River Tsunami Simulation Experiment with Large Hydraulic Model

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1. Characteristics of River Tsunami to Consider in Studying Measures

The water level of tsunami is essential information in considering various measures for tsunami disasters, such as determination of levee height and discussion on town development / evacuation. Water levels in rivers or flooded areas are generally obtained through tsunami analysis by tracing a series of events including arrival at the coast and run-up along the river channel. In such tracing, characteristics of rivers should be taken into consideration.

One of such characteristics is topographic changes in river channel. As flood control measures, a sand bar and other areas where river bed is high may be dug down to lower the water level in case of flood or flood plane may be dug to widen the river. If such digging causes any change to tsunami water level, it should be considered in determining the height of levee.

Another characteristic is that whether tsunami water could overtop from the river or magnitude of tsunami may change according to the condition of levee breakage. The reason for mentioning this is that if tsunami water breaks the levee and overtops and floods, the level of water that further runs upward from the breakage point may be lowered. Since such events occur in various ways, it is important to consider them and observe the condition of flood at various points in the upstream and downstream.

2. River tsunami simulation experiment using a large model

In order to deepen the understanding of such characteristics of river tsunami, we conducted a simulation experiment [1)] by running water up a large scale model of an actual river to obtain data on various tsunami scales and terrains, in addition to the data on the actual tsunami caused by the Great East Japan Earthquake. We made a 1:330 model of the area of 10 km x 11 km, as shown in the **Photo**, which includes the protected lowland up to the point about 10 km upward from the mouth of Kitakami River.

Digging a sand bar or flood plane was expected to facilitate the run-up of tsunami and consequently raise upstream water level, which was, however, not observed in the simulation, and the water level was lower than before digging at some points.

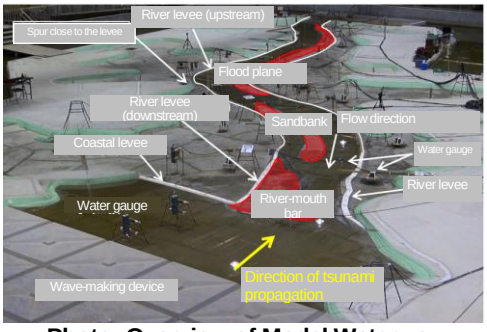

Photo: Overview of Model Waterway

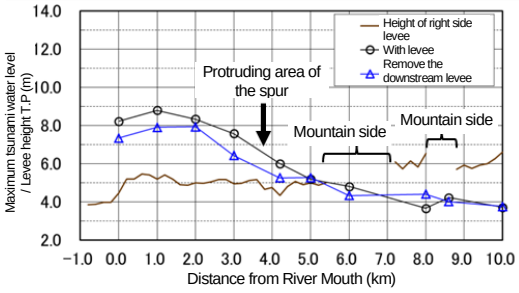

Figure: Measurement of Maximum Water Level of Run-up Tsunami

To simulate a situation where the downstream levee shown in the Photo was broken, we also conducted the experiment by removing the same levee. The result showed the water overtopped about 1 m from the levee upstream the river in the protruding area of the spur, while the water overtops about 2 m in the experiment simulating a situation where no breakage of the levee occurs (see the **Figure**).

3. Future study

It is not yet clarified what conditions of tsunami and topography cause such phenomena but they would suggest the necessity of study under various conditions according to locations, scales of topographic changes, etc. In order to study such issues more simply and accurately, we are further considering with tsunami experts aiming for further improvement of analytical methods and presentation of how to set conditions.

[Reference] Masaki FUKUSHIMA, Tatsuro MATSUURA, Atsushi HATTORI, "Experimental Study on the Characteristics of River Tsunami," Journal of Japan Society of Civil Engineers, Ser. B2 (Coastal Engineering), Vol. 60, No. 2, pp. I_261-265, 2013.