

## J-traditional River Engineering on Ichikawa, Himeji

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A river engineer, who is working abroad, has many chances to think hard how to maintain rivers within limited budget and materials. At such time, what is most reliable is the wisdom in traditional river engineering. As a good example, I would like to introduce cases on Ichikawa flowing in Himeji, Japan.

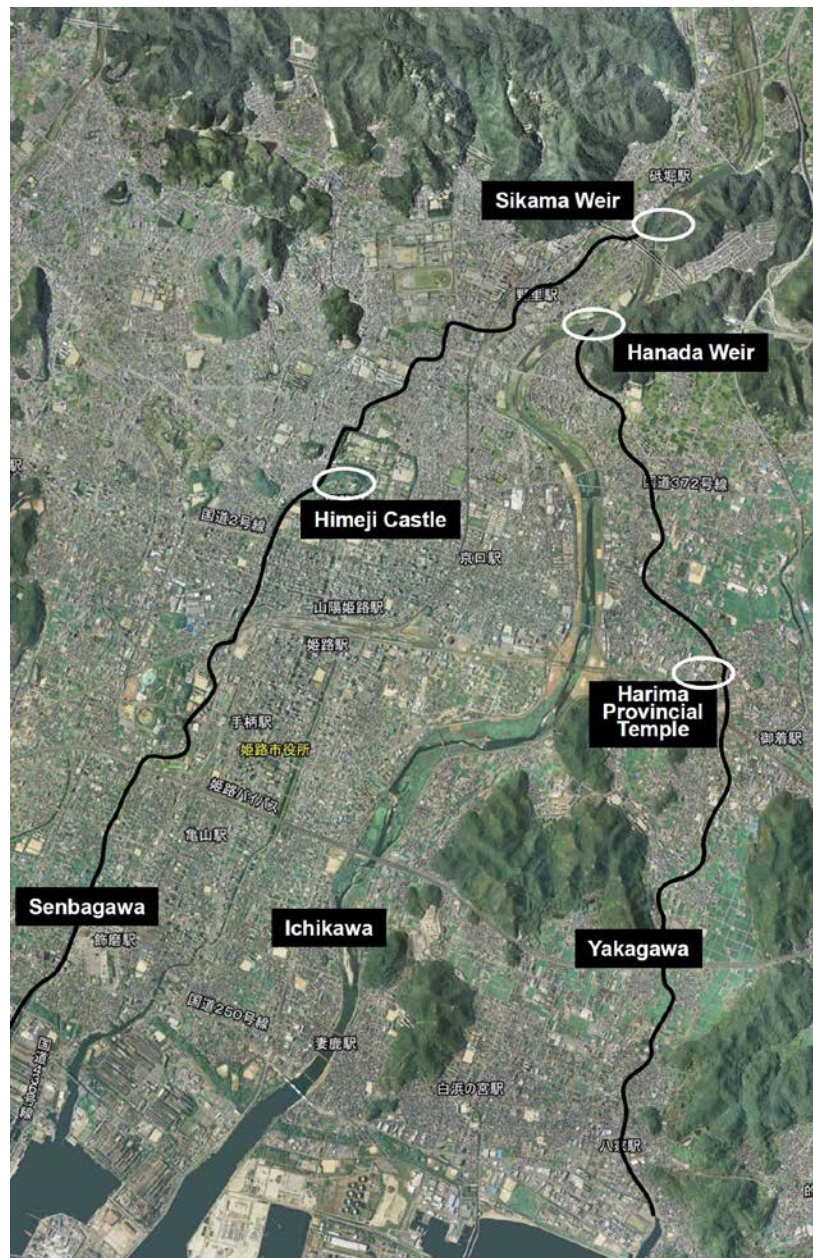
The famous castle town Himeji was opened on the alluvial plain of Ichikawa. Since drastic reconstruction of the castle in Keicho, the town has been developing through 400 years up to now. This sustainable progression has been supported by J-traditional river engineering. Today we can observe the unique river facilities around the river in Nozato area and understand they are quite active to assure the city's security against water disasters. This article guides the river facilities and adds explanation on the traditional engineering which can be applied to other rivers.

### Ichikawa, Senbagawa and Yakagawa

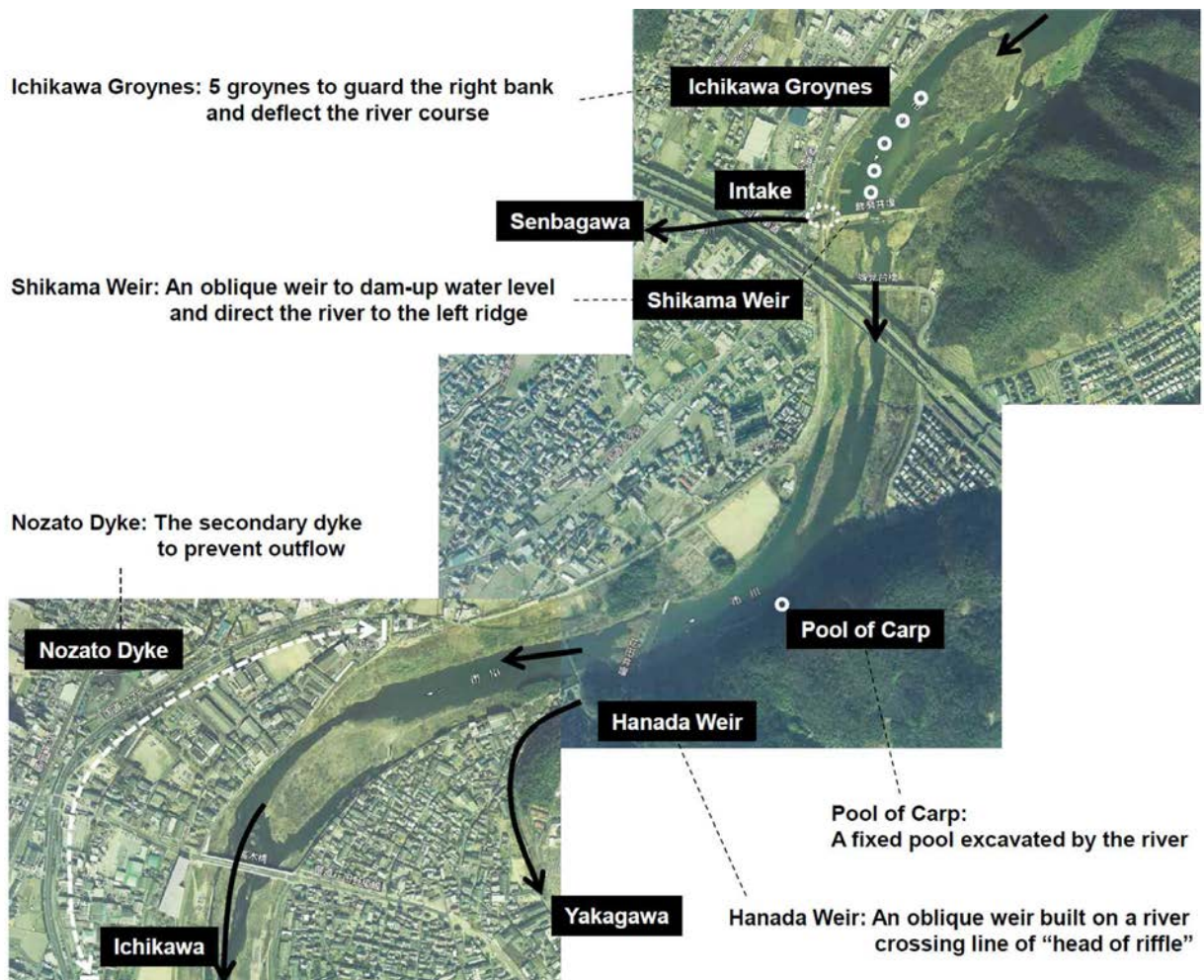
On a aerial photo, we can see that Ichikawa takes a left (east) side route definitively at the entrance of the alluvial plain. The reason is quite simple that the river has been artificially trained not to threaten Himeji Castle and its town. Then we can also find 2 branches on the plain edges: Senbagawa on the right (west) and Yakagawa on the left (east).

Senbagawa runs from an intake at Shikama Weir. The stream fulfills castle moats and provided canal water to a sea port since castle enlargement in early Edo era in 1600s. Another Yakagawa is divided by Hanada Weir and flows down beside a diluvial terrace to irrigate paddies surrounded by ancient tombs. The channel is supposed to supply water to old Harima Provincial Temple built in 750s in Nara era.

These 3 rivers have been maintained by time-honored river techniques which are well working today as (1) Ichikawa Groynes, (2) Shikama Weir, (3) Pool of Carp, (4) Hanada Weir and (5) Nozato Dyke.



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Ichikawa, Senbagawa and Yakagawa in Himeji city



Traditional river facilities on Ichikawa

**(1) Ichikawa Groynes**

Ichikawa was enforced to come closer to the left side hill by the right side dyke. This dyke is an ordinary crucial facility for Himeji Castle and its town. In fact, in 1749, a dyke breach on this point destroyed the intake and caused the worst disaster to Himeji town. Since 1900 this dyke has been protected from strong current by a unit of 5 low riprap groynes.

The most upstream groyne is built on beginning of flood attacking section to the dyke body. This short groyne blocks flood flow touching the dyke and passes it to the next groyne. The second to fifth groynes, each of them are longer than the former, lead the flow to run in front of their tips away from the dike line. Finally, the groyne unit bends the flow to Shikama Weir.



The fifth groyne



Groynes, Intake and Shikama Weir

### (2) Shikama Weir

Shikawa Weir is an important river crossing structure to dam up water for Senbagawa intake. The weir axis has non-right angle against the river channel which comes northeast. The east-west axis of the weir indicates an intention of engineers in Edo era of long ago who understood that a low-lying straight structure refracts overflowing water to its right angle direction. At Shikama Weir, therefore, Ichikawa changes its course southward.

### (3) Pool of Carp

Aim of the river course is to make Ichikawa collide directly to the left side ridge. River water, which is blocked its path by a hard obstacle, excavate the bed using its motional energy. In the case of Hanada Ridge, Shikama Weir settles Ichikawa's course and Ichikawa excavate fixes a deep scour hole for hundreds years, which has been called Pool of Carp.

After consuming energy for the scouring work, Ichikawa loses the tractive force. The tired flow diffuses leeward and deposits sediment to mound a bar finally on a naturally curved line. This is "head of riffle" which determines a peak of the river bed and the minimum depth of the widely spread flow. Ichikawa demonstrates that a fixed deep pool has function to form a cross bar to keep water level even in droughts.

### (4) Hanada Weir

A river crossing structure built on the "head of riffle" is Hanada Weir. Because of the natural curve of the bar, the weir has an oblique angle. This type of weir has feature that every flood flow overflows the longer crest with smaller shear force. The weir, therefore, has advantage of resiliency and reparability against flood disaster. That's why the Hanaga Weir is on the best position among intakes and keeps on sending water to Yakagawa over 1,000 years.



Pool of Carp and Hanada Weir

### (5) Nozato Dyke

Hanada Weir, however, deflects flood flow rightward due to its non-right angle. Downriver dyke on the right side, which gets collision of the flow, has risk of breaching to inundate the castle town. Then, in Edo era, Nozato Dyke was built about 300m away from the riverside dyke to form a double-line dyke.

To preserve function of Nozato Dyke, in Meiji era, Bantan Railway and National Road 312 was designed to go around the dyke line. And outside of the Nozato Dyke was a wide houseless buffer zone until Meiji Era, named Dainichi Gawara (dry riverbed). Up to now, Nozato Dyke has been an aftermost guard against unexpected flood disasters.



Nozato Dyke

### Traditional Engineering for today's river management

Water distribution system on Ichikawa alluvial plain was controlled by Ichikawa, right branch Senbagawa and left branch Yakagawa. The 2 branches supplies water resources to Harima Provincial Temple, Himeji Castle and paddies on the plain. And Ichikawa main channel drains waste water and carries flood discharge to the sea. A radical and sustainable water control system has been handed over since Edo era.

That is traditional river engineering of Ichikawa. Its core facilities; the groynes, the oblique weirs, the fixed pool and the double line dyke; are working totally, fitting in with the right-and-left land geometry, coordinating the up-to-down uninterrupted flow and utilizing natural power of the river itself. Ichikawa teaches us the principles of river flow and the wisdom of river engineers in Edo era. And ichikawa suggests to study and arrange them in practical river management in Japan and the world. Ichikawa is an active-duty heritage of traditional river engineering and her cultural values are not less than that of Himeji Castle.

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