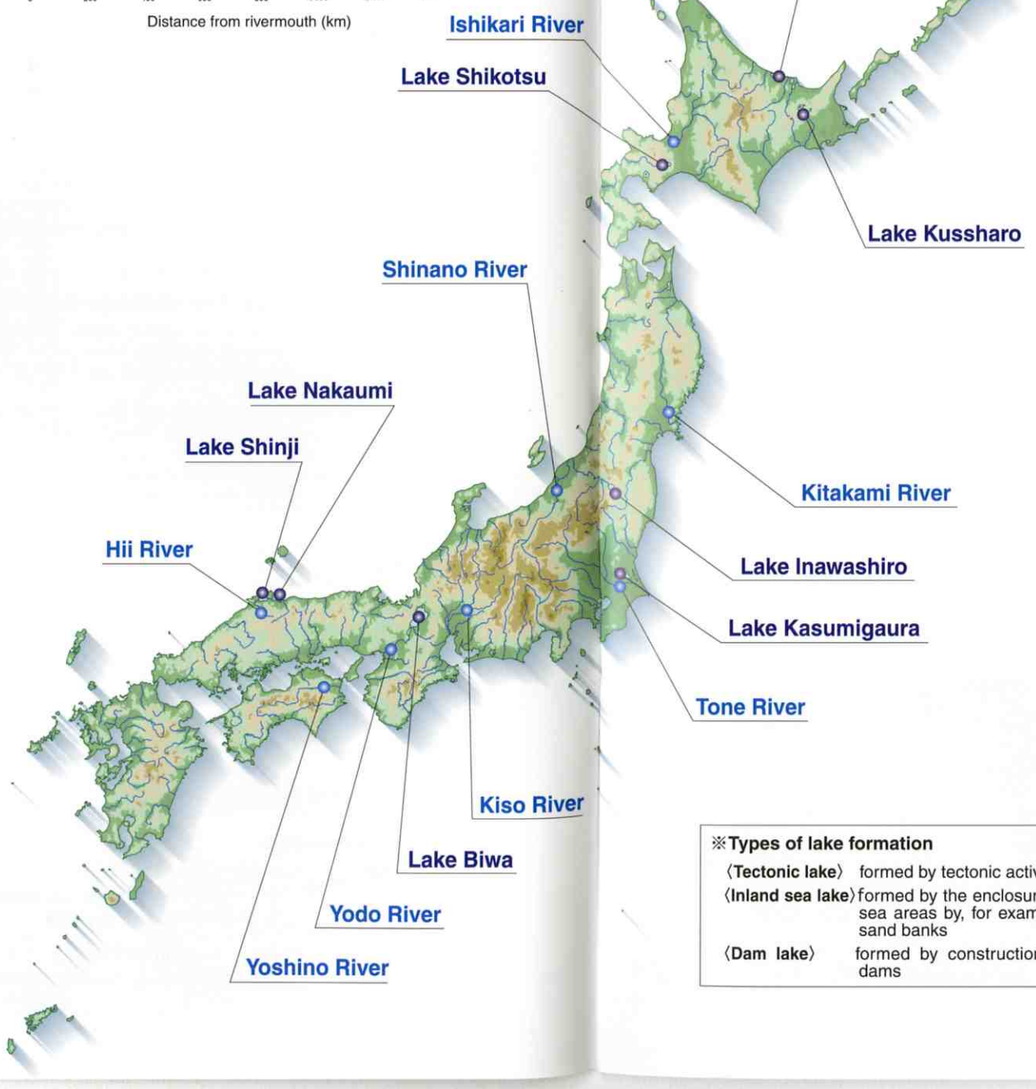


【Concentration of Population and Properties in Flood Prone Areas】

70% of Japan is occupied by mountains and only 10% is plain area. Although most plains are flood prone areas, 50% of the total population and 75% of properties are concentrated in these plains.

■ **Population and properties in the flood prone areas** [5]





Characteristics of Japanese Lakes

【Small Scale Japanese Lakes】

Japanese lakes are small compared to other lakes in the world. Globally, there are approximately 200 lakes larger than Lake Biwa, the largest lake in Japan, and the Caspian Sea, the largest lake in the world, is 550 times as large as Lake Biwa.
The water depth of many large lakes in Japan is shallow relative to the lake area. Out of the top ten lakes with large surface areas, 5 lakes have an average depth below 10m.

■ **Major lakes in Japan**

Name of lake	Surface area (km²)	Rank	Diameter (km)	Rank	Water depth (m) Max.	Average	Origin of formation	Brackish / Freshwater
Saloma	151.9	3	87	6	28.8	6.7	Inland sea	Brackish
Kussharo	79.3	6	57	8	117.8	28.4	Caldera	Freshwater
Shikotsu	78.4	8	40	15	363.2	265.4	Caldera	Freshwater
Inawashiro	103.3	4	50	9	94.6	57.5	Tectonic	Freshwater
Kasumigaura	167.6	2	120	2	7.8	3.4	Inland sea	Freshwater
Biwa	670.3	1	241	1	103.6	41.2	Tectonic	Freshwater
Nakaumi	86.2	5	105	4	8.4	5.4	Inland sea	Brackish
Shinji	79.1	7	47	11	6.0	4.5	Inland sea	Brackish

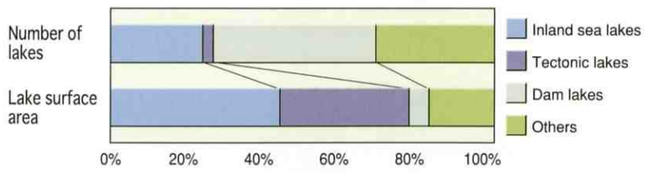
※**Types of lake formation**

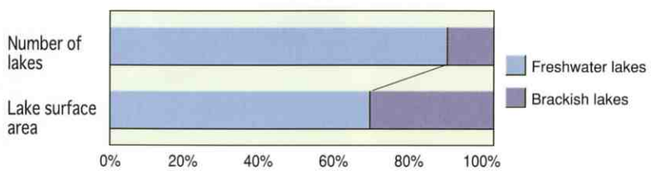
〈**Tectonic lake**〉 formed by tectonic activity
〈**Inland sea lake**〉 formed by the enclosure of sea areas by, for example, sand banks
〈**Dam lake**〉 formed by construction of dams

【Inland Sea Lakes and Brackish Lakes】

Lakes are formed in various ways. In Japan, approximately 40% of natural lakes are dam lakes and approximately 20% are inland sea lakes. However, 40% of the total lake surface area in Japan is contributed by inland sea lakes such as Lake Saloma, Lake Kasumigaura, Lake Nakaumi and Lake Shinji, due to their large surface area.
Although, brackish lakes constitute only 10% of the natural lakes in Japan, their total surface area represents approximately 30% of the total surface area of Japanese lakes. This is partly due to the existence of some large brackish lakes.

■ **Ratio of natural lakes and ratio of freshwater and brackish lakes in Japan** [6,7]





2 Topography of the Hii River Catchment Area

Topography and Geography of Hii River Catchment Area

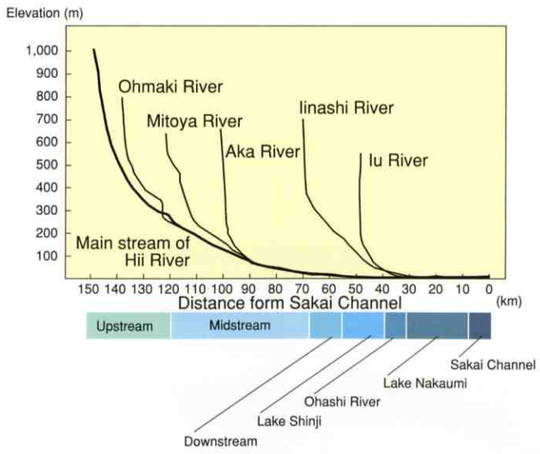
Hii River originates from Mount Sentsu (1,143m), which lies between the boundary between Shimane and Totori Prefecture. The river runs northward combing with several side streams, and when it reaches the Izumo Plain, changes its direction eastwards, flowing into Shinji Lake and then Nakaumi Lake. The river is finally discharged into the Sea of Japan through the Sakai channel.
The catchment area of Hii River is 2,070km² (29th in Japan) and the length of the main stream is 153 km (19th in Japan). The catchment area can be segmented into 3 areas, the main stream area down to Lake Shinji, Lake Shinji area, and Lake Nakaumi area.

Topographic Characteristics of Hii River

【Steep River】

Hii River runs along a steep slope and the gradient of the river basin is 1/500 – 1/750 at the midstream section and flattens to 1/1000 at the Izumo Plain.

■ Vertical transection of Hii River



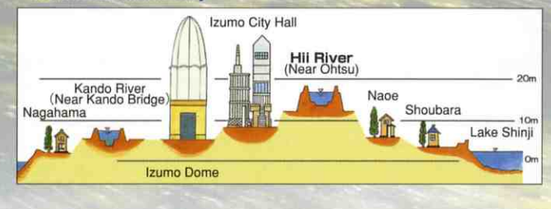
【Hii River, a Unique River in Japan】

The upstream area of Hii River is surrounded by fragile granite. The decomposed granite soil flows into the river. High quality iron sand can be extracted from these granite soil, thus ironworks have been popular in this region, resulting in huge amounts of sediment accumulation over the years.
These sediments formed net like sand banks and so formed the Izumo Plain.

【Elevated Riverbed】

The large amount of sediments carried by Hii River formed the Izumo Plain. When excessive sediments accumulated along the river basin, flooding incidents increased. The river banks were raised to counter flooding but this induced further sedimentation. This cycle led to Hii River having a distinctive elevated riverbed.

■ Elevation of the Hii River riverbed relative to ground level near Izumo City



●Net like sand banks formed by Hii River (Izumo City)

●Confluence with Kuno River (Kisuki Town)

●Upstream of Hii River - Oni-no-shita-burui (Nita Town)

●Origin of Hii River - Mount Sentsu (Yokota Town)

Topography of Lake Nakumi and Lake Shinji

Lake Nakumi and Lake Shinji, both located downstream of the Hii River system, are major brackish lakes of Japan. Both lakes were once part of the Sea of Japan.
The surface area of Lake Shinji is 79.1 km² (7th in Japan) and the diameter is 47 km (11th in Japan). Water from Lake Shinji flows into Lake Nakaumi through Ohashi River and also flows directly out into the Sea of Japan through Sada Canal, which was built during Edo period. The surface area of Lake Nakaumi is 86.2 km² (5th in Japan) and the diameter is 105 km (4th in Japan). It is connected to the Sea of Japan through Sakai Channel.

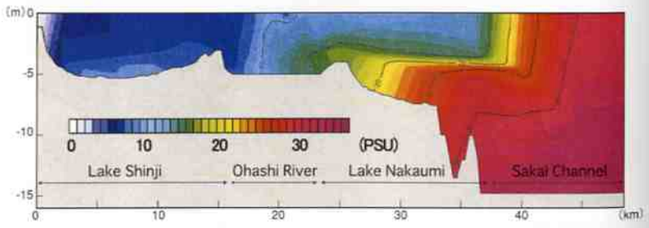
●Mouth of Hii River Sakai Channel
(Sakaiminato City & Mihonoseki Town)

●Ohashi River, which connects Lake Shinji and Lake Nakaumi
(Matsue City)

【Lake Nakaumi and Lake Shinji, Inter-connected Brackish Lakes】

Lake Nakaumi and Lake Shinji are brackish lakes inter-connected by Ohashi River. These two lakes have different salinity levels.
Salt water flows into Lake Nakaumi through Sakai Channel, and occupies the lower layer. Therefore, in Lake Nakaumi the salinity is approximately half that of seawater in average. The salinity of Shinji Lake depends on the freshwater inflow from Hii River, but is generally 1/10 that of seawater.
In these brackish environments, salt water, freshwater and brackish water species coexist. Also, due to variations in salinity, the fish fauna composition differs according to the lake area. Seasonal migration of fish is also observed in these lakes.

■ Salinity distribution



Observed on 30 Sep. 2000

【Inefficient Flushing and Surrounding Lowlands】

The difference in water level between Lake Nakaumi and Lake Shinji and the level of the Sea of Japan is very small. Also, the width of Ohashi River, which connects Lake Nakaumi and Lake Shinji, has narrowed over the years. Due to these factors, flushing is inefficient during floods especially in Lake Shinji and consequently the surrounding lowland areas of Matsue City and Izumo Plain have become prone to flooding.

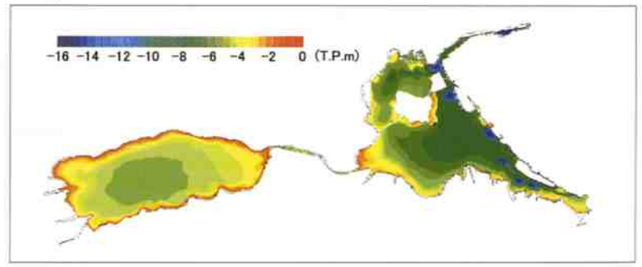
●Yonago Bay inside Lake Nakaumi and the adjacent Yonago City

●Hii River flows into Lake Shinji (Hirata City)

【Shallow Lakes with Large Surface Areas】

Lake Shinji has a large surface area but is very shallow and has a smooth bottom topography. Lake Nakaumi is also a shallow lake with a large surface area. The bottom slowly deepens from Ohashi River to Yumigahama Peninsula.

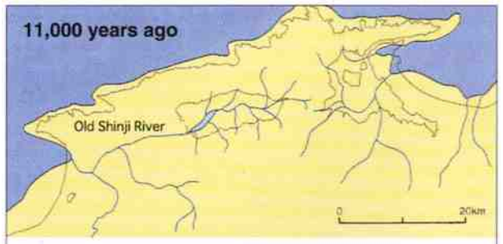
■ Depth of lake bottom



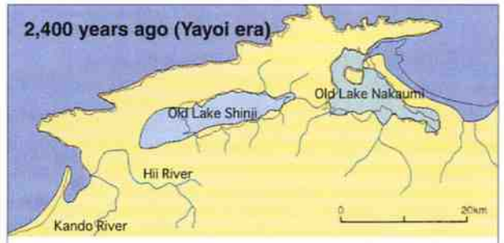
3 Transition of Hii River Catchment Area

Transition of Hii River Downstream Area, Lake Nakaumi and Lake Shinji [8]

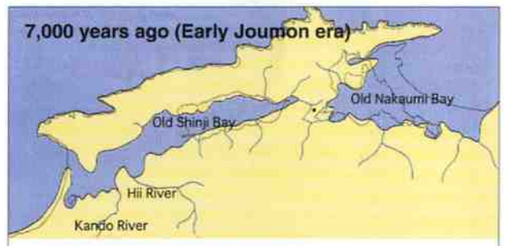
Land area　Sea area　Brackish area　Freshwater area　Present shoreline



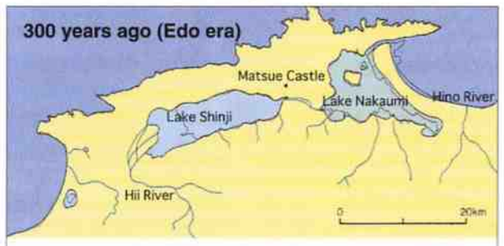
The sea level started to rise following the rise in global temperature and sea water intruded into the Sakaiminato area in the eastern region and Taisha Bay in the western region. A small freshwater body existed in the Lake Shinji area.



The sea level decreased slightly. Yumigahama sand bank appeared and Nakaumi Bay became a brackish lagoon. Sediments started to accumulate in Kandono-mizuumi from the sediments discharged from Hii River and Kando River.



The sea level continued to rise and Shinji Bay was formed in the western region extending from Taisha Bay to Matsue. Nakaumi Bay was formed in the eastern region.



Sediment started to accumulate in the Hii River riverbed and the floods of 1630's caused the river to diverge eastward towards Lake Shinji, consequently turning the lake into freshwater. The size of Yumigahama increased due to sediment from Hino River and Lake Nakaumi was formed.

Shinji Bay was separated from the sea due to sediment deposition from Hii River, and old Lake Shinji was formed. In Nakaumi Bay a sand bank was gradually being formed in the present Yumigahama area. In the mouth of Hii River and Kando River the foundation of "Kandono-mizuumi" was gradually being formed.

Sediments deposited by Hii River further accumulated on the west side of Lake Shinji, consequently expanding the area of Izumo Plain. The canalization of Sada River and dredging of Ohashi River turned Lake Shinji into a low salinity brackish lake.

Izumo Plain Created by Hii River

【Divergence of Hii River】

Before the 17th century, Hii River was a westward flowing river, flowing into Taisha Bay via Kandono-mizuumi (now called Lake Jinzai). The vast amount of sediment discharged by Hii River formed the vast Izumo Plain.
The discharged sediment from Hii River raised the riverbed, and the floods in 1630's altered the flow direction of Hii River from westward to eastward, leading the river into Lake Shinji.

■ Old illustration of Hii River when it flowed westward

In Shimane Prefectural Library

【Divergence of the Hii River Course and Development of New Rice Fields】

Since the discharged sediment from Hii River raised the riverbed and caused frequent flooding, the river course was artificially diverted at 40 to 60 year intervals. Reclamation works were conducted in Lake Shinji utilizing the sediments from Hii River and the reclaimed land was turned into new rice fields.
In 1832, a new river called Shin River was created south of Izumo Plain but the river was eventually closed after approximately 100 years because over 10 million m^3 of sediment accumulated in this river during the period upto 1939.
Currently, no steelworks operate along the Hii River catchment area, and sediment deposition has decreased as a consequence.

Era	Lines of lake shore	Past river course
Around 1635		
Around 1687		
Around 1723		
Around 1785		
Around 1809		
Around 1832		

■ Divergence of the river course

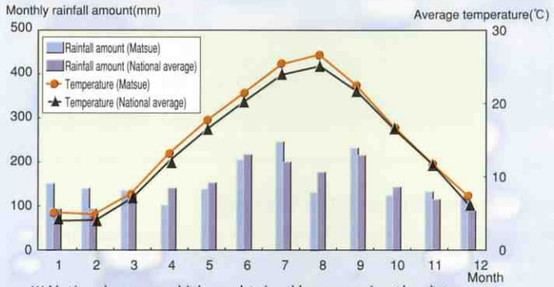
4 Climate and Hydrology of Hii River Catchment Area

Climate of Hii River Catchment Area

【Temperature and Rainfall】

The annual average temperature in Matsue is approximately 15 ℃. The coldest month is in February with an average temperature of 5 ℃, and the warmest month is in August with an average temperature of 27 ℃. Compared to the average temperature of Japan, the temperature is 1 to 2 ℃ higher throughout the year.
The average rainfall is 1,800 mm and is slightly higher than the national average rainfall of 1,700 mm. Most of the rainfall comes in the winter snow season and summer rain season.

■ **Temperature and rainfall** [1]

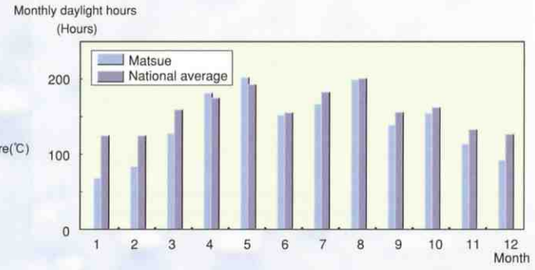


※ National average: Values obtained by averaging the data of all the meteorological observatories in Japan

【Daylight Hours】

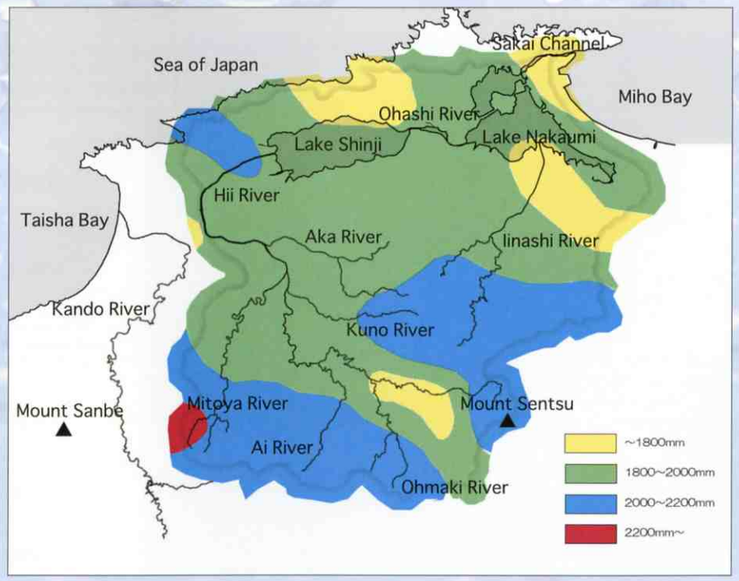
Compared to the average daylight hours of Japan, the monthly daylight hours in Matsue are slightly less in the winter season but similar in other seasons.

■ **Daylight hours** [1]



【Rainfall Distribution in the Catchment Area 9】

The annual rainfall is 1,800 to 2,000 mm in the plain area and 2,000 to 2,200 mm in the mountain area.

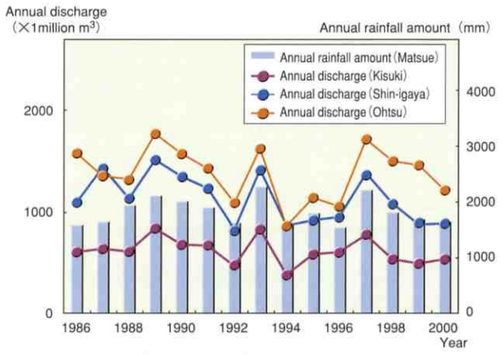


Hydrology of Hii River System

【Annual Discharge and Rainfall Amount】

Annual discharge of Hii River system shows large yearly fluctuations. According to the measurements at Ohtsu Discharge Observatory, the annual discharge varies between 1 to 2 billion m³ and averages to approximately 1.4 billion m³.
The discharge is heavily influenced by the rainfall and the fluctuation of discharge usually follows the rainfall pattern.

■ **Annual discharge and rainfall amount**



【Infiltration Water】

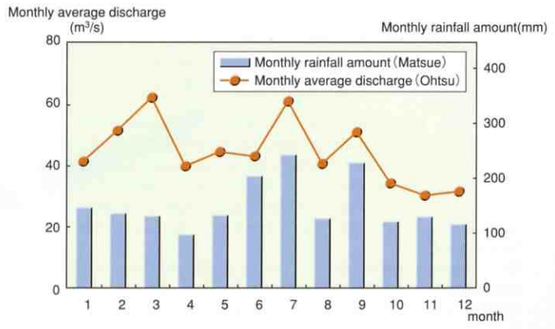
Major discharge observatories in the Hii River system are Kisuki, Shin-igaya and Ohtsu in upstream order.
In some years, the discharge in Shin-igaya is greater than in Ohtsu Observatory, which is located farther downstream. This occurs due to the elevated riverbed between the upstream section of Ohtsu and the river mouth, and vast amounts of water infiltrate into the subsoil.
In order to secure irrigation water, headraces and drains were built.

●Elevated riverbed of Hii River (Near Izumo City and Hikawa Town)

【Seasonal Fluctuation of Discharge and Rainfall】

Monthly rainfall reaches a peak in the June, July rainy season and reaches a second peak in the September typhoon season. A small peak is observed in the January snow season as well.
Although the monthly discharge mostly follows the rainfall pattern, the peak discharge is observed during March despite scarce rainfall during this period. This is due to the snowmelt water from the mountain ranges.

■ **Monthly discharge and rainfall**



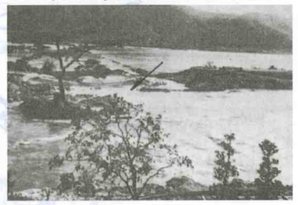
5 Prevention of Floods

History of Floods & Why They Happened

【Frequent Flood】

The first record of flooding in Hii River can be found in the 8th century literature. In modern records, many references to this flooding (usually at four-year intervals) are to be found. After the Meiji period, many catastrophic floods are reported to have been caused by powerful typhoons and seasonal rain fronts.

●Collapse of Agu levee in Hikawa Town, 1945



●Disaster in Kamo Town, 1964

【Why So Many Floods?】

The main causes of such frequent flood are considered to be:

- ●The elevated riverbed resulting from the large inflow of sediments from Hii River
- ●Lake Shinji and Nakaumi, which are on almost the same water level as the Sea of Japan, are situated on the lower Hii River

●Disaster in Matsue City, 1972

●Disaster in Hikawa Town, 1972

■ **Floods in Hii River**

Year	Events
1635	Flood. Water from Hii River overflows to Lake Shinji
1639	Flood. Levee collapsed and river redirected eastward
1674	Flood. Matsue city submerged (229 deaths, 1,450 households lost)
1702	Flood. Levee collapsed and town submerged (50 deaths, 4,157 households lost)
1722	Flood (54 deaths、928 households lost)
1826	Flood. Many levee collapsed, Kisuki Town disaster (130 deaths, many households collapse)
1873	Flood due to typhoon (80-deaths, Approx. 470 households lost, 4,000 households submerged)
1893	Flood due to typhoon, many levees collapse, Matsue City submerged to a depth of 3 m (54 deaths, 288 households lost, 19,133 households submerged)
1943	Flood due to typhoon, many levee collapsed, Lake Shinji flooded and Yomegashima submerged (6 deaths, 1,463 households lost)
1945	Flood due to typhoon, main river levee collapsed (4 deaths, 11 households lost, 580 households submerged)
1964	Flood from stationary rain front, all households submerged in the center of Kamo Town, approx. 11,000 households submerged in Izumo plain
1972	Flood from stationary rain front, approx. 70 km² submerged for more than a week in Matsue City (11 deaths, approx. 24,000 households submerged)

The History of Hii River is a History of Attempts to Prevent Flooding

【Flood Control in Modern Times (17th - Early 19th Century)】

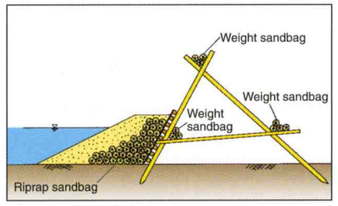
Flood control activity in Hii River started with the construction of a river levee in the beginning of the 17th century. The flood of 1639 made Hii River change its direction to flow eastward to Lake Shinji.
After this redirection of the river, repetitive "Kawa-tagae" (divergence of the river course) were tried at the river mouth. As areas along the Lake Shinji such as Matsue castle town faced serious submergence, Sada River was excavated in 1787 to discharge the lake water to the Sea of Japan. However, it failed to eliminate enough lake water to resolve the problem fundamentally.
Shin River, a branch canal flowing westward from Hii River, was excavated in 1832. However, due to gradual build-up of sediments, the canal was abandoned in 1939.

●Sada River, excavated to discharge water of Lake Shinji (Matsue City)

【Izumo Yui】

As Hii River is formed mainly by sand, a unique construction method called "Izumo yui" was applied for flood prevention. This method works by attaching tree branches or bamboos onto supporting pillars. The transported bottom sediments are trapped and accumulated by these structures. Eventually a temporary levee will be formed and will provide protection against the next flood.

■ **Structure of Izumo yui**



●Izumo yui during flood,1934

Source: Hikawa Town Gov.

【Flood Control in Modern Times (Late 19th Century - Present)】

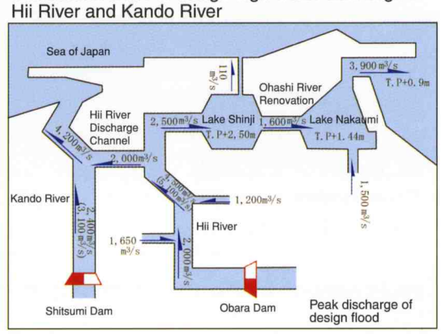
Flood control projects in late modern times began in 1922, when the main Hii River was re-excavated. Concurrently, to prevent a water level increase in Lake Shinji, dredging activity in Ohashi River started.
Later bank terracing was implemented downstream to reduce sediment and take measures against leaks. Levees were constructed for Lake Shinji and Lake Nakaumi.

Three Key Flood Control Projects

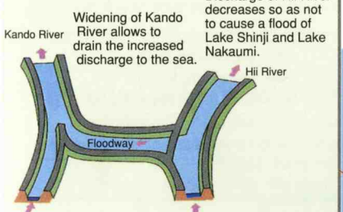
Even after the re-excavations made after 1922, there were still some floods that could not be prevented from 1940's to 1970's. In 1976, as a radical flood control strategy for Hii River and Kando River, the construction plan was revised. The revised plan integrates flood control strategies for both rivers, and includes 3 key projects to be executed, which are;

- ● Construction of dams at the upstream areas of both rivers (Obara Dam & Shitsumi Dam)
- ● Construction of a discharge channel at the midstream of Hii River, and renovation of Hii River
- ● Renovation of Ohashi River, and development of levees at Lake Nakaumi and Lake Shinji.

Distribution chart of design high water discharge in Hii River and Kando River

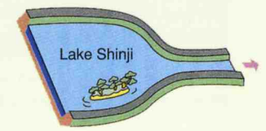


《Hii River Discharge Channel Project》

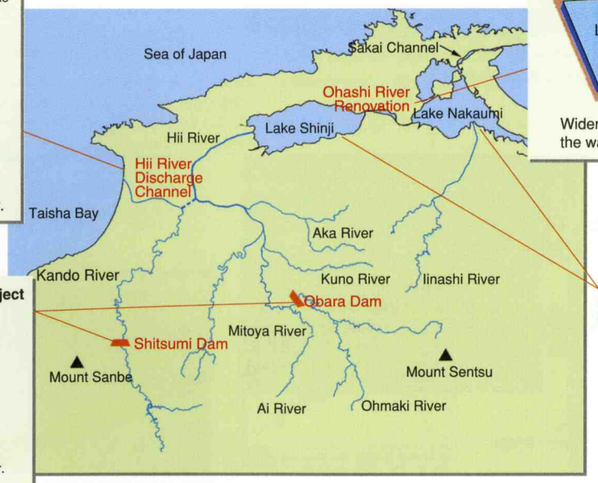


The floodway diverts part of flood water from Hii River to Kando River.

《Ohashi River Renovation Project》



Widening of Ohashi River decreases the water level of Lake Shinji.



Development of levee at Lake Nakaumi and Lake Shinji

《Flood Control Dam Construction Project (Obara Dam & Shitsumi Dam)》

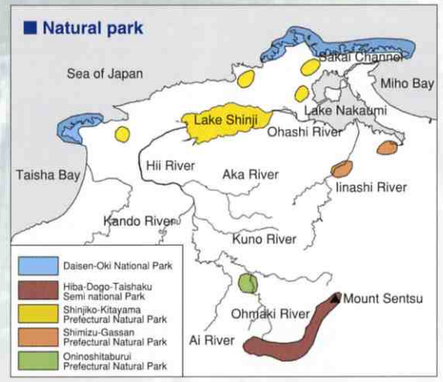
Dams reserve part of flood water.

Decreased flood water flows downstream.

6 Environment of Hii River Basin

Rich Environment in Hii River

The water that flows from Hii River has created a diverse and unique water environment and a plentiful and diverse natural environment along the Hii River.
Hiba Dougo Taishaku National Park is situated at Mt. Sentsu near the headstream of Hii River. Also, "Shinjiko Kitayama" near Lake Shinji, and other areas are designated as Natural Parks by the Prefecture.



Environment in the Upstream of Hii River

【Nature fostered by Bounteous Waters and Forests】

Natural vegetation of beech trees is found in the mountainous area at the headstream of Hii River. Boars, Japanese monkeys, and Himalayan black bears can be seen in this area. In the mountain streams, the giant salamander, a nationally designated protected species, can be found.

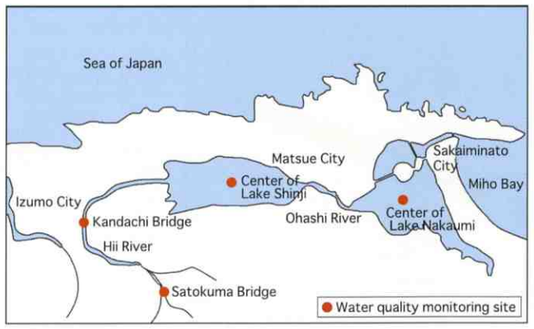
●Japanese monkey

●Giant salamander

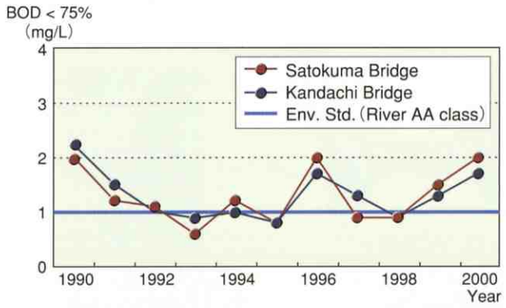
Environment along the Midstream of Hii River

【Rich Natural Environment along the River】

Hii River initially flows through the secondary forests in the mountain ranges, then turns eastwards at the vast rice field of Izumo Plain, and finally flows into Lake Shinji promoting natural sand banks and reed vegetation. Animals typically seen in this area are raccoons and foxes. In the river, there are some precious fishes such as the head-spotted char, reddish bullhead, and Japanese sculpin.



■ Water quality of the mainstream of Hii River (BOD)



●Head-spotted char

●Reddish bullhead

【Sanctuary for Birds】

Many birds are found in the sand banks and ditch reed vegetation at the river mouth in Lake Shinji, and in the rice fields along the river. This area is the only place in western Japan where the white-fronted goose and bean goose, both designated protected birds of Japan, land in groups. Also it is the southernmost wintering spot for the tundra swan. Sand banks provide feeding places for snipe, and the reedy vegetation along the lake is used as a breeding ground by the Great Reed Warbler.

●White-fronted goose

●Bean goose

●Tundra swan

●Great reed warbler

Natural Environment around Lake Shinji and Lake Nakaumi

【Diversified Fishes from Brackish Environment】

A variety of fishes such as the common brackish goby and Lake Shinji goby, which are typical fishes found in brackish waters, mullet, and gizzard-shad, both of which are sea water species, and carp and crucian carp, both of which are freshwater species, are found in Lake Shinji and Lake Nakaumi.
Yamato clam is a typical resource in Lake Shinji. The salinity in the lake is said to be providing a suitable environment for the clams and bringing large clam harvests.

●Lake Shinji goby

●Icefish

【 Largest Migration Spot for Waterfowls】

Lake Shinji and Lake Nakaumi provide one of the largest areas of land to which waterfowls migrate. Approximately 100 thousand birds inhabit this region, composed of mainly wild geese and ducks. Tufled Duck, which feeds on Yamato clams, is found in Lake Shinji. Scaup and Pochard, which feed on Asian mussels, are found in Lake Nakaumi.

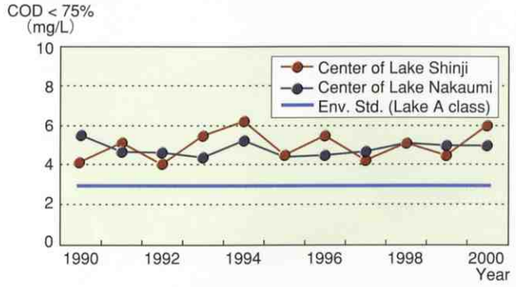
●Yamato clam

●Tufled duck

【Pollution in Lake Nakaumi & Lake Shinji】

In Lake Nakaumi and Lake Shinji, eutrophication is causing serious environmental problems. Occasional "water-bloom" and "red tide" caused by excessive growth of phytoplankton are observed.
Water quality in these lakes does not meet the environmental standards; its COD has constantly been at 4-6mg/L levels for the past 10 years, and requires the improvement of aquatic ecosystem.

■ Water quality of Lake Shinji and Lake Nakaumi (COD)



●Water-bloom in Lake Shinji

●Red tide in Lake Nakaumi

7 Bounteous Waters and People's Lives

Ancient Civilization of Izumo Arose from Hii River

In the ancient times, the area centered on the Hii River basin was called "Izumo". It is said that the civilization established around the area played a central role both politically and culturally. Izumo is also known as a place from which many myths have been derived, as seen in "Records of Ancient Matters", "Chronicles of Japan" and "Izumo no Kuni Fudoki" compiled in the Nara period (710-784 A.D.).

[Hii River in Ancient Times]

According to "Records of Ancient Matters" and "Chronicles of Japan", Hii River was once called "Hi no kawa", and surfaces in many myths. According to "Izumo no Kuni Fudoki", people lived by agriculture and fishery, and steel was produced in the mountains.

●Dance expressing a myth

[Myths Surrounding Hii River]

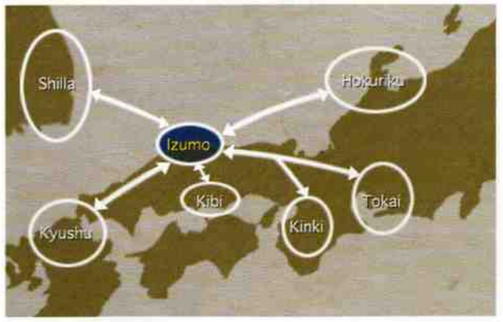
A lot of myths often reflect what actually happened in the natural environment.
In the myth of "Kuni Biki" (country towing) in the "Izumo no Kuni Fudoki", the present Shimane Peninsula was said to have been formed by pulling and binding four neighboring regions such as the Koshi (Hokuriku) region in Japan and the Shilla region in Korea. This myth parallels the process how Shimane Peninsula was formed from the sediment carried by Hii River and Hino River.
Also, Hii River is often described as a giant serpent "Yamata no Orochi" (Eight-headed Giant Serpent), which made people suffer from frequent floods.

■ Myth of Kuni Biki [10]

[Trade in Ancient Times & Transportation Routes]

The story of "Kuni Biki" implies that there was some trade between the neighboring countries around the Sea of Japan. Earthenware from Northern Kyushu, Kibi (Okayama), Hokuriku, Kinki, and Tokai regions were also found in Izumo, and this indicates the extent of the interaction.
During this period, a transportation channel was developed to connect the capital and the urban areas, and "Watashi" (gap bridge) was seen in Hii River, Kando River and Ohashi River.

■ Exchange with other civilizations [10]



●Hii River meandering through sand banks that look like scales of a giant serpent (Izumo City and Hikawa Town)

Gift from Water, Soil and Fire "Tatara" Steel Industry

Chugoku district achieved a high level of steel production during the 18th and 19th centuries with its "Tatara" steel technology, which produces steel by refining sand iron. "Tatara" steel production was recorded in "Izumo no Kuni Fudoki" as the key industry in the upstream region of Hii River, however it disappeared after the rise of the modern steel manufacturing method in the mid-20th century.

●Tatara steel production

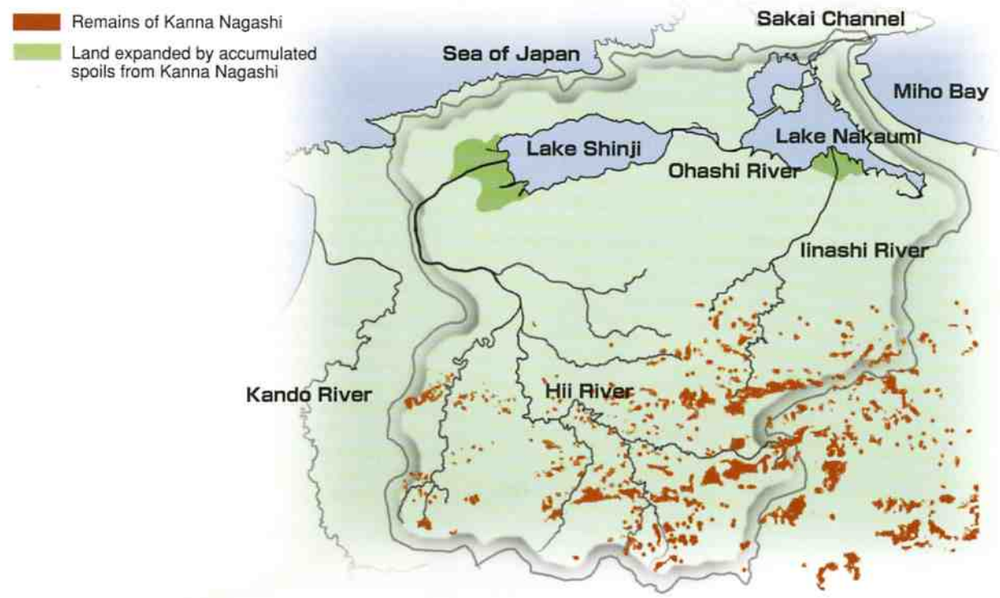
Photo presented by Nihon Bijutsu Token Hozon Kyokai

[Kanna Nagashi]

The iron sand used for the "Tatara" steel production was collected by throwing the scraped surface from the mountains into the river to separate the high-density sand iron. This process was called "Kanna Nagashi", and generated a great amount of sediment accumulation in the channels and lower parts of Hii river.

●Kanna Nagashi

■ Remains of Kanna Nagashi in Hii River basin and land expanded by accumulated sediment [9]

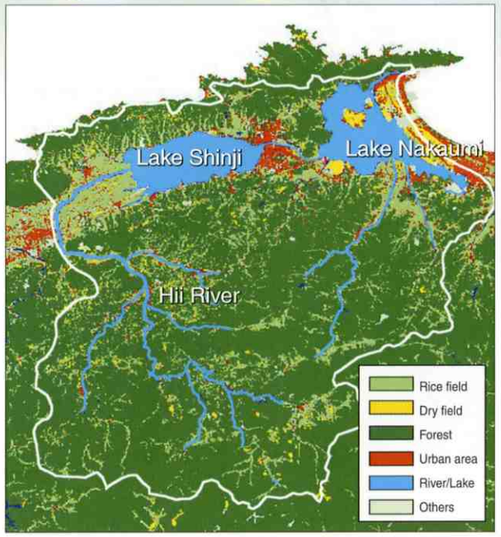


Outlook of the Region

【Changes in Land Use】

Agricultural lands and urban areas occupy the lower watershed of Hii River, where various human activities take place. The upstream area is mountainous and widely covered with the forest.

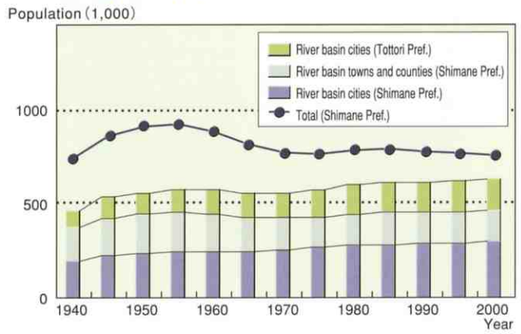
■ **Changes in land use**



【Population】

In 2000, the population in Hii River basin area, including the population in Tottori Prefecture (Yonago City and Sakaiminato City), was approximately 630 thousand, and has shown constant growth in recent years. Of these people, 460 thousand were from Shimane Prefecture, mostly living in the plains that Hii River created, and comprised about 60% of the total population of Shimane Prefecture.
The total population of Shimane Prefecture is decreasing due to the constant decline in the population in towns in the mountains.
On top of the population decline, the significant aging of society in the mountainous area is posing a serious social concern.

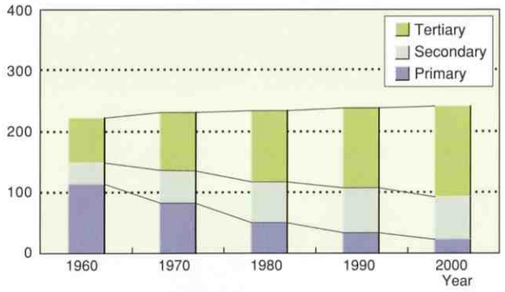
■ **Changes in population** [11]



【Industry】

Hii River basin has evolved as a center of industry in Shimane Prefecture, and its agricultural production, industrial shipments and sales comprise 60-70% of that of the total prefecture.
More than 60% of the population is dedicated to tertiary industry, such as trading. The labor force in the primary sector, mainly agriculture and fisheries, flourished on the resources brought by Hii River. It was once in the majority, but has since declined to about 10% of the population.
Rice cultivation, fisheries, "Tatara" steel making, and shipping, all of which are deeply connected to Hii River, have been the typical industries in the modern times. Today, fishing, steel manufacturing, tourism, and wholesale trading are the major industries of the Hii River basin.

■ **Changes in population by industrial sector** [11]



■ **Major industries and productions in Hii River basin**

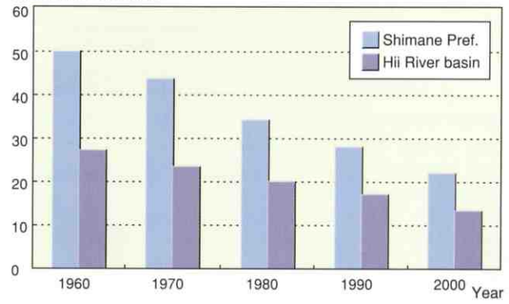
Sector	17th - early 19th Century	Late 19th - Present	Present
Primary	Rice cultivation, Cotton cultivation, Fisheries	Rice cultivation, Silk culture, Beef cattle breeding, Fisheries	Rice cultivation, Fisheries, Yamato clam harvesting , Fish processing
Secondary	"Tatara" steel making, Izumo Washi paper making	"Tatara" steel making, Silk reeling, Unshu abacas production	Molybdenite and steel production, Electronic parts, Textiles
Tertiary	Shipping	Shipping	Tourism, Wholesale trading

Predecessors' Wisdom in Agricultural Development

【Rice Field Development and Flood Control】

Development of new rice fields in Izumo region began in the 17th century from the delta plain along Hii River and Kando River. In Hii River, "Kawa-tagae", a re-directing of the river course, was conducted to prevent flooding. Also, alluvial sediment was utilized to reclaim Lake Shinji, which was turned into new fields and became the leading granary of the region.
However, due to excessive production, land use for rice field has been diminishing since 1970's and is changing over to roads and housing.

■ **Area of wet paddy rice field** [11]



●Rice fields downstream of Hii River

[Namazu no O (Catfish tail)]

Even in the dry season when there is no surface water, some water can be acquired by digging a water channel at around several tens cm depth along the levee to utilize sub soil water.

●Namazu no O (Izumo City)

【Wisdom and Methods for Agricultural Water Intake】

As Hii River is an elevated river, the majority of the water runs subsoil. Sometimes in the dry season, there is almost no surface water to be seen in the river. Even though maintaining the necessary water intake is the key issue for rice cultivation in this region, it was difficult to build a common intake gate, as that would have led to the collapse of the river levee, which was primarily comprised of sand. Much effort has gone into establishing a method to provide enough water for the rice fields and also prevent the river from flooding.

●Mizuyose (Hikawa Town)

[Mizuyose (Water collecting)]

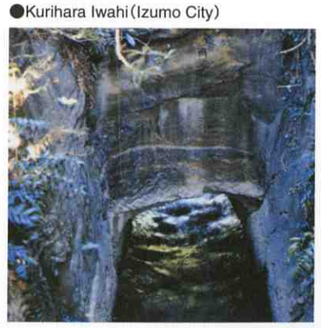
Constructing gutters or mounting the bottom sediment helps to increase the intake from the river. These methods are called "Mizuyose".

【Land Development Using the Water from Hii River】

In late 17th century, Shichibei Ohkaji excavated a canal called Kurihara Takasegawa to exploit the barren land of Arakihama and open the area to agriculture and transportation.
The water intake facility on Hii River called "Kurihara Iwahi" was made of a large rock gouged out in such a manner that it would not cause the levee to collapse.

●Shichibei Ohkaji and Takasegawa (Izumo City)

●Kurihara Iwahi (Izumo City)

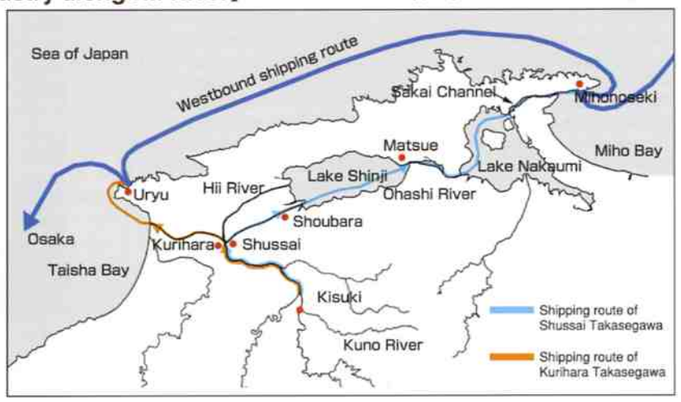


Transporting the Bounty of Hii River

【Development of a Shipping Industry along Hii River】

In medieval times, shipping transportation via the tranquil waters of Lake Nakaumi and Lake Shinji was highly developed.
The transportation of goods produced in southern Izumo, such as rice and steel, contributed much to the development of a shipping industry along Hii River. Shipping on Hii River started with the loading of the goods upstream, typically in a Takasebune, then transferring the load to a mid-sized sailboat at Shoubara situated at the mouth of the river. Via Lake Shinji, cargoes were unloaded at Matsue, then shipped to Osaka in greater bulk. After the completion of the Kurihara Takasegawa, the shipping route via Port Uryu to Osaka was also used.

■ Shipping routes of Hii River system



【What is a "Kitamae-sen"?】

Marine products, timbers, and rice from Hokkaido, Tohoku and Hokuriku regions were transported via the westbound shipping route exploited in modern times which also carried bags of rice paid as rent. Also taking the westbound route, "Kitamae-sen" frequently transported salt, sugar, soy sauce, cotton, steel and rice from Osaka to ports all over Japan and vice versa.
In Izumo region, Kitamae-sen is known to have anchored at ports at Mihonoseki and Uryu not only to wait for the wind but also to trade steel and cotton made in Izumo.

●Miniture model of a "Kitamae-sen"

In Michinoku Hoppo Gyosen Museum

【Shipping in Modern Times】

In modern times, before railroads and roadways were in place, transportation along Hii River played an important part in the transporting of goods from upstream to Matsue and back.
Later, when steamboats were introduced in Lake Nakaumi and Lake Shinji, many passengers traveled on the regular lines that were in service between Matsue and Yonago, and between Matsue and Shoubara/Hirata. The new waterways and seaways to Osaka and Maizuru then became the major transportation routes until the San-in railroad line was completed. Presently, Lake Nakaumi holds Matsue and Yonago ports, mainly dealing with shipments of industrial goods and their raw materials.

●A small harbor remaining the old atmosphere (Matsue City)

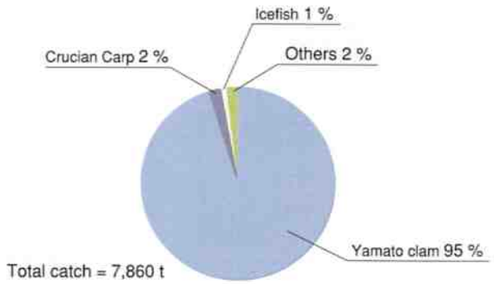
●Yada-no-watashi (ferry) at present (Ohashi River, Matsue City)

Fisheries

【Yamato Clams in Lake Shinji】

Lake Shinji has highly productive fisheries. The total catch in Lake Shinji in the year 2000 was 7,900 tons, the highest among the lakes of Japan. 95% of this catch (7,500 tons) comprises the harvest of Yamato clams, and also ranks the highest in Japan (about 40% of the total Yamato clam harvest in Japan).
Apart from Yamato clams, icefish, crucian carp, carp, and eel are caught. Carp and icefish can be found cooked in "Shinji ko Shicchin" (7 delicacies of Lake Shinji), a local specialty menu.

■ Catch in Lake Shinji by fish type (2000) [11]



【Transition of Yamato Clam Catches】

In the 1950s, Yamato clam catches were only about 100 to 200 tons. After the introduction of powered vessels and mechanized fishing in the 1960s, the catch increased and reached 19,000 tons in 1973. Later, as there were signs of a decline in the fish resources, fishermen voluntarily started to control their catches. In spite of their efforts, the resources still appear to be decreasing.

■ Yamato clam harvesting in Lake Shinji

■ Harvest of Yamato clams in Lake Shinji [11]

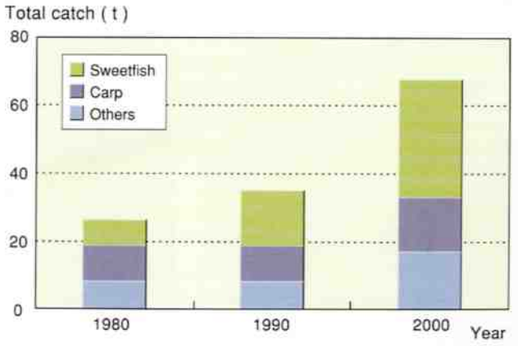
【Fisheries in Nakaumi】

In Lake Nakaumi, saltwater scads, black porgy, flatfish, freshwater carp, crucian carp, and eel are found. In the past, ark shell was also found abundantly, however the total catch has decreased to 1/5 of its peak, and after 1975 ark shell has not been found in Nakaumi.

【Fishing in Mainstream of Hii River】

Fish catches in the Hii River are relatively small compared to other rivers in the prefecture. Main catches are sweetfish and carp, and the catch has been increasing in recent years.

■ Catches from Hii River [11]



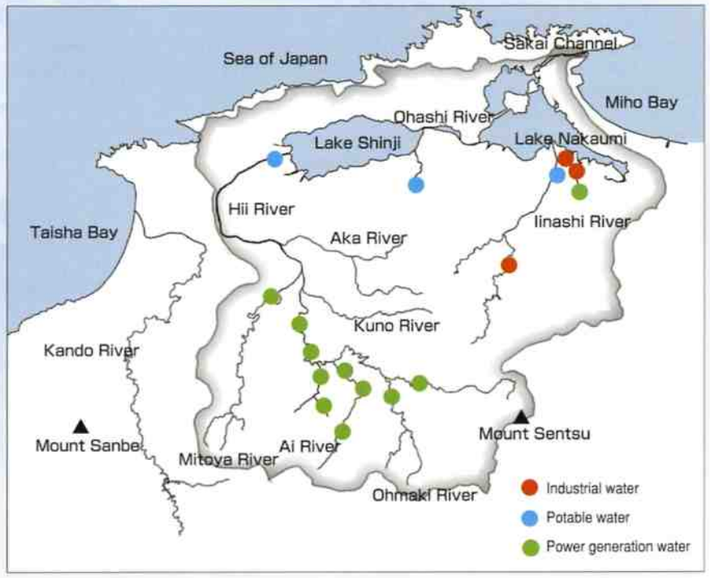
Plentiful Water Resources

【Status of Water Utilization】

Water from Hii River is used for agriculture, water supply systems, industry, and power generation. Agriculture uses the largest amount of water, followed by power generation.

- **Water for Agricultural Use**
  Approximately 70% of the rice fields in Hii River basin are irrigated using water from Hii River. The largest irrigated area is located east of Izumo Plain, where a large amount of water is used for agriculture.
- **Water for Water Supply Systems**
  There are 3 intakes to supply enough water to cities mainly in the plain, such as Matsue, Yasugi, and Hirata Cities.
- **Water for Industrial Use**
  There are also 3 water intakes, mainly supplying the area near the new industrial area located on the coast of Lake Nakaumi.
- **Water for Power Generation**
  There are 14 hydraulic plants along Hii River, generating the maximum of 55,000 kwh.

■ Location of the water intake [9]



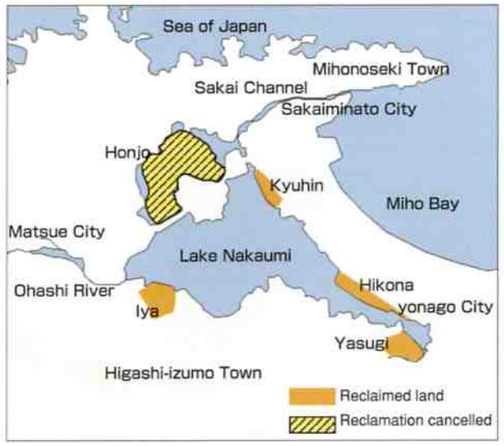
Cancellation of Reclamation/Desalination Project for Lake Nakaumi & Lake Shinji

The Reclamation/Desalination Project for Lake Nakaumi & Lake Shinji was planned in the 1950s to secure land and water for agricultural development.
However, due to changes in socio-economic status and some concern over water quality degradation from desalination activity, the reclamation project was ceased in 2000, and the desalination project was ceased in 2002.

■ Chronological table of Reclamation/Desalination Project for Lake Nakaumi & Lake Shinji

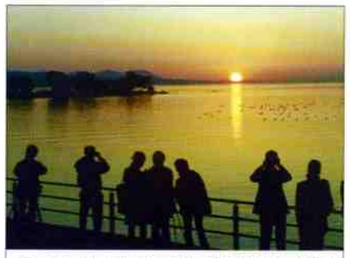
Year	Events
1953	Development plan formulated by Shimane Pref.
1963	Project launched
1969	Policy to cut rice acreage announced by gov't
1988	Reclamation of Honjo area and Desalination postponed
1989	Reclamation completed at Iya, Yasugi, Kyuhin areas
1992	Reclamation completed at Hikona area
2000	Reclamation at Honjo area cancelled
2002	Desalination project cancelled

■ Reclamation site in Lake Nakaumi



Diverse Scenery and Culture

The Hii River is surrounded by beautiful views that reflect the changes in season. There are also many historic and cultural sights along the river.

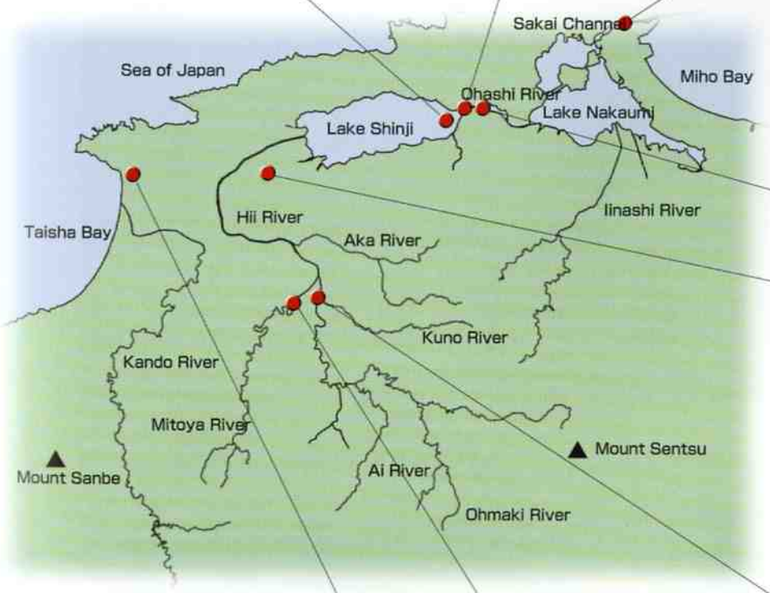


Yomegashima in light evening (Matsue City)
Sun setting on Lake Shinji.
One of 8 symbolic scenes in Lake Shinji waterfront area

Waterfront with Shimane Art Museum (Matsue City)
Built next to the reverted shore and a promenade for comfort.

Fish market in Sakaiminato
A leading fishing center by the Sea of Japan

"Horan-Enya"(MatsueCity)
One of the 3 major ship festivals held once every 12 years.



Tuiji Pine Tree on Izumo Plain (Hikawa Town)
Fence made from pine trees to provide a barrier against winds from the northwest. Topiary type is unique to the Izumo Plain.

Izumo Shrine(Taisha Town)
Dedicated to the spirit of marriage, with a large shrine pavilion

Mitoya Sakura Dote(Mitoya Town)
Famous for cherry trees with green petals.

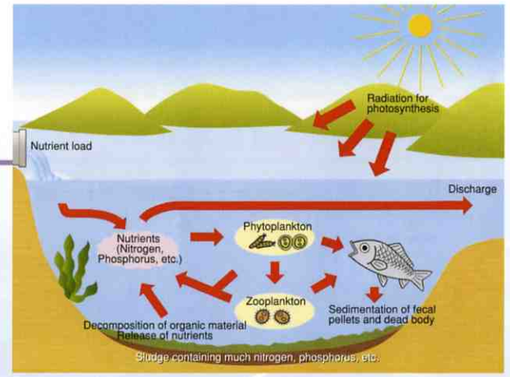
Kisuki Sakura Dote (Kisuki Town)
2km tunnel of cherry trees

8 Conserving the Water Quality

Water Quality Conservation

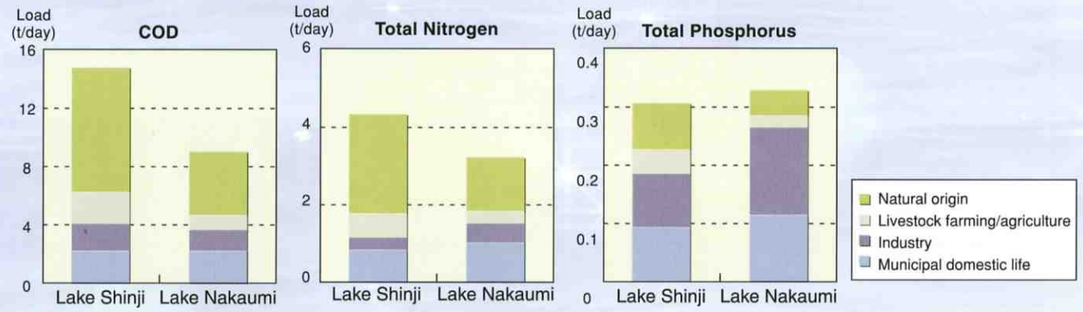
【Causes of Water Degradation】

One of the causes of pollution in Lake Nakaumi and the Lake Shinji is considered to be the inflow of nutrient salts, such as nitrogen and phosphorus, and of pollutants resulting from the modern lifestyles and industrial activities of the people in the neighboring areas.



■ Mechanism of eutrophication

■ Pollution in Lake Shinji and Lake Nakaumi [12]



【Lake Water Quality Management Plan】

Under the Law for Special Measures for Lake Water Quality Management, Lake Shinji and Lake Nakaumi were specified as designated lakes in 1989. The first Lake Water Quality Management Plan was formulated in 1990. A holistically designed approach to conserve the water quality was laid out and remains in action.

■ System for Water Quality Management Activities and Major Policies

Lake Water Quality Management Plan

Conservation Activities
- Installation of domestic waste water treatment system
- Improvement of lake water quality

Restrictions / Other Activities
- Restriction on waste water from factories/business institutions
- Education of the public
- Measures against pollution of natural origin

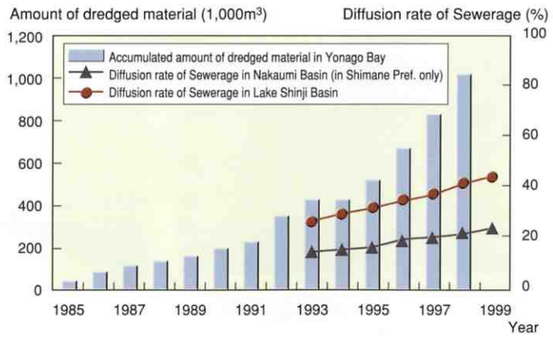
Other Activities in need
- Water quality monitoring, promotion of R&D efforts
- Promotion of environmental education
- Grants for business institutions

【Major Activities for Water Quality Management】

Many water conservation activities are underway in the Lake Shinji and Lake Nakaumi areas, such as installation of domestic wastewater treatment systems, restrictions on waste water discharged from factories, education of the public, and countermeasures against pollution of natural origin.

Dredging in Yonago Bay in Lake Nakaumi was completed in 1998. Currently, sand capping is being experimentally conducted to cover the deposited sludge in the lake bottom. Ditch reed vegetation was planted on the artificial lakeshore to improve the lake water quality and the living environment for various species.

■ Progress of the water quality management measures



Conservation and Creation of Natural Environment

【Environmental Conservation Measures in Executing Flood Control Activities】

Presently, as part of the key flood control projects, Obara dam and a discharge channel are under construction at Hii River. In these projects, measures are taken to minimize the adverse effects of construction on the environment and to recover the natural resources lost during construction. Various other activities to create the high quality natural environment are also underway.

【Creation of a 1000 Year Forest】

The planned Hii River Discharge Channel will involve the plantation of indigenous trees along the channel route to achieve a primary-like forest in a short period of time.

■ Hii River Discharge Channel

●Plantation festival of "1000 Year Forest"

●Creation of a highly diversified river in Kando River (Izumo City)

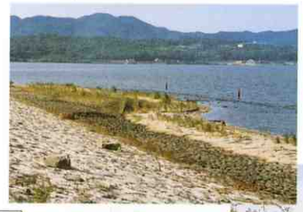
【Creation of a Highly Diversified River】

The renovation project for Kando River cares that the existing aquatic plants will be conserved as much as possible.

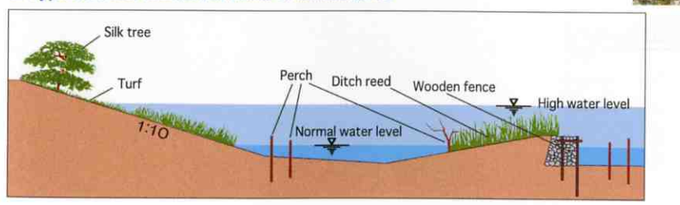
【Conservation of Vegetation along West Shore of Lake Shinji 】

Along the west shore of Lake Shinji, ditch reed is planted to improve the lake water quality and to recover habitats for fish, insects, and birds. As the base for ditch reed vegetation, bamboo pots, thin wooden stakes and rocks are used.

●Reeds planted on the lake side



■ Typical cross-section of biota-oriented levee



●Plantation of reeds using bamboo pots

9 For the Future of Hii River Basin

Safety of Hii River

【Promotion of the Flood Control Projects】

Presently, as part of the 3 key flood control projects, Obara & Shitsumi Dams and a discharge channel are under construction at Hii River. As a next step, a prompt start-up and execution of the Ohashi River renovation is expected.

●Construction at Obara Dam

●Construction at Hii River Discharge Channel

【Strengthened Disaster Prevention】

To prevent flood disasters, quick and precise information sharing system, accurate flood forecasting, and preparedness in households are vital.

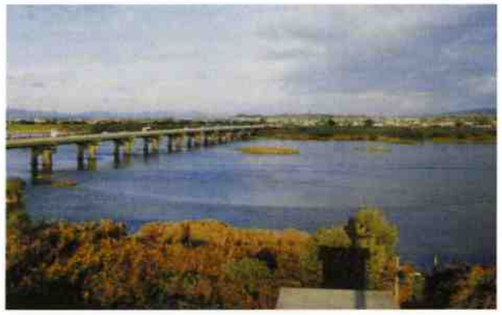
【Creation and Disclosure of Flood Hazard Maps】

A Flood Hazard Map, which indicates estimated submerged areas, levels of submergence, evacuation spots and routes, etc. is now being prepared for distribution to citizens.

【Provision of Real Time Images of the River】

A system to provide real time pictures of Hii River to citizens via fiber-optic cables is under development.

●Flood drill



●Visuals from the camera from Ohtsu

Richness of Hii River

【Measurement and Disclosure of Water Quality Data】

Presently, measurements of water quality in Lake Shinji and Lake Nakaumi are collected at 4 stations and shared to the citizens on Hii River Information Board located at Matsue City and Yonago City.

●Station at the center of Lake Shinji

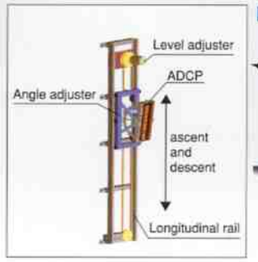
●Station at the center of Lake Nakaumi

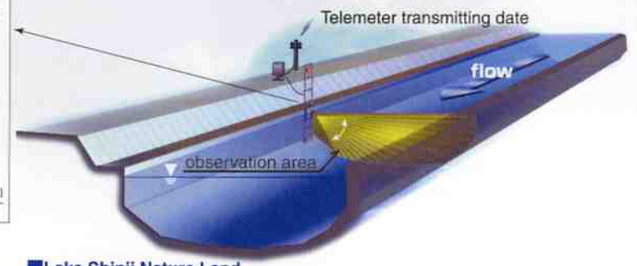
●Hii River Information Board

【Promotion of Research on Water Flow in Lake Shinji and Lake Nakaumi】

Water flow in Lake Shinji and Lake Nakaumi is being monitored using an ADCP (Acoustic Doppler Current Profiler) at Ohashi River, which connects these lakes.

■Acoustic Doppler Current Profiler





【Lake Shinji Nature Land - Area to Enjoy Nature】

Lake Shinji Nature Land integrates facilities and spaces to contact and enjoy nature in the west shore of Lake Shinji. It also has areas to recover the natural ecosystem.

【Basis for Interactive Environmental Education】

"Lake Shinji Nature Museum of Shimane Prefecture"(or GOBIUS, as it is popularly known) was built on the west coast of Lake Shinji in 2001. Here, people enjoy and learn from interactive exhibits on organisms in the river basin. The neighboring "Lake Shinji Green Park" provides excellent bird watching sites in the atmosphere of the natural forest.

■Lake Shinji Nature Land

●Environmental and nature studies

【Restoration of Ecosystems by the Communities of the Region】

Along the lakeshore in "Lake Shinji Green Park", a "Diversified Lake Levee for Lake Shinji, Hirata Area", which consists of a gentle slope levee and offshore artificial island, has been constructed. It provides a place for children to experience and study nature through "plantation of reeds by bamboo pots", an exercise in which various groups such as NPOs, local people, researchers, fishermen, and administration personnel participate.

●Seedling with bamboo pots

Eight Symbolic Scenes of Lake Shinji

❹Juroku-Hage in Winter

❸Manganji (Mangan Temple) Coastal Water in Fall

❺Waterfront with Shimane Art Museum

❽Green Park in Summer

❻Yomegashima in Light Evening

❷Izumo Airport Beach Park in Summer

❼Fishing Turtle

❶Lake Side in Tamayu Area in Spring

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