Direction for Utilizing Flood Risk Maps to Enhance Watershed Flood Preparedness

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1. The starting point for watershed flood preparedness is to share a sense of crisis

In July 2020, the Social Infrastructure Development Council submitted a report regarding the transition to watershed flood preparedness. The report emphasizes that, beyond concrete actions by river administrators and evacuation plans by local governments, various stakeholders within a watershed should collectively participate in a range of measures implemented in catchment and flood-prone areas, hereafter referred to as "disaster mitigation measures," forming a multilayered collaborative approach.

Achieving collaboration in flood preparedness across a watershed begins with fostering a shared sense of crisis, realizing the need to take preventive actions and avert potential disasters. Achieving this necessitates the sharing of flood risks, specifying the locations and frequency of potential flood disasters linked to climate change. River administrators, who have diverse river-related information, are anticipated to provide flood disaster risk information, forming the essential basis for cultivating a shared awareness of the impending crisis.

In light of this awareness, the NILIM formulated guidelines[1] in January 2023 outlining the process of developing a flood risk map and concurrently conducted a study on their effective utilization.[2] This paper presents the results of these initiatives.

2. Flood risk map emphasizing the likelihood of flooding

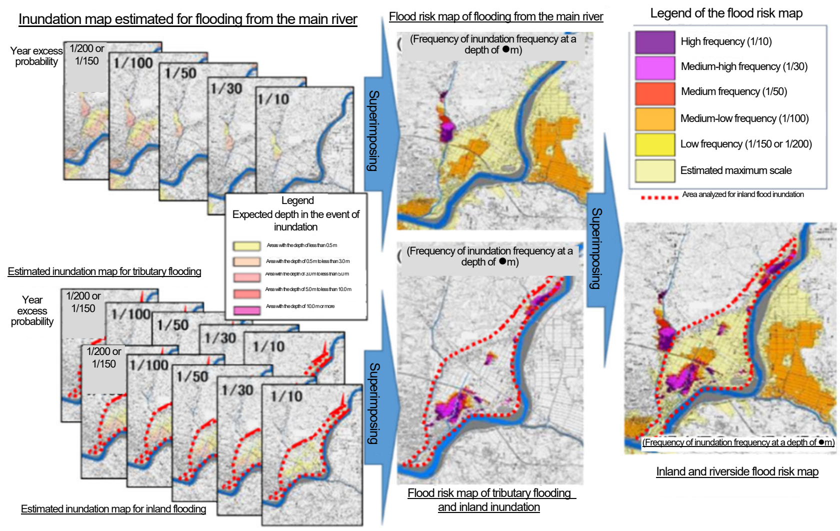

Figure 1. Illustration of creating a flood risk map

Figure 1 illustrates the steps involved in crafting a flood risk map. For more detailed steps, please refer to the reference.[2] The flood risk map displays the distribution of rainfall levels (annual exceedance probability) anticipated to result in inundation depths of 0.5 meters or more and 3.0 meters or more referred to as "inundation frequency." Traditional flood inundation area maps depict flood depths and other information during the peak anticipated rainfall, helping estimate potential damage to an area in the event of a major flood. These maps have been frequently utilized for implementing evacuation measures. In contrast, flood risk maps concentrate on the likelihood of flooding (frequency of occurrences). The flood risk map, covering both landside and riverside waters, enables users to identify the frequency of inundation by depths and occurrences caused by branch rivers and within levees.

With this map, local residents find it easier to comprehend the inundation conditions resulting from the different levels of rainfall they have experienced. This type of map, by depicting inundation in a manner closely aligned with the perception of local residents, is anticipated to serve a wide range of purposes.

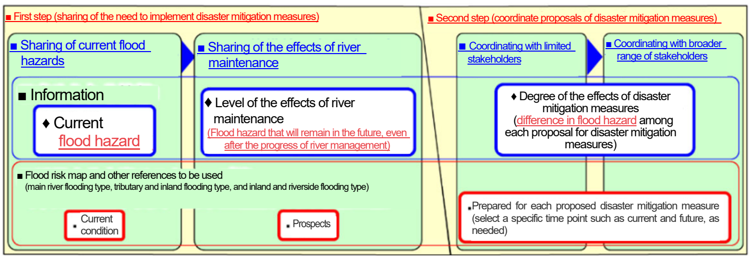

Figure 2. Disaster mitigation measures consensus building process and flood risk maps and other references utilized

3. The process of building consensus among diverse stakeholders within the watershed

Figure 2 illustrates two structures of the consensus-building process that led to the collaboration of all stakeholders in the watershed. The first step involves stakeholders sharing a collective awareness of the urgency to take action and reaching an agreement to implement disaster mitigation measures. In the second step, stakeholders specifically explore and coordinate the specific combination and approach of disaster mitigation measures to be implemented on-site by reaching an agreement.

The first step requires identifying flood risks that persist both presently and in the future even as river improvement measures are underway. In the second step, it is necessary to identify the locations of existing flood risks and anticipate how they might change as a result of implementing disaster mitigation measures.

4. Challenges in using flood risk maps

To identify the flood risks required at each step of the consensus-building process outlined in section 3 above, the interpretation of flood risk maps and other references is needed. This process organizes information on inundation depths and inundation frequency categorized by different depths for the present, future, and before and after the implementation of disaster mitigation measures.

Conversely, the flood risk map illustrates an instance of numerical analysis results obtained by uniformly configuring such conditions as the spatiotemporal distribution of rainfall and initial water level. On the contrary, the flood risk generated based on actual flooding, a natural phenomenon, inherently carries uncertainty. This uncertainty arises because, even with the same level of rainfall, there can be variations in the spatiotemporal distribution of rainfall, as well as differences in river levels, flooding, and inundation conditions **(Figure 3).**

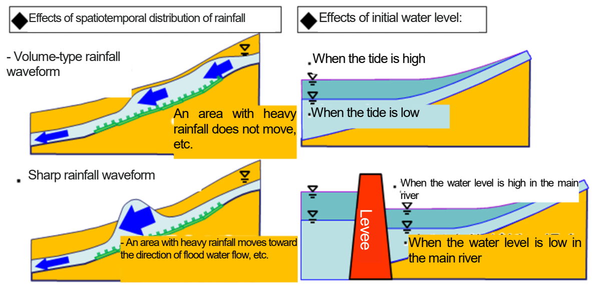

Figure 3. Example of a variety of natural phenomena which affect numerical analysis (illustration)

Moreover, a variety of disaster mitigation measures exist, including utilizing rice paddies and reservoirs, and installing rainwater storage facilities and double levees. The effectiveness of these measures varies based on their types, the volume and flow movement of inundation water, and the terrain. In certain instances, these specific measures prove effective in mitigating the damage caused by mid-to-small-scale inundations. In mid-to-small-scale flooding events, such factors as sewage pipes, microtopography, and channels influence the amount and direction of inundation flow. However, enhancing the sophistication of models for sewage pipes and other factors requires significant costs in terms of both finances and time.

Simply put, we must employ numerical analysis to evaluate current and future flood risks as well as the effectiveness of disaster mitigation measures. However, there is often a large discrepancy between the actual inundation volume and flow direction during real disasters and the outcomes of numerical analysis. Hence, we must devise an evaluation method that takes into account both the impact of this disparity and the influence of numerical analysis on the assessment.

5. Future prospects - for the progress of watershed flood preparedness -

To encourage the progress and effectiveness of watershed flood preparedness, it is crucial to implement effective disaster mitigation measures. Achieving this requires consensus building among diverse stakeholders within the watershed. Moreover, as the Task Force on Climate-related Financial Disclosures (TCFD) issues recommendations[3] and environmental, social, and governance (ESG) investment gains popularity, there is a growing societal interest in flood risks.

This paper has introduced flood risk maps as a tool to illustrate flood risks in the context of advancing watershed flood preparedness.

We will continue to develop tools and conduct additional research to ensure the accuracy and fairness of flood risk information, including flood risk maps, in order to meet their intended purpose.

☞For more information:

1) Guidelines for Studying and Creating Multi-Level Inundation Estimation Maps and Flood Risk Maps http://www.mlit.go.jp/river/shishin_guideline/pdf/guideline_kouzuishinsui_2301.pdf
2) Inoue, et al. Utilization of Flood Risk Maps for the Advancement of Disaster Mitigation Measures in Watersheds (in Japanese). *Civil Engineering Journal*, Vol. 64, No. 12, 2022, pp. 28-31.
3) Task Force on Climate-related Financial Disclosures. Final Report: Recommendation by the Task Force on Climate-related Financial Disclosures. 2017.