EFFECT OF THE CHECK DAMS AGAINST DEBRIS FLOWS IN THE HOFU CITY AREA ON JULY 21, 2009

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INTRODUCTION

The Hofu City in Yamaguchi Prefecture, Japan had heavy rain on July 21, 2009. The accumulated rainfall was 240.5mm and the largest hourly rainfall was 63.5mm/hour. This rainfall caused many shallow landslides, debris flows and flood flows in this city. The situation of the rainfall and the flood water level are shown in Figure 1.

The Tsurugi River and the Hachimandani River are selected as the study areas. In the Tsurugi River, two successive closed-check dams have been constructed, while in the Hachimandani River two successive open-check dams have been constructed, as shown in figure 2. It is important to know the effect of check dams against the debris flow event. This requires an investigation into the effect of the check dams on the sediment deposition.

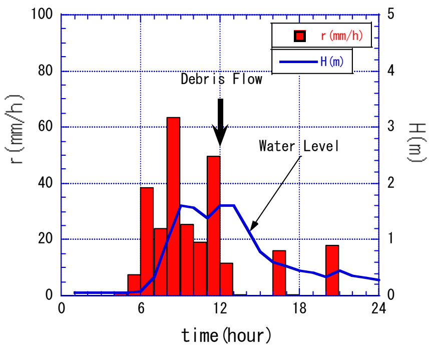

Fig. 1. Rainfall at the Hofu station & water level of the Mate River in the downtown of Hofu City.

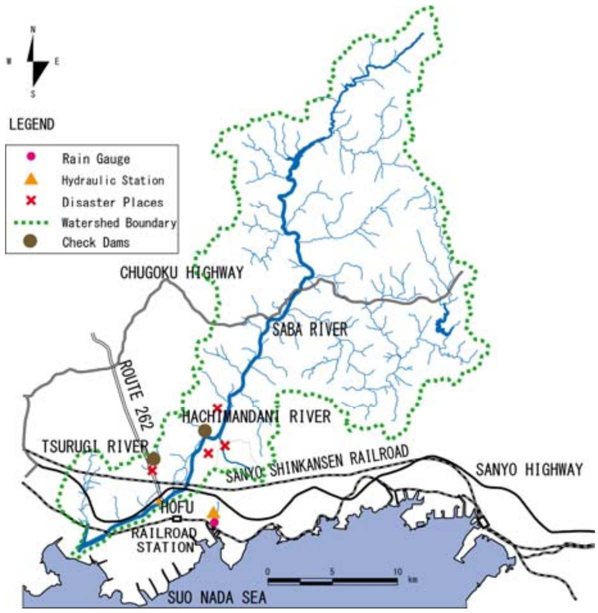

Fig. 2. Study Area.

The purpose of the present study is to examine the effect of the check dams against debris flows from the comparison of river bed profiles before and after the debris flow event.

SEDIMENT DEPOSITION IN THE CHECK DAMS

On November 25 to 27, 2009 and on December 7 to 8, 2009, we visited the Tsurugi River and Hachimandani River. We found that significant amount of sediment was trapped in the check dams. We surveyed the sediment deposition areas of check dams. Figure 3 is the photo of the situation of sediment deposition caused by the upstream check dam of the successive ones in the Tsurugi River. The sediment deposition formed new river bed configuration behind the check dam after the debris flow event. This river reach has a curvature and an inflow of another debris flow from the left-hand side. It can be seen that the river bed has higher part in the outer region and lower part in the inner region of the river bend. The width of sediment deposition zone and the width of the lower part of the river bed is changed.

Fig.3. Sediment deposition caused by the upstream check dam of the successive ones (View from upstream to downstream direction on November27, 2009)

(a)Front of open-check dam　　*(b) Top of open-check dam*

Fig 4. Sediment and driftwood at the upstream check dam in the Hachimandani River.

In the Tsurugi River with two successive closed-check dams, driftwood did not arrive at the check dam but stopped in the central region of the river at x=50 m. Here x is defined as distance measured along the centre line in the upstream direction from the check dam. Whereas, in the Hachimandani River with two successive open-check dams, we found that driftwood had accumulated in the opening of the check dam. However we did not find larger sizes of sediment such as boulders in the opening of the check dam or in the sediment deposition area. The accumulation of driftwood obstructed the sediment transport in the downstream direction (Fig. 4)

DISCUSSION

Characteristics of the sediment deposition in four check dams are summarized in Table 1. The curvature of river course produced space-variation in river bed at the upstream check dam in the Tsurugi River. The lateral inflow of the other debris flows caused an increase in bed elevation due to significant deposition at the check dam areas in the Tsurugi River. The vegetation zone flattened river bed elevation in the Hachimandani River. The Hachimandani River has less space-variation in river bed than the Tsurugi River, because the Hachimandani River has no curvature and lateral inflow near the check dams. Although the Tsurugi and Hachimandani River differ significantly in their river bed slope before the debris flow event, sediment deposition profiles after the event have their almost same longitudinal slope in the upstream and downstream check dam, respectively.

Tab. 1. Summary of the investigation into the check dams in the Tsurugi and Hachimandani River.

	Tsurugi River		Hachimandani River	
	Upstream check dam	Downstream check dam	Upstream check dam	Downstream check dam
Longitudinal river bed slope before the event	3.3°	4.5°	6.3°	7.1°
Longitudinal river bed slope after the event	1.9°	3.4° (0≤x≤50m) 1.4° (50m≤x)	2.0°	1.3°
River bed configuration after the event	Sediment deposition at the outer side and bed erosion at inner side in the river bend region	Sediment deposition near the lateral inflow	Sediment deposition in the central part of the river bed	Nearly flat
Lower part of the river bed	Width = 3～7.5m Depth = 1.5～2m	Width = 2～6.4m Depth = 1m	Width = 1.5～4m Depth = 0.5～1.5m	Width = 2～4m Depth = 0.5～1m
Driftwood accumulation position	In the central region of the river bend area	Near the lateral inflow	In the opening of the check dam	In the opening of the check dam
Boulder	Boulders near the lateral inflow	Boulders near the lateral inflow	No boulders	No boulders
d_{50}	1.42mm	0.96mm	1.38mm	0.99mm
Width of River behind the check dam	16～37m	14～34m	14～46m	19～35m
Volume of the trapped sediment	7,400m^3	2,200m^3	7,300m^3	2,200m^3

Driftwood accumulated above the river bed surface near the region of river bend and lateral inflow in the Tsurugi River, whereas it accumulated in the opening of the open-check dams in the Hachimandani River. The accumulation of driftwood in the opening of the check dams obstructed the transport of the whole sizes of sediment to the downstream direction.

The volume of sediment trapped by the upstream check dam in the Tsurugi River is almost same as that by the upstream check dam in the Hachimandani River. The volume of sediment trapped by the downstream check dam in the Tsurugi River is same as that by the downstream check dam in the Hachimandani River. The ratio of sediment volume by the downstream check dams to that by the upstream ones is 0.3 : 1. The total amount of sediments trapped by the two successive check dams is about 9,500 m3 in each river. This result reduced the sediment outflow from the mountainous areas to the residential areas. It is concluded that more severe disasters have been avoided by the two successive check dams

CONCLUSION

In the Hachimandani River, accumulation of driftwood in the opening of the open-check dams obstructed the sediment transport to the downstream direction. On the other hand, in the Tsurugi River, driftwood did not accumulate at the closed-check dams. The volume of sediment trapped by the check dams in the Tsurugi and Hachimandani River is almost same.

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