For Avoiding the Worst-Case Flooding Scenario

--- Study on damage reduction measures in case floods overwhelm flood control structures ---

(Research period: FY2021 to FY2023)

OKAYASU Kotaro, Researcher,
ITAGAKI Osamu (Ph. D. in Disaster Management), Head
Flood Disaster Prevention Division, River Department

Key words: River Basin Disaster Resilience and Sustainability by All, flood damage reduction, flooding scenarios

1. Introduction

In recent years, due to the impact of climate change, large-scale floods that exceed the design scale of flood control structures have frequently occurred and caused severe flood damage throughout Japan. Accordingly, the Water and Disaster Management Bureau of the MLIT is promoting "River Basin Disaster Resilience and Sustainability by All," a sustainable flood damage prevention / reduction measure that is carried out on a basin-wide basis with the cooperation of all stakeholders throughout the river basin. Conventionally, measures to prevent flooding through the development of flood control structures such as levees and dams (Level 1 measures) and measures to protect lives by evacuation and other means from the assumed maximum scale flood (Level 2 measures) have been mainly implemented (**Fig. 1**). However, in light of the fact that the boundary lines in **Figure 1** are expected to shift to the left (to the red dashed lines) due to climate change, "flood damage prevention / reduction measures that protect not only lives but also assets and livelihoods" ("Level 1.5 measures") that fill the gap between the two measures will become even more important in addition to the above measures. This research aims to develop a specific method for studying Level 1.5 measures, which are not yet established, and a method for evaluating the effectiveness of the measures.

2. Specific examples

As examples of Level 1.5 measures, **Figure 2** shows an example of overtopping sections installed on existing riverine levees in the Saga Plain (Nokoshi), and **Figure 3** shows a conceptual diagram of the U.S. Army Corps of Engineers ECB No. 2019-8, "Managed Overtopping of Levee Systems". The former is a traditional flood damage reduction method that has been documented since the Edo era, in which a certain amount of flood flow or more is allowed to overflow to prevent damage to irrigation facilities downstream, etc. The latter is designed to ensure evacuation time for the community and to achieve cost reduction and acceleration of the restoration of levees, etc. by providing longitudinal elevation differences in the height of riverine levees to allow flood water to overflow from a section where damage from flooding is considered relatively small in the event of a flood that exceeds the design scale of the levee system.

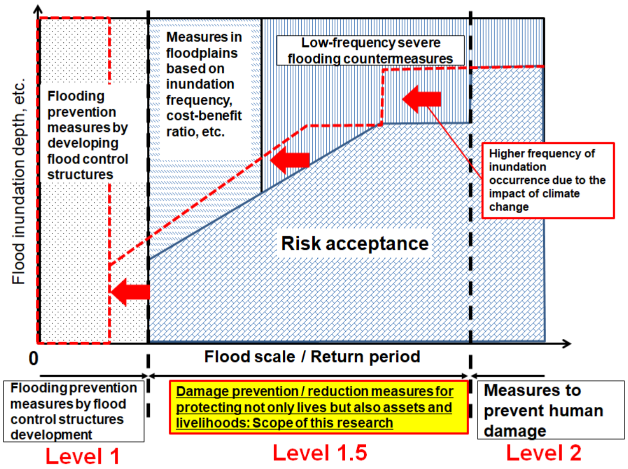

Fig. 1; Damage prevention / reduction measures according to flood scale

Fig. 2: Nokoshi, letting overflow for damage reduction

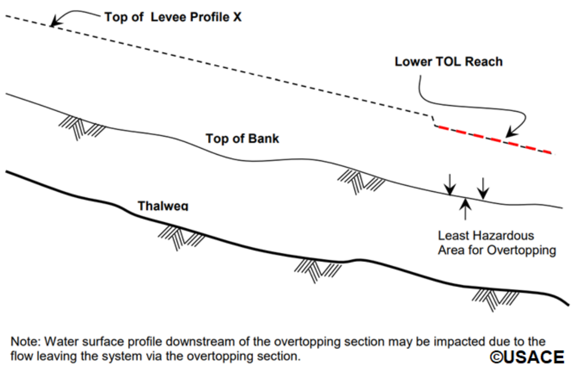

Fig. 3 Conceptual diagram of managed overtopping in the U.S. Army Corps of Engineers levee system

As of the 2019 survey, there were no sites where this method was actually implemented.

3. Study of level 1.5 measures based on flooding scenarios

For studying Level 1.5 measures, measures to avoid the worst-case flooding scenario for the area were selected as the subject of research. The reason for selection was that these measures should be studied first from the perspective of avoiding fatal damage in the area. **Figure 4** shows a conceptual diagram of studying the worst-case flooding scenario. In a series of levee sections where the safety factor is considered the same, the levee can breach at any point in the event of a flood exceeding the design scale, but the flooding damage is different according to the locations of levee breach, e.g., the damage is particularly severe when hospitals and city halls are flooded. In this research, the worst-case flooding scenario was identified from a set of possible flooding scenarios based on land use and distribution of residences, etc., and measures to avoid this scenario were examined (**Fig. 5**).

4. Interim report on test application

We selected a test application area based on the level of interest of local governments in flood countermeasures, and collected necessary materials and data from relevant organizations. The flooding analysis model was designed to calculate both pluvial flooding (flooding caused by rainfall due to insufficient drainage capacity in urban areas, etc.) and fluvial flooding (flooding caused by increased river discharge due to rainfall in mountainous areas upstream of rivers). The area of the site was approx. 20 km^2 with a mesh size of approx. 25 m.
Three flooding scenarios were prepared and compared for the levee breach flooding in the main river section (about 6 km in length). The target floods were set by expanding a well-known recent flood to the design scale. The assumed levee breach points were determined to be where the volume of flooding water is the largest (i.e., smallest flow capacity corresponding to the bottom height of the possible levee break) in each of the three sections divided from the 6km segment at the interval of about 2 km. Among these flooding scenarios (**Fig. 6**), the upstream levee breach scenario is considered to be the flooding scenario that should be avoided with top priority because it causes more serious damage, such as flooding of the city hall. We will continue to study the criteria for determining the worst-case flooding scenario, as well as branch river flooding and pluvial flooding.

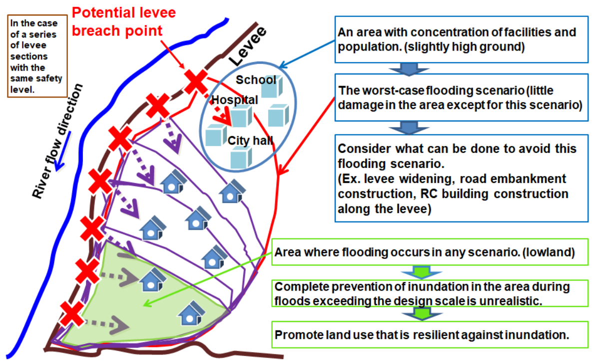

Fig. 4: Image of study on worst-case flooding scenario

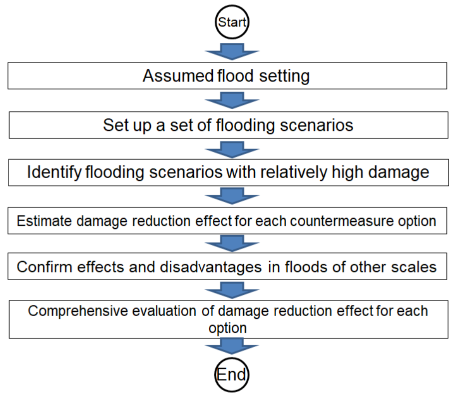

Fig. 5: Steps for studying countermeasures based on a set of flooding scenarios

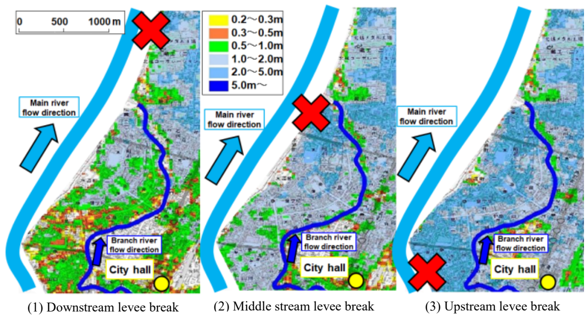

Fig. 6: Results of trial calculation of inundation depth distribution for each flooding scenario

5. Conclusion

We plan to study specific measures to avoid the worst-case scenario, evaluate their effectiveness, and develop easy-to-understand methods of presenting the analysis results, etc., which are necessary to build consensus in the community.

☞See the following for related information.

1) Research on evaluation methods for flood damage reduction effects by flood damage reduction measures for consensus building necessary to promote River Basin Disaster Resilience and Sustainability by All
https://grips.repo.nii.ac.jp/?action=pages_view_main&active_action=repository_view_main_item_detail&item_id=1850&item_no=1&page_id=13&block_id=24