A Quantitative Approach to the Environmental Impact Assessment with Hydraulic Model Experiments

Takeshi OSAKA[1], Takashi ISHII[1], Yosuke MURAMOTO[1], Soji SUZUKI[2*] and Seiji SAWAKI[2]

[1] Ministry of Land, Infrastructure, Transport and Tourism, Tateyama Sabo Office, Hokuriku Regional Development, Japan
[2] CTI Engineering Co., Ltd, Japan
[*]Corresponding author. E-mail: so-suzuk@ctie.co.jp

INTRODUCTION

The Magawa River, one of the tributaries in the upstream area of the Joganji River, has a strong possibility of sediment disaster due to the unstable sediment accumulated on the riverbed. Thus, a series of sediment disaster prevention (hereafter called "sabo") works on the Magawa River has been implemented since the upstream section of the Magawa river is featured by its gentle slope, wide river channel which cause accumulated sediment. Also, the section holds beautiful natural river environment such as sandbars. In order to conserve the natural river environment, installation of low dams has been examined with particular consideration on maintaining existing river environment.

The paper is prepared to report an quantitative approach to the environmental impact assessment with hydraulic model in order to contribute environment-friendly sabo facility installation plan.

BACKGROUND

In Magawa river, sediment discharge equivalent to the Sabo Basic Plan occurred during the flood in 2011. Since then, it remains a risk of sediment discharge which may affect the camp sites and the public roads in the downstream area of the river. Also, it may disturb the natural habitats including spawning sites and wetlands for endemic alpine plant species, amphibians and fish called Iwana (*Salvelinus leucomaenis*). Considering the current situation mentioned above, a series of low dams with effective height from 3.0 meters to 4.5 meters were planned in consultation with experts to suppress the sediment runoff and to conserve river environment. The effect was verified by a hydraulic model experiment.

OUTLINE OF HYDRAULIC MODEL EXPERIMENT

The outline of the hydraulic model experiment is shown in **Tab. 1** and **Fig. 1**. In the experiment, the sediment status after flushing was measured with the following three cases: CASE-1(baseline), CASE-2(with six low dams) and CASE-3(with five low dams).

Tab. 1 Experimental conditions

Item	Condition
Model Scale	1/80
Discharge	Design flood (1/150)
Sediment supply	352,000m^3
Grain size	10cm (average)

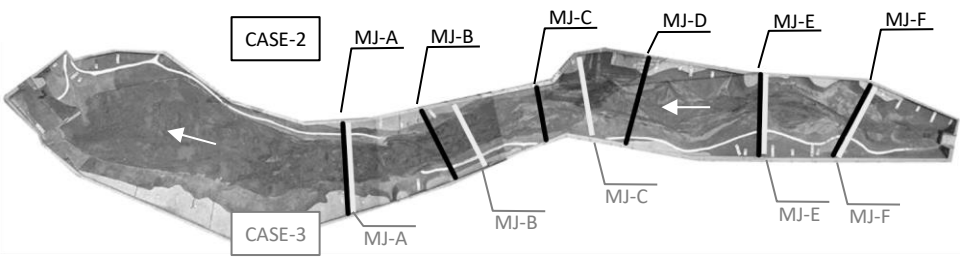

Fig. 1 The study model picture and sabo facilities allocation

ENVIRONMENTAL IMPACT ASSESSMENT

Based on the results of the hydraulic model experiments, the significance of changes in the river environment were compared among all the three cases.

1. **Changes in bed shapes**

Fig. 2 shows the longitudinal distribution of the riverbed slope after the experiment. Although some locations where the sabo facilities installed indicated steep slope, no significant changes were recognized among CASE-1 (baseline) and CASE-2, CASE-3(with low dams) in the entire study area.

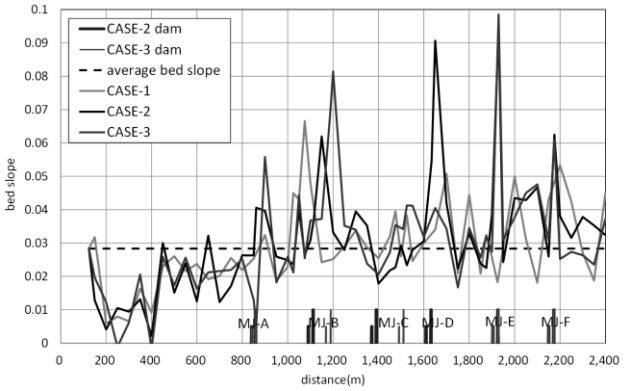

Fig. 2 Changes in riverbed slope

2. **Changes in bed morphology**

Fig. 3 presents the result of overlay of the river width / depth ratio with the ccurrence area map of the sandbars. In the 500m section where the bed slope is gentle, all three cases were resulted in the same double-row bar regime area. In the 1,350m section where the bed slope is steep , CASE-1 was located in single-row bar regime but CASE-2 and CASE-3 results suggested that sandbars could change into double-row bar. Formation of sandbars is maintained in the upstream area, but careful consideration should be given to the potential changes in the form of sandbars.

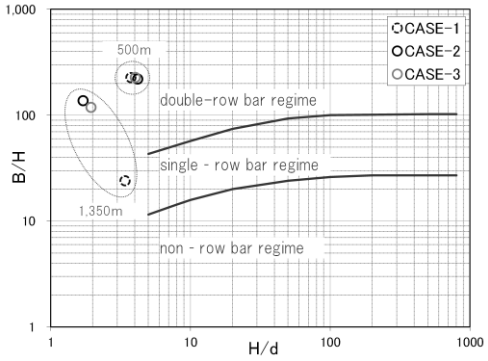

Fig. 3 Sandbars generation area

3. **Continuity of water areas**

The slits of the sabo dams are expected to function as a fishway, but there are some cases recognized in which the slits are blocked due to the accumulation of sediment. For this reason, the sediment shape at the slit was studied by three-dimensional terrain model derived from the photographic images (**Fig. 4**). The model allowed to calculate the water depth and flow velocity of the fishway. As a result, it was suggested that the function of fishway will be maintained (**Tab. 2**).

Tab. 2 Evaluation of fishway function

Case		Depth (cm)	Velocity (m/s)	Fishway
CASE-2	MJ-B(Left)	22.7	1.27	○
CASE-3	MJ-A(Right)	34.8	0.82	○
CASE-3	MJ-B(Left)	43.1	0.66	○

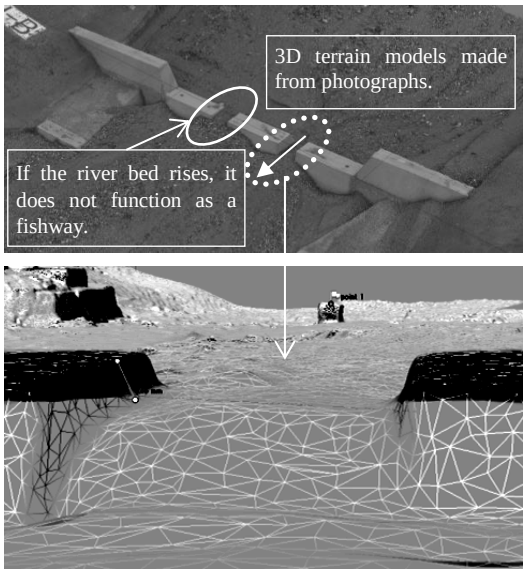

Fig. 4 Three-dimensional terrain model

CONCLUSIONS

As a result of the experiments, quantitative comparisons of the changes in the river environment with sabo facilities are achieved. In addition, it suggests that the impact on the river environment is reduced by the environment-friendly low dams series. On the other hand, it is desirable to conduct monitoring to verify the modelling results, since it remains that the change in sandbar formation is still unclear.

Keywords: hydraulic model experiment, environmental impact assessment, low dams series