THE CASE OF SEDIMENT OUTFLOW FROM MOUNTAIN TO THE COAST DUE TO SMALL AND MEDIUM-SIZE FLOODS

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INTRODUCTION

Smaller rivers in Japan can be characterized as having short distances from the mountainous areas of the source of sediment production to the estuary and steep slopes. Therefore, sediment produced from the mountains and river channels at the time of flooding immediately contributes significantly to the sediment dynamics at the estuary and coast in a short period of time. On the other hand, there have been few observations or studies that have measured the volume of landslides and riverbed fluctuations in the mountains in the entire basin before and after the occurrence of flooding, and quantitatively linked them to the amount of landslide movement and shoreline changes in the entire basin.

This paper discusses the Chitose River basin (basin area A: 30km^2, river channel distance L: 0.179km, stream gradient I: 1/14) and the Niizaki River basin (A: 16km^2, L: 0.213km, I:1/17), which have an estuary on the Yugawara coast in Kanagawa Prefecture. The effect of sediment production from mountains and riverbeds at the time of flooding on coastal sediment dynamics on July 3rd, 2021 is reported here.

Figure 1 shows the target basin. The riverbed gradients of the target rivers are all about 1/20 to 1/10. Near the mouth of the river, it is 1/54 at the Chitose River and 1/34 at the Niizaki River, which is the transition zone from debris flow to bed load (Fig.2).

CONDUCTING AERIAL SURVEY

On May 28th, 2021, Airbone Laser Profiler (LiDAR) measurements in the two target basins were carried out. After that, the torrential rain that occurred on July 3rd of the same year caused sediment damage due to flooding of roads, revetment outflow, and debris flow in Yugawara City. At the rainfall observatory near the 2 basins (Odawara point of the Japan Meteorological Agency), 228 mm (5 to 10-year probability scale) for 24-hour rainfall and 317 mm (10 to 20-year probability scale) for 48-hour rainfall were recorded. Due to this damage, the LiDAR measurement was carried out again on July 21st after the flood. Based on the LiDAR measurement results from before and after the flood, the amount of landslides and riverbed fluctuations from the mountains were calculated (Fig. 3).

INVESTIGATION RESULTS

From the LiDAR survey results, it is considered that there are only a few landslides, and sediment mainly moved in the river channel. As a result of calculating the sediment volume in the entire basin by differential analysis using the results of two LiDAR dates (in May, 2021 and in July, 2021), the amount of sediment that flowed out from the estuary was 22,000 m^3 for the Chitose River and 13,000 m^3 for the Niizaki River.

Numerical calculations were performed to recreate the amount of sediment runoff and changes in the riverbed to understand the actual situation . As a result, it was found that the conditions without sand supply were calculation conditions that matched the actual situation from the following two points: (1) the riverbed fluctuation confirmed in the field survey after the disaster, and (2) the amount of sediment runoff was about the same as the difference amount of the LiDAR. In this case, when the riverbed changes were checked in the longitudinal direction of the Chitose and Niizaki rivers and the accumulation amount of quicksand, it was found that even if the riverbed rose due to confluence during the flood period, it eventually turned to a decline. As a result, the section set as the moving bed

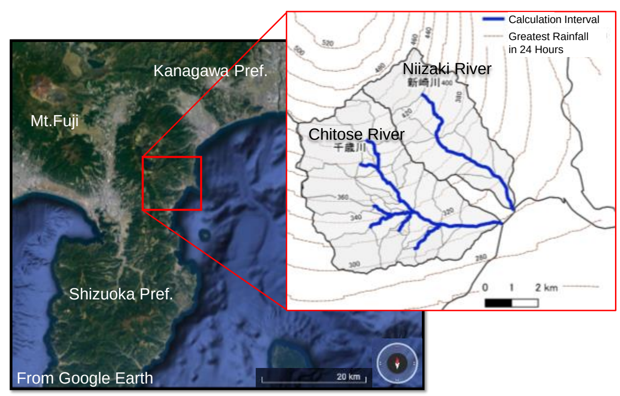

Figure 1 - Location of Chitose River and Niizaki River basin

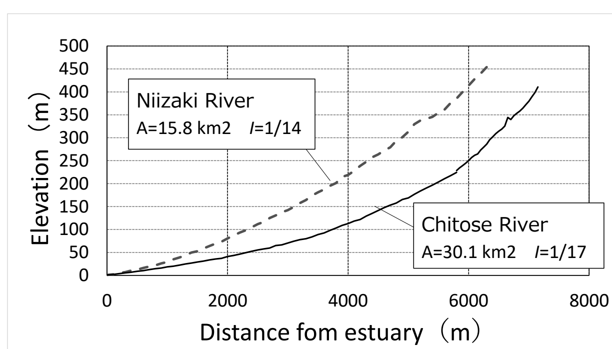

Figure 2 - Riverbed profile

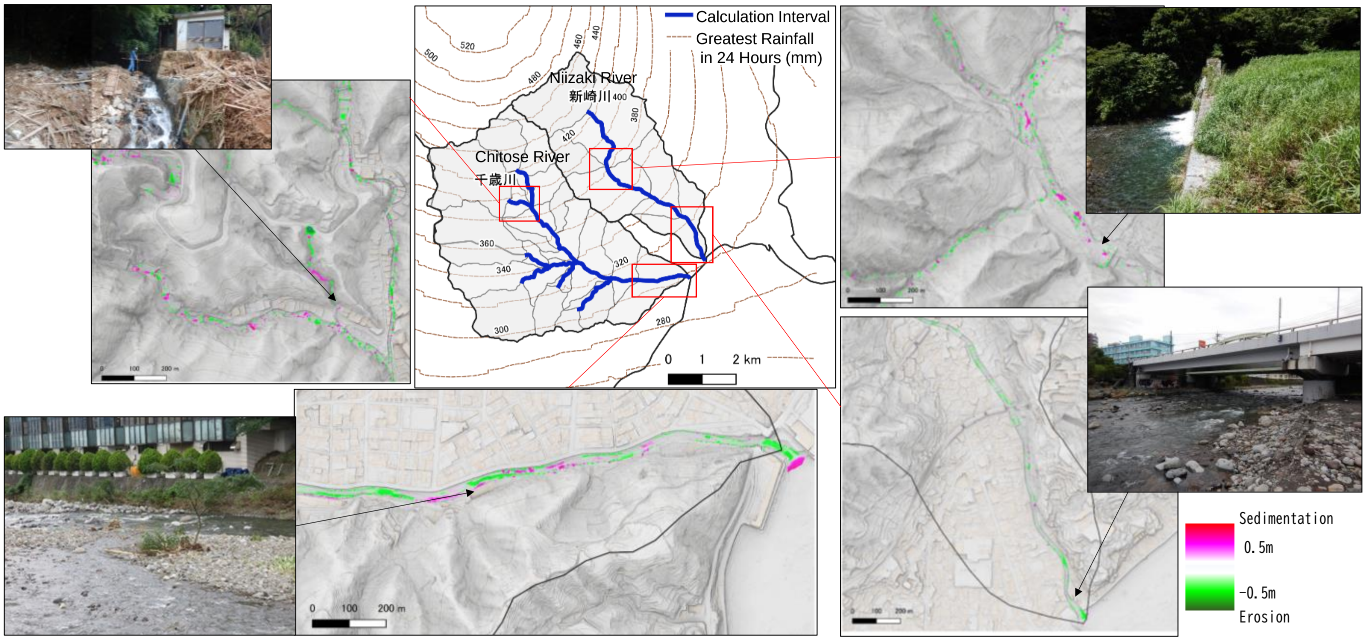

Figure 3 - Front-back difference analysis result by Airbone Laser Profiler (LiDAR)

lowered to the lowest riverbed height. Since it is a torrent river that is well developed and the accumulation of quicksand also shows a nearly uniform increasing trend from upstream to downstream, except for the erosion control dam, it can be assumed that the sediment supply flows almost straight to the mouth of the river (Fig. 4).

In order to confirm sediment dynamics in the estuaries and coastal areas of each basin before and after the flood, the shapes of the estuaries and shorelines before and after the flood were compared using aerial photographs (Fig. 5). At the mouth of the Chitose River, it was confirmed that the sand spit was pushed upstream from the sea side before the disaster. However, after the disaster, the sand spit in the river channel was pushed offshore and the estuary was blocked. The sand spit was formed by flooding at the mouth of the Niizaki River.

PREDICTION OF BEACH TOPOGRAPHIES

Beach topography was predicted by a numerical simulation using the BG model (a model for predicting three-dimensional beach changes based on Bagnold's concept) (Uda 2017; Uda et al. 2018) and the calculated sediment volume. In this calculation, in order to qualitatively evaluate the impact on the coast, the initial topography was simply reproduced and simulated. The initial topography is shown in Figure-6.1.

The sediment that flowed out from the river mouth (Chitose River: 22,000 m^3, Niizaki River: 13,000 m^3) was put into the initial topography, and coastal deformation prediction calculation was performed (Fig. 6.2). Figure-6.3 shows the difference analysis between the initial topography and the calculation results. The sediment that flowed out from the Niizaki River is deposited on the left bank, and the sediment that has flowed out from the Chitose River is deposited on the right bank and in front of the landfill site.

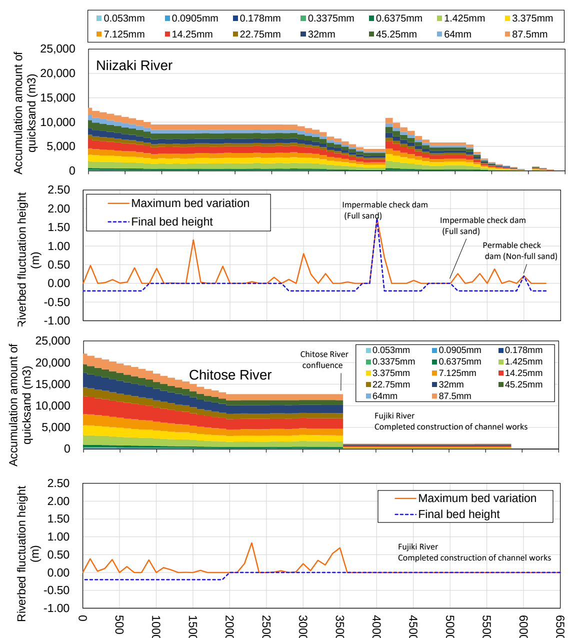

Figure 4 - One-dimensional riverbed fluctuation calculation result (without sand supply)

CONCLUSION

Due to this heavy rain, it was confirmed that while some of the sediment produced in the mountain was confirmed to be deposited on the check dam, but it hardly accumulated in the river channel and eroded the riverbed and flowed directly to the estuary. In addition, from the riverbed variability calculation, it was confirmed

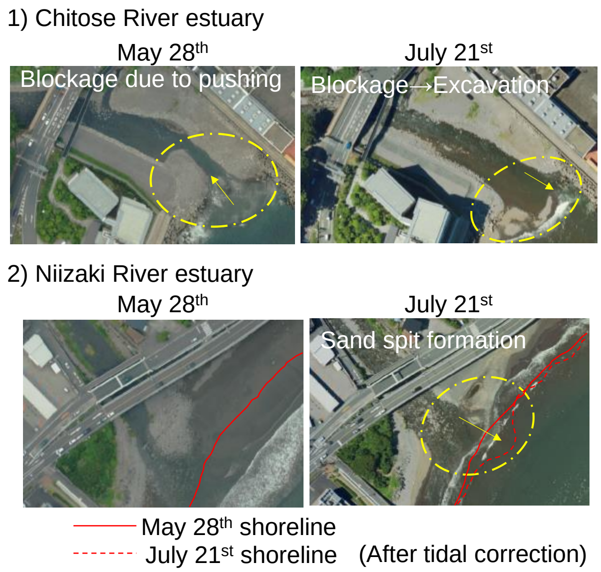

Figure 5 - Transition before and after heavy rain by aerial photography

that when the basin is small, the amount of sediment generated from the mountain affects the estuary and coastal sediment dynamics in a short period of time, from the survey and the results of riverbed variability calculation for the entire basin.

As for the impact on the coast, beach deformation prediction calculations on the impact of sediment produced by small and medium floods on the coast was performed, and it was confirmed that the sediment supplied from the Niizaki River and the Chitose River contributes to the shoreline advance of the coast. In this study, the topographical conditions are set simply. However, in reality, there is an artificial reef in front of the reclaimed land, and the land shape behind it is a circular arc, so it is slightly different from the initial topography. Therefore, it is a future task to reproduce the actual land shape and evaluate the impact of the sediment supply from the river on the coast. In addition, the aerial photograph in Figure 5 confirms the blockage of the estuary, and quantitative evaluation and analysis by reproducing the blockage of the estuary will be undertaken as well.

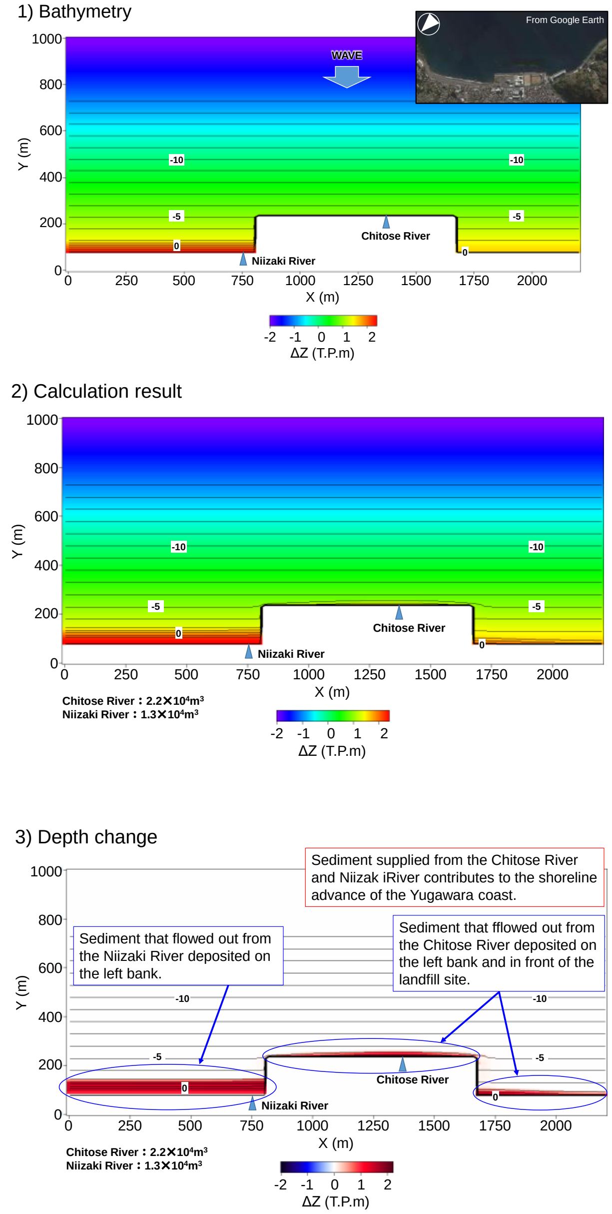

Figure 6 - Prediction of beach topographies

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