

The history of flood control and the floodway projects of the Hiikawa River

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1. Preface

Once, the Hiikawa River ran through the Izumo Plain to the west and poured into Taisha Bay. About 360 years ago, floods changed the river course and as a result, it has flown through the Izumo Plain toward the east and poured into Lake Shinji. Since then, the coastal area of Lake Shinji, including Matsue, has been annoyed by floods.

The Matsue han (feudal clan) and the Ministry of Home Affairs took some flood control measures, but they were far from being drastic, because of the social and economic conditions in those days.

The area suffered from damage caused by floods in 1945, 61, 64, 65 and other floods, in succession. Especially, the worst case occurred in July 1972, when water from Lake Shinji flooded over about 70km² of coastal areas, including a part of the Matsue City, and also the eastern part of the Izumo Plain. About 25,000 houses suffered damage from the flood. The water did not recede for over a week.

Following this flood, a radical and comprehensive plan to deal with flood control of the Hiikawa and the Kandogawa Rivers was formulated.

Finally, radical flood control steps has been taken, for the Hiikawa and the Kandogawa Rivers, after three and a half centuries of hardship endured by our ancestors.

This report outlines the history of struggle against flood by our ancestors for the Hiikawa River Basin, and the drastic flood control project currently underway.

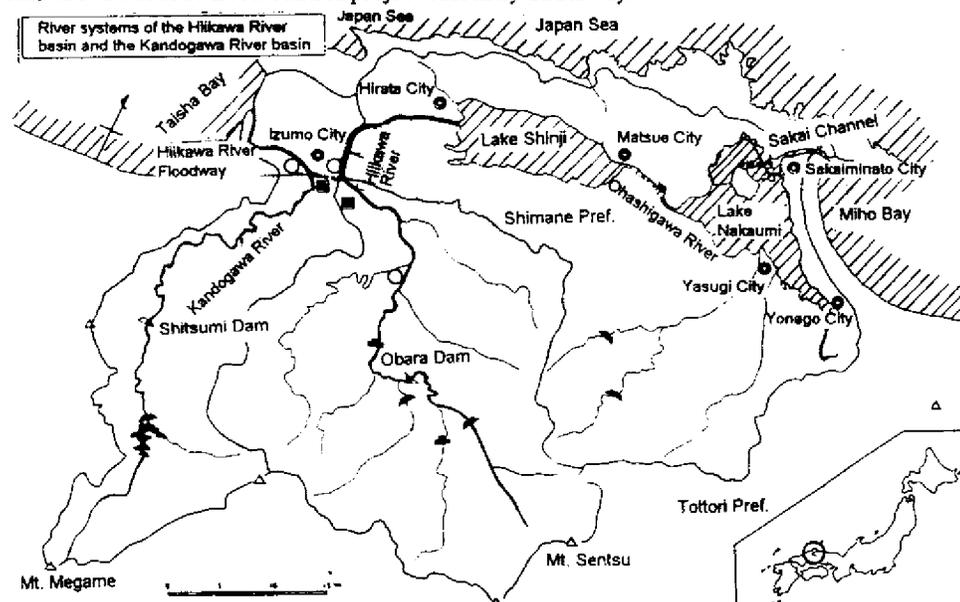


Figure 1 River systems of the Hiikawa River basin and the Kandogawa River basin

2. An overview of the basin

The Hiikawa River flows from Mt. Sentsu in the Chugoku Mountains, on the border between Tottori and Shimane Prefectures. It then flows to the north along with its tributary rivers including the Mitoyagawa and the Akagawa Rivers. It turns to the east in the middle of the Izumo Plain and the water flows into Lake Shinji, the Ohashigawa River, Lake Nakaumi, the Sakai Channel, and then ,finally pours into the Japan Sea. Its basin area is about 2,070km² and the total length of trunk river is about 153km. Its basin is divided in three: the Hiikawa main stream basin, the Lake Shinji basin and the Lake Nakaumi basin.

The average annual precipitation in the Hiikawa River Basin is 1,800mm to 2,000mm on the plains and 2,000mm to 2,200mm in the mountains.

The main stream runs through an area of weathered granite which supplies much sediment. The sediment has been deposited along the river course and the river bed has been higher than the neighboring plain; "Tenjo-gawa." The slope of the river bed until it reaches Lake Shinji is around 1/1000, which is rather steep even on the Izumo Plain.

Lake Shinji is about 79km² in size and its water pours into Lake Nakaumi through the Ohashigawa River as well as directly into the Japan Sea through the Sadagawa River.

Lake Nakaumi about 86km² in size. Comparatively large tributaries like the Iinashigawa River and the Hakutagawa River flow into the lake.

The average difference in the water level between Lake Shinji and Japan sea is about 10cm, and that between Lake Nakaumi and the Japan Sea is several centimeters. Since the difference is so small, sea water flows in and out of the lakes due to ebb and flow of the tides. Because of this, the two lakes contain a mixture of sea water and fresh water.

3. The course changes of the Hiikawa and the Kandogawa Rivers

A bay between the Shimane Peninsula and the Chugoku Mountains was dammed up by the earth and sand carried by the Hiikawa and other rivers, and thus became Lake Shinji and Lake Nakaumi.

At the time when the "Fudoki" (the 8th century) was written the Hiikawa River flowed westward through the Izumo Plain, pouring into the Japan Sea after passing the Kando-Suikai (known today as Lake Jinzai). Its course changed to the east due to the floods of 1635 and 1639, and began to flow into the Japan Sea through Lake Shinji and Lake Nakaumi. In the time of "Izumo Fudoki", there is a description in the myth entitled "Kunibiki" that the Shimane Peninsula is a piece of surplus land which Yatsuka-mizuomitsuno-mikoto hauled from Shiragi and Koshi.

This myth is interpreted as a description of the geographical change in which the earth and sand carried by the Hiikawa River connected the Chugoku Mountains and the Shimane Peninsula.

There is an opinion that the story of Yamata-no-orochi in "Kojiki" is a metaphor of the flood control of the Hiikawa River.

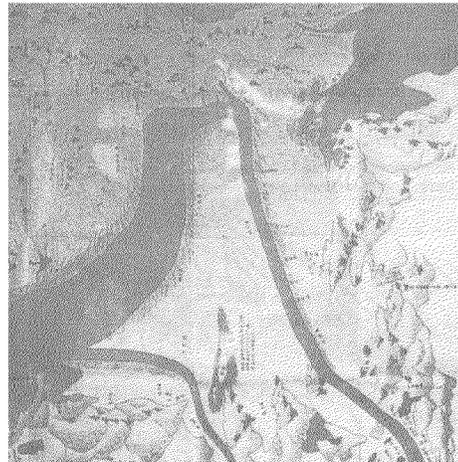


Figure 2 The picture of the Hiikawa River's course in old days
(From Fudokito Kan-ei period)
(Property of the Shimane prefectural library)

4. Kanna-nagashi and Tenjo-gawa

(1) Kanna-nagashi

The Chugoku Mountains was once the largest area in Japan of iron production from iron sand.

This production method is called the Tataro iron production method.

The iron sand to be used as material was collected in a method called Kanna-nagashi.

This method entails building a channel on the slope of a mountain. Weathered granite earth is pulled down from the mountains and dropped into the channel.

Then the iron sand is separated from dirt according to specific gravity by means of the flowing water

On that occasion, a huge amount of dirt after collecting iron sand was thrown away into the river

Therefore, the more thriving Tataro iron production became, the more dirt was thrown into the rivers by the Kanna-nagashi method.

Figure 4 shows the distribution of Kanna-nagashi (Tataro iron production) sites along the Hiikawa and the Hinokawa River systems and the state of plains expanded since the Edo period.



Figure 3 Kanna-nagashi

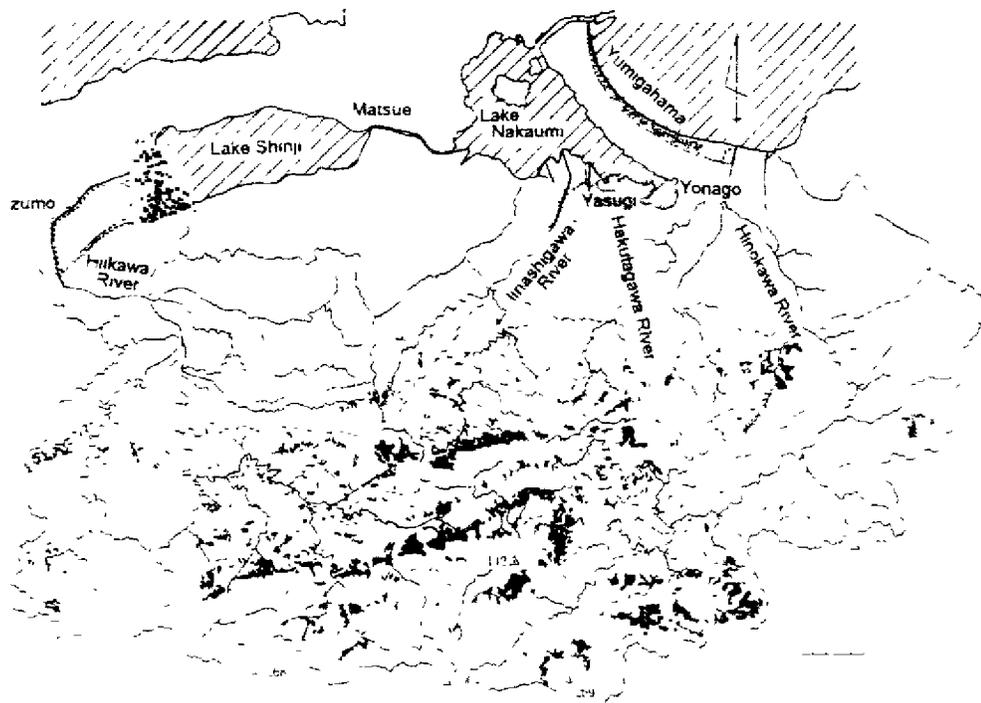


Figure 4 The distribution of Kanna-nagashi (Tataro iron production) sites along the Hiikawa and the Hinokawa River Systems and the expanded plains since the Edo period.

Black area: Kanna-nagashi sites Half-tone area: Expanded plains

Tatara iron production had been in operation since the "Fudoki" time, prevailing in the 17th century and culminating from the end of the Edo period and to the early Meiji period.

Tatara iron production declined with the rise of modern steel production, and almost disappeared in the mid 1950s.

According to a topographical study of the Kanna-nagashi sites, the total amount of mining dirt thrown into the Hiikawa River is estimated at around 200,000,000m³.

Besides for Tatara iron production, a large number of trees was felled for charcoal production, devastating the mountains, and causing an increase in the amount of sediment in the rivers.

Because of the large amount of dirt and sediment caused by Kanna-nagashi and the construction of the river banks since the Edo period, the Hiikawa River became a typical "Tenjo-gawa".

(2) Tenjo-gawa (a river whose bed is higher than the neighboring plain)

In recent years, the rise of the river bed was halted because Kanna-nagashi is no longer in use and due to the construction of erosion control dams in the upper reaches of the rivers. However on the Izumo Plain there are still some areas where the river beds are 3 to 4m higher than the neighboring plain.

As such, the Hiikawa River is a tenjo-gawa, and becomes very dangerous during floods because the water flows in higher places than the heights of people's houses.

Once the river banks break, the major flood discharges into the lower plains inflicting serious damage to the basin.

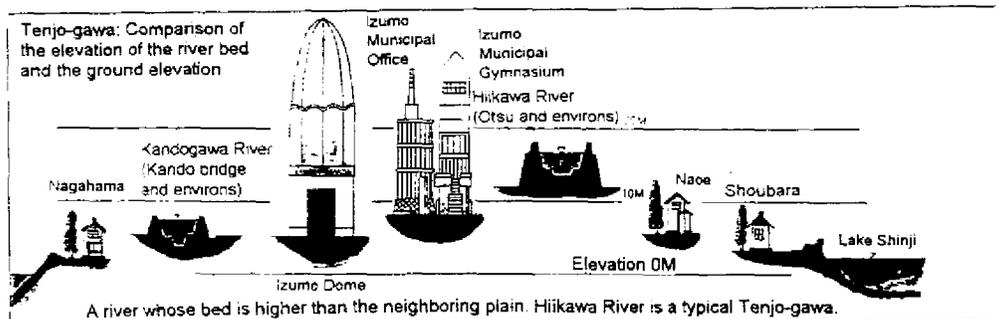


Figure 5 Comparison of the elevation of the river bed of the Hiikawa River and the ground elevation of neighboring areas

5. Flood control measures before the Edo period (1600-1867)

The oldest record of flood control in this area is written in "Izumo Fudoki", stating there was already an embankment along the Hiikawa River.

And the oldest flood on record is the Izumo Deluge that occurred during the Yoro period, between 717 and 723.

There are almost no records on flooding in the Middle Ages. However, in the Edo Period when the reducing grain harvest of the feudal clans was a matter of concern, records were taken regarding various natural disasters.

In the time of the Matsue clan, 62 floods were recorded during the 245 years between 1621 and 1866, averaging a flood every four years.

Because of this, the Matsue clan regarded it as important from the beginnings and made great efforts towards flood control and the development of the Hiikawa River.

The Kyogoku family started the construction of the main embankment, and in 1657, the concourse was completed connecting Lake Shinji.

In the Edo period, a large amount of earth and sand was dumped into the Hiikawa River due to Kanna-nagashi, and because of this, the river beds became higher than the neighboring plains. Therefore, the course of river was changed every 40 to 60 years to lower areas. This process was called "Kawatagae".

"Kawatagae" was done actively for the purpose of land reclamation of Lake Shinji close to the lower reaches of the Hiikawa River as well as for flood control.

Also, the 1826 deluge brought about fatal damage to Kisuki-cho. Thus, Matsue clan was accused to not only establish the flood control project, but also planed to reclaim the Shoubara Bay, and a new 9km long river, the Shinkawa River, was constructed on the southern part of the Izumo Plain.

This river also had the problem of sediment. For about a hundred years until 1939 about 10,000,000m³ of earth and sand was accumulated on the river bed and as a result, the river was closed.

On the other hand, Matsue, had been annoyed by the rise of the water level of Lake Shinji due to floods of the Hiikawa River. In order to solve this problem, the Matsue clan excavated the Tenjingawa River (from Lake Shinji to Lake Nakaumi) in 1689 and the Sadagawa River (from Lake Shinji to the Japan Sea) in 1787.

However, compared to the influx from the Hiikawa River, the drainage volume through these two rivers was very small. Therefore, this measure did not come to radical flood control.

In 1867, in the construction department of the Matsue clan, there was a heated debate over the plan to restitute the course of the lowest reaches of the Hiikawa River to its state before the Kan-ei period and discharge its water into the Japan Sea in the west. This is the foundation of the current flood control plan for the Hiikawa River as studied and examined by an engineer named Sekiya, among others.

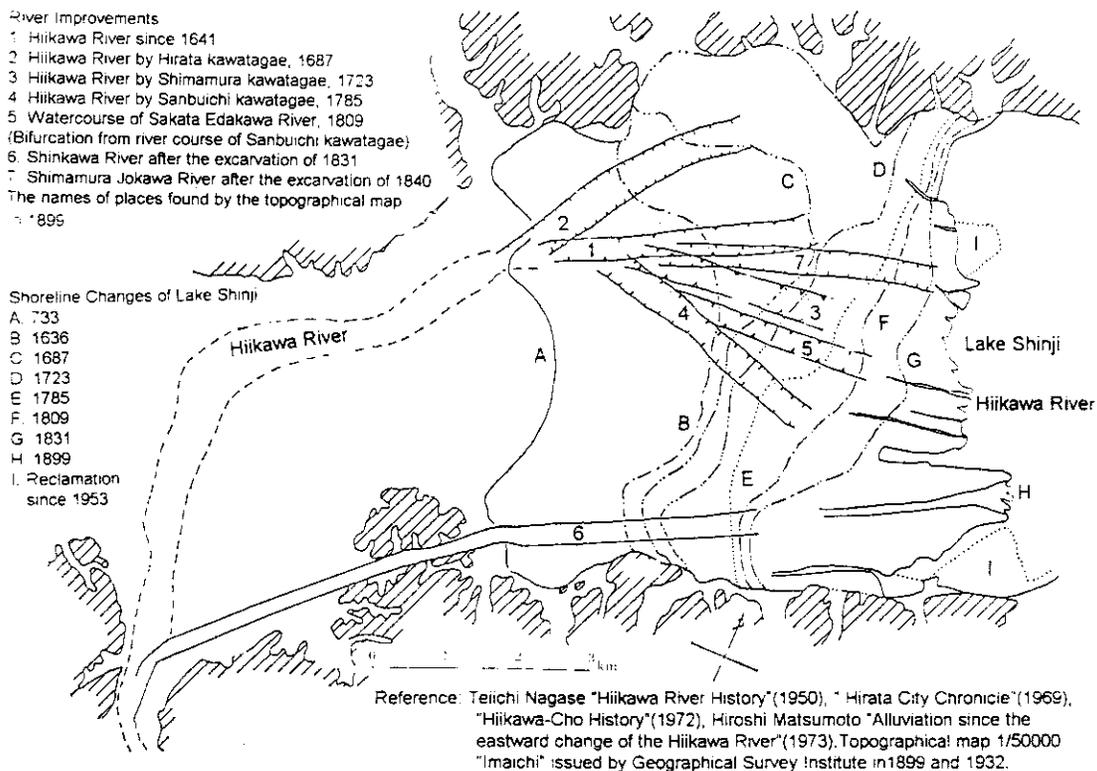


Figure 6 The transition of the course of the Hiikawa River and the coast line of Lake Shinji after the Edo Period

6. Flood control project in the Meiji period (1868-1912)

There were no large-scale flood control projects from the end of the Edo period to the early Meiji period, and the region was inflicted by one flood after another in 1873, 1880, 1886 and 1893.

The flood of October, 1893 raised the water level of Lake Shinji. In the lower areas of Matsue City, the water reached as high as 3m and about 8,000 houses were inundated.

The 1893 flood urged the government of Shimane Prefecture to request the Ministry of Home Affairs to conduct a survey on flood control in this region.

The survey was assigned to Sekiya, an engineer of the Ministry of Home Affairs, who conducted overall research including tracing the floods.

The result of the survey was made public by Shimane Prefecture in 1896.

In the report, Sekiya reexamined the flood control plan drafted by the Matsue clan during the Keio period (1865-1868), and presented the following three flood control plans with his new findings and knowledge.

1) Improve a watercourse from Lake Shinji to prevent the extreme rise of the water level of Lake Shinji.

2) Separate the flow of the Hiikawa River completely from Lake Shinji

3) Allow some part of flood of the Hiikawa River to flow into Lake Shinji and discharge the rest of flood into other area of Lake Shinji

Among the above, 1) is based on the first plan of the Matsue clan, which Sekiya named "Asakumi Line". The watercourse requires a width of 1,800m. If it is adopted, a large part of the upper reaches of the towns in Matsue must be used as river course, which seems impossible

Plan 2) is regarded as not being worth adopting, because of concerns about the damage from salt water, deterioration of water quality due to no influx of fresh water into Lake Shinji, and a reduction of sea routes (even though it could be effective to prevent flooding).

Plan 3) is recommended as the best measure. This is not simply a plan to change the river course but a plan to construct a floodway to discharge excessive water at the time of flooding. This is the foundation of the Hiikawa River floodway plan of today.

However, this plan was not realized mainly due to financial difficulties.

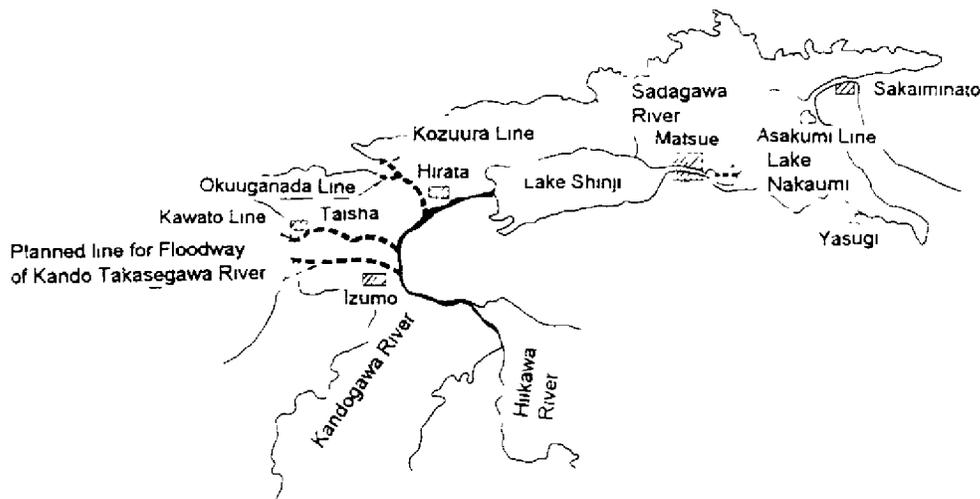


Figure 7 Sekiya's flood control plan

7. The 1922 river improvement plan

In 1918, there was serious flood damage, which urged the local people to make an earnest request to the central government about a river improvement project. In answer to that request, the government launched the project in 1922.

On the basis of the survey conducted by Sekiya, the design flood discharge was set at $3,600\text{m}^3/\text{s}$ at the upstream reaches of the diversion of the Shinkawa River taking into account of the largest discharge on record at the time of the flood of October, 1893.

At that time, the plan to build a floodway was discussed, but the following plan was adopted because it required the least land acquisition and cost and would increase fluvial transportation in the Ohashigawa River.

- * Widen the main stream to convey the design flood discharge safely.
- * Adjust the center line of the main stream to the Kyu-Jokawa River and close all the outlets of the tributaries which formed the delta. Close the Shikawa River.
- * Improve drainage of Lake Shinji and the Ohashigawa River. Widen the Ohashigawa River for the convenience of fluvial transportation.

According to this plan, the first phase improvement project was completed for the Hiikawa and the Ohashigawa Rivers by the end of fiscal 1944.

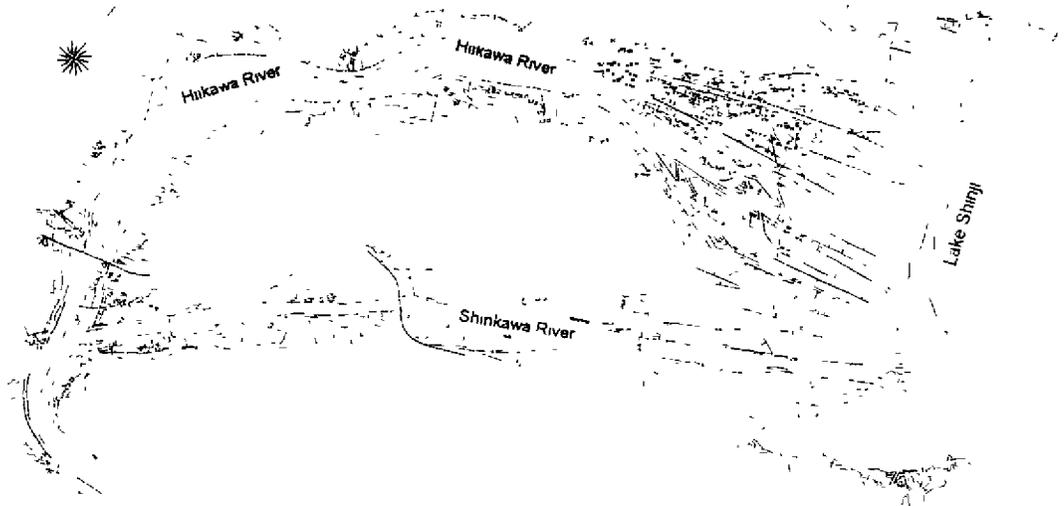


Figure 8 A layout of the improvement project of the main stream of the Hiikawa River in 1922

8. The survey for the flood way project in 1945

A flood in September, 1943, just before the completion of the first phase of the project, and another in September, 1945 immediately after the end of the World War II, devastated the Hiikawa and the Kandogawa River basins.

This was caused by reduced discharge capacity because the cross section of the rivers was reduced to the sedimentation.

In the case of these flood, the maximum flow at the Ohtsu Observation Station was estimated at about $2,100\text{m}^3/\text{sec}$ for the 1943 flood, and about $2,500\text{m}^3/\text{sec}$ for the 1945 flood. These estimates were around 60 to 70% of the design flood discharge. However, the water level exceeded the design high water level by about 20cm in the downstream reaches.

With this as a turning point, the authorities planned to merge the two rivers as a radical flood control project, which triggered the argument of the pros and cons of the plan at the concerned area.

The Ministry of Home Affairs also started a full-scale survey, setting up the "Office of Flood Control Survey for the Hiikawa River" in Koshi-cho Izumo City in March, 1946.

But the residents in Enya-cho Izumo City were strongly against the plan to merge the rivers, as the land of the town would have to be requisitioned for the river course. Then, there happened intense campaigns against the plan in various places. The city council of Izumo unanimously adopted a resolution to oppose the plan.

Responding to these movements, the Ministry of Home Affairs decided to suspend the survey and the surveyors left the town.

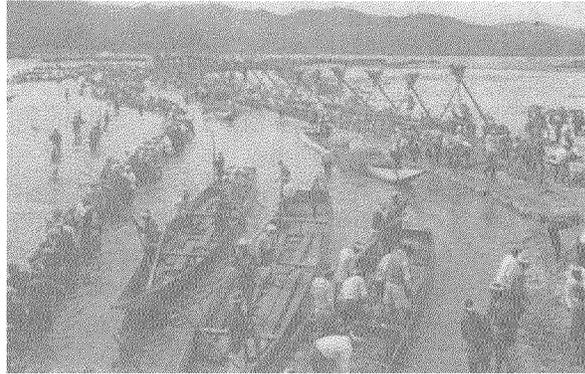


Figure 9 The collapse of embankment in Izumo City at the time of the 1943 flood

9. The flood control plan in 1965

In 1961, the "Hiikawa River Basin Flood Control Council" was organized, comprising of members of the prefectural assembly, mayors of the related cities, towns and villages, section chiefs of the related departments of the prefectural government and the Ministry of Construction, along with the governor as the chairman.

This council was established so that the related authorities could cooperate to facilitate the flood control projects. Because there have not been radical measures realized yet, though the Hiikawa River is in extremely grave condition regarding the danger of floods.

In the Council of 1965, the Ministry of Construction explained several flood control plans for the Hiikawa River were under consideration and wanted to conduct more surveys. The plans under consideration are as follows.

(1) Dam

Construct a flood control dam at upstream reaches of the Hiikawa River in Kisuki-cho.

(2) A floodway into the Kandogawa River

There are two floodway plans: one is by an open channel and the other is by a floodway tunnel. There are also options for the discharge amount into the Kandogawa River: $800\text{m}^3/\text{s}$, $1,500\text{m}^3/\text{s}$ and $2,000\text{m}^3/\text{s}$. This matter is under consideration.

If the diverted discharge is set $800\text{m}^3/\text{s}$, two tunnels of 12m in width and 9m in height are necessary. $1,500\text{m}^3/\text{s}$ requires 4 of the same size tunnel, $2,000\text{m}^3/\text{s}$ needs 6.

If the plan of a floodway into the Kandogawa River is adopted, the width of the Kandogawa River must be doubled approximately in the downstream reaches in the case $2,000\text{m}^3/\text{s}$ of the diverted discharge join into the Kandogawa River. (From the current width of 280m-250m to 615m-520m.)

Furthermore, the meandering part of the river is to be straightened and the mouth of the river will be moved to the Sotozono area of Izumo City.

(3) A floodway connected to the port of Kawashimo

Construct a floodway, about 6.5km long to the port of Kawashimo (Uppurui Bay) from the Kunidomi district in Hirata City.

In order to discharge a large amount of water, the width of the floodway has to be more than 500m. The length is also substantial, so it is unlikely this plan will be realized.

This explanation surprised the related authorities and people in Izumo City, where this floodway is planned.

Along the Kandogawa River lower than the confluent point, the width of the river is to be doubled approximately, and the rice fields and houses will be requisitioned for the floodway. The local residents received such a sacrifice was unbearable so they formed groups to stage campaigns against the plan, protesting to the prefectural and city governments.

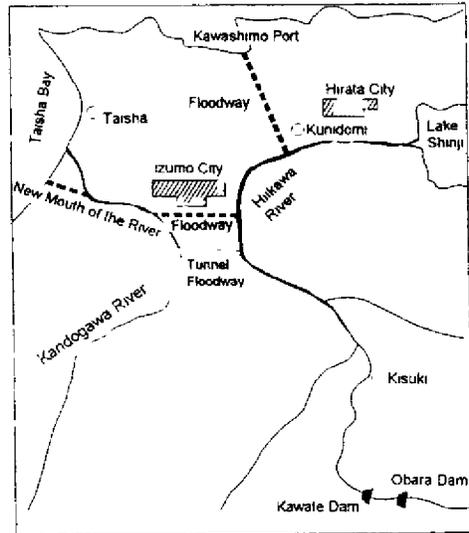


Figure 10 An overview of the 1965 plan

10. The flood of 1972

In July, 1972, the torrential rain in the Chugoku region brought about 333mm of the average two days rainfall in the upstream reaches of Ohtsu. The maximum discharge flow was about 2,300m³/s in Ohtsu, and rendered the downstream reaches of the Hiikawa River very dangerous.

This increase of discharge raised the water level of Lake Shinji. An area of about 70km² including Matsue, and the eastern part of the Izumo Plain was inundated for about a week and about 25,000 houses were damaged.

Also, the Kandogawa River's embankment was on the verge of collapse



Figure 11 The 1972 flood (Matsue City)

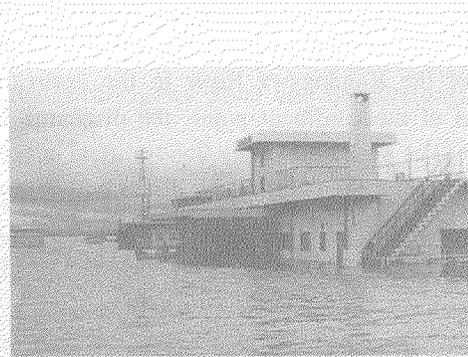


Figure 12 The 1972 flood (Izumo Airport)