# RESEARCH ON METHODS FOR ANALYZING THE IMPACT OF FLOOD CONTROL FACILITIES ON EXTREME RAINFALL EVENTS

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## 1. Introduction

The basin of the Chitose River, which is the basin addressed in this study (Ca=1,244km$^2$, L=108km), is characterized by the fact that much of the river flows through low-lying areas **(Figure 1)**. The Chitose River is affected for an extended time by backwater from the Ishikari River. The backwater eventually affects tributaries of the Chitose River and navigable/drainage canals connected to those tributaries. The authors have been developing a flood analysis model for large river basins in low-lying areas. This study aims at estimating the effectiveness of flood control facilities against extreme rainfalls. For this purpose, flood analysis was conducted by considering inland waters and river water in an integrated manner for the cases with and without flood control facilities including flood control basins, on the assumption that climate change will cause critical rainfall in the future.

## 2. Study method

The flood analysis was conducted in three stages **(Figure 2)**. In the first stage, data were extracted regarding heavy rainfall events that are likely to take place in the future due to climate change. The grid size of the data used for extraction was downscaled from 20km given by d4PDF to 5km by Yamada et al. Rainfall events in the Ishikari River Basin were extracted in descending order of 3-day cumulative rainfall. **Table 1** shows the top 10 cases of the 5400 cases in the Ishikari River basin. The largest case was the input condition for flood analysis.

In the second stage, runoff analysis was conducted for each of the sub-basins of the upper mainstream of the Chitose River, its tributaries, and 10 drainage canals. In the third stage, the inflow rates obtained by the runoff analysis were fed into a 1-D unsteady flow calculation model. Then, a 2-D planar unsteady flow calculation model was used for estimating inundation heights on the assumption that overflow water runs toward floodplain areas when the river overflows its banks.

## 3. Analysis results

- According to the result of d4PDF (Future rainfall), the maximum 3-day cumulative rainfall in the Chitose River basin is 547 mm, which is 1.61 times the maximum 3-day cumulative rainfall of 340 mm recorded during the flood in August 1981 (**Figure 3**).
- **Figures 4** and **5** show the estimated heights of inundation associated with climate change. **Figure 4** shows the estimation results under the condition that no flood control facilities are in place. In **Figure 5**, the estimation results are based on the condition that drainage pump stations and 6 flood control basins are in place. The inundation area without flood control facilities is increased to 177km$^2$ **(Figure 4)**. Because urban areas and national highways will be affected by inundation, high risks to human life and economy are expected. An area equivalent to 142km$^2$ will be inundated when 6 flood control basins and other flood control facilities are in place **(Figure 5)**.

## 4. Conclusions

- Excluding the total inundated area in the flood control basins, the area affected by inundation is 35km$^2$ (=177-142) smaller in **Figure 5** than in **Figure 4**. With the flood control facilities, the total area with inundation heights of 0.5m or greater decreased by 25km$^2$. Because a water depth of 0.5m makes it difficult for people to walk, it can be concluded that flood control facilities help to mitigate flood disaster.
- This analysis model is useful for evaluating the effectiveness of flood control facilities against the risks associated with climate change as well as for examining disaster prevention countermeasures for the future.

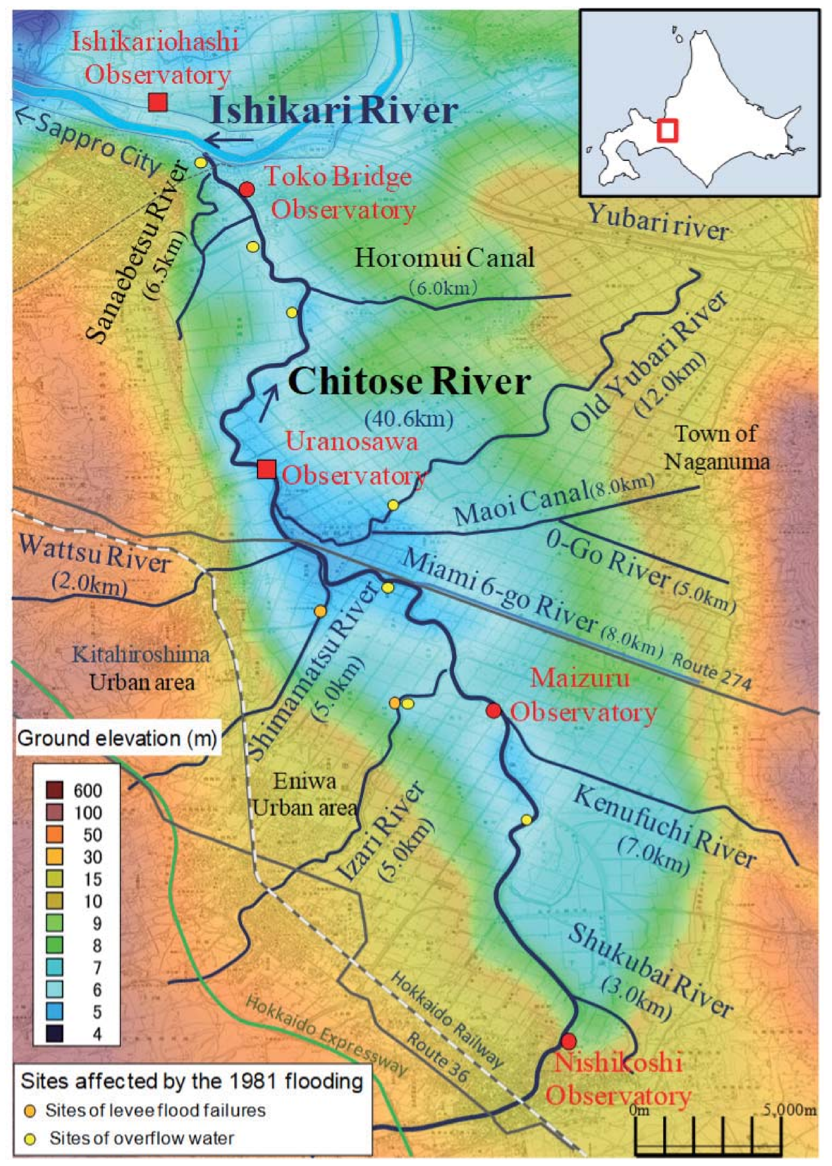


**Figure 1.** Topographic map of the Chitose

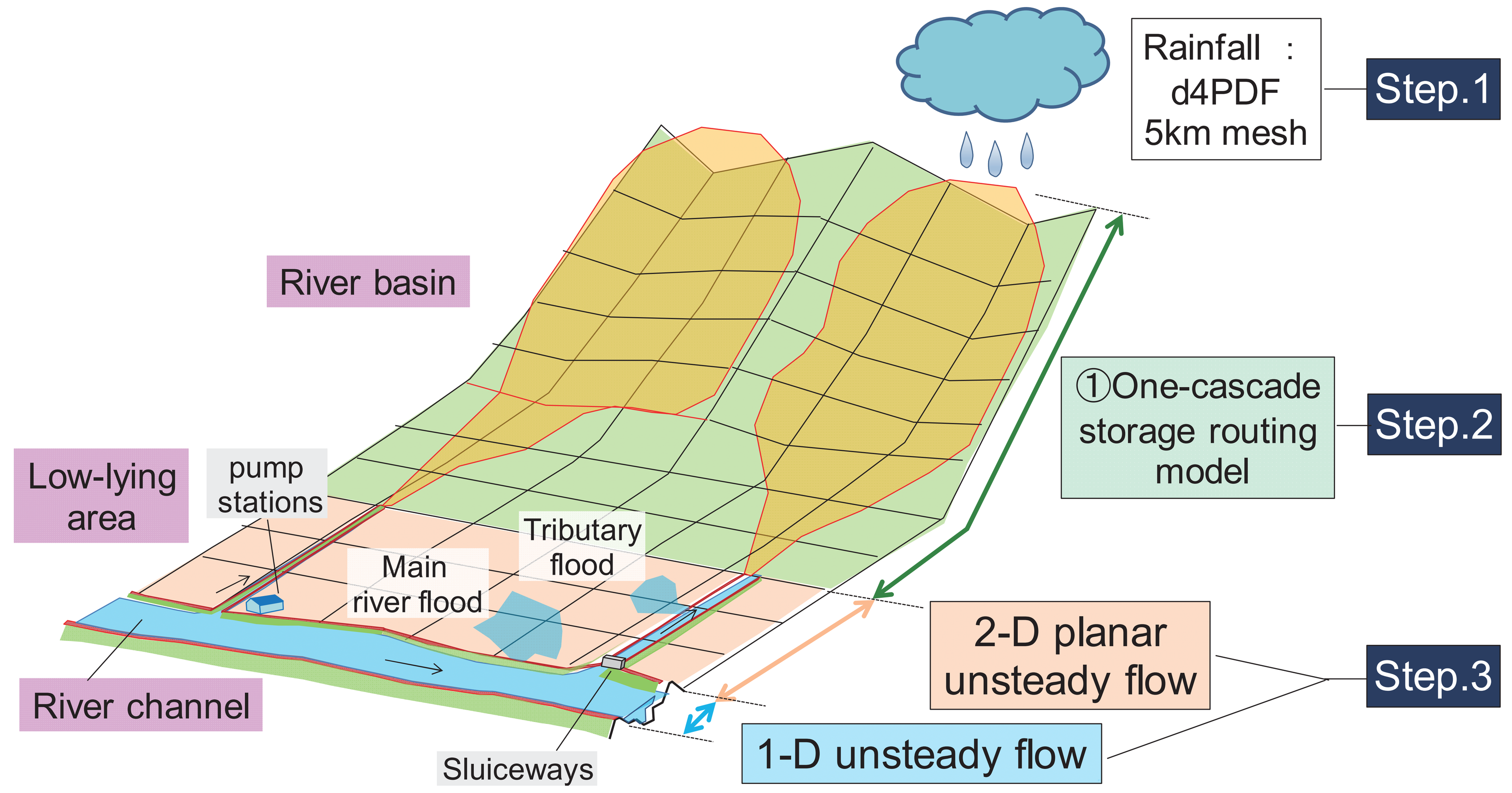


**Figure 2.** Flood model integrating inundation due to interior runoff and river flooding

**Table 1.** Estimated future extreme rainfall events and their magnitudes in comparison to the past 10 largest rainfall events (Ishikari River).

| Ranking | Cases forecast on the basis of D4PDF | Annual maximum rainfall in Ishikari basin (mm/72h) | Multiplying factor in comparison to the rainfall in Aug. 1981 |
|---|---|---|---|
| 1 | HFB_MP_m112_2062 | 454 | 1.61 |
| 2 | HFB_MI_m108_2094 | 454 | 1.61 |
| 3 | HFB_GF_m110_2052 | 386 | 1.37 |
| 4 | HFB_GF_m104_2072 | 373 | 1.32 |
| 5 | HFB_MR_m102_2062 | 356 | 1.26 |
| 6 | HFB_HA_m102_2065 | 345 | 1.22 |
| 7 | HFB_CC_m114_2085 | 331 | 1.17 |
| 8 | HFB_MI_m103_2103 | 325 | 1.15 |
| 9 | HFB_MI_m106_2059 | 315 | 1.12 |
| 10 | HFB_MP_m101_2067 | 311 | 1.10 |

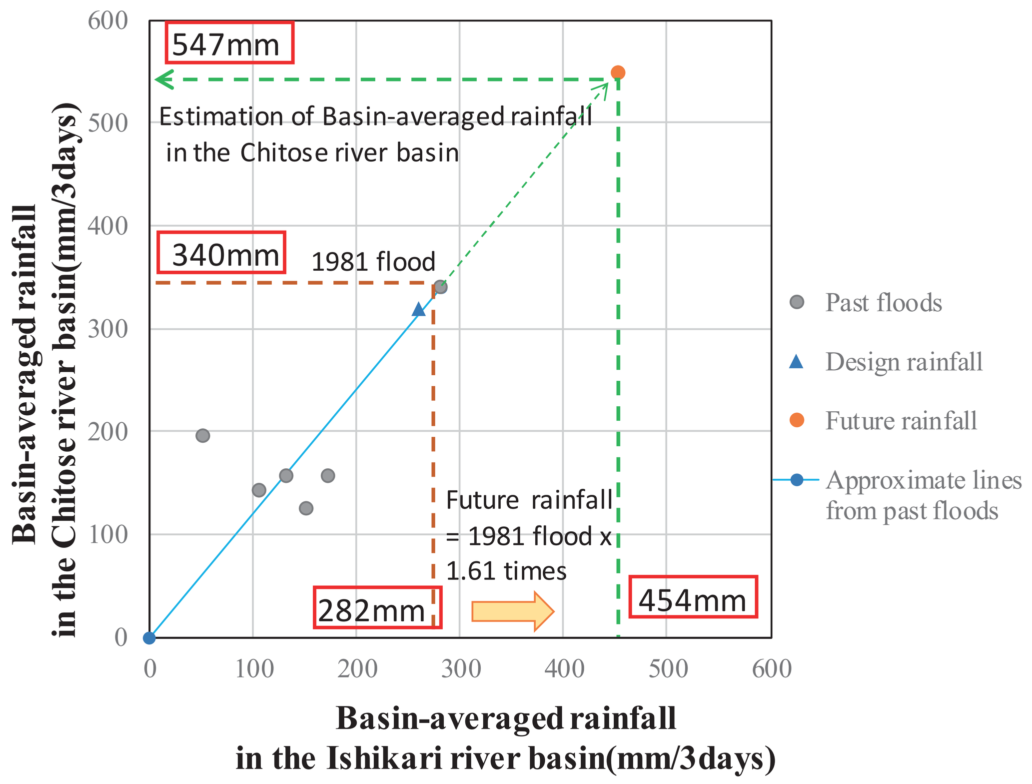


**Figure 3.** Estimation of future extreme rainfall events in the Chitose River Basin

<No flood control facilities in place>

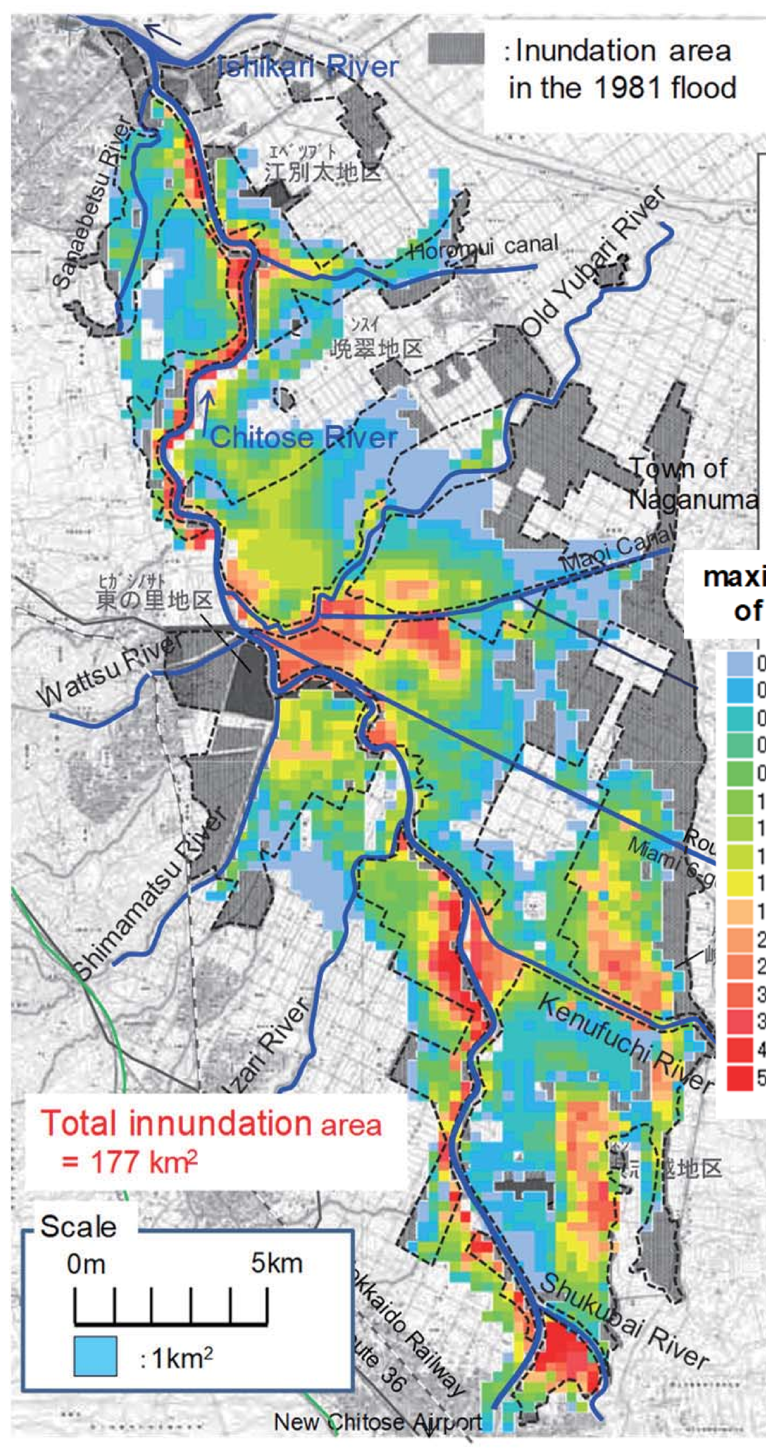


**Figure 4.** Simulation results for maximum depths of inundation(w/o flood control facilities)

<Flood control facilities in place>

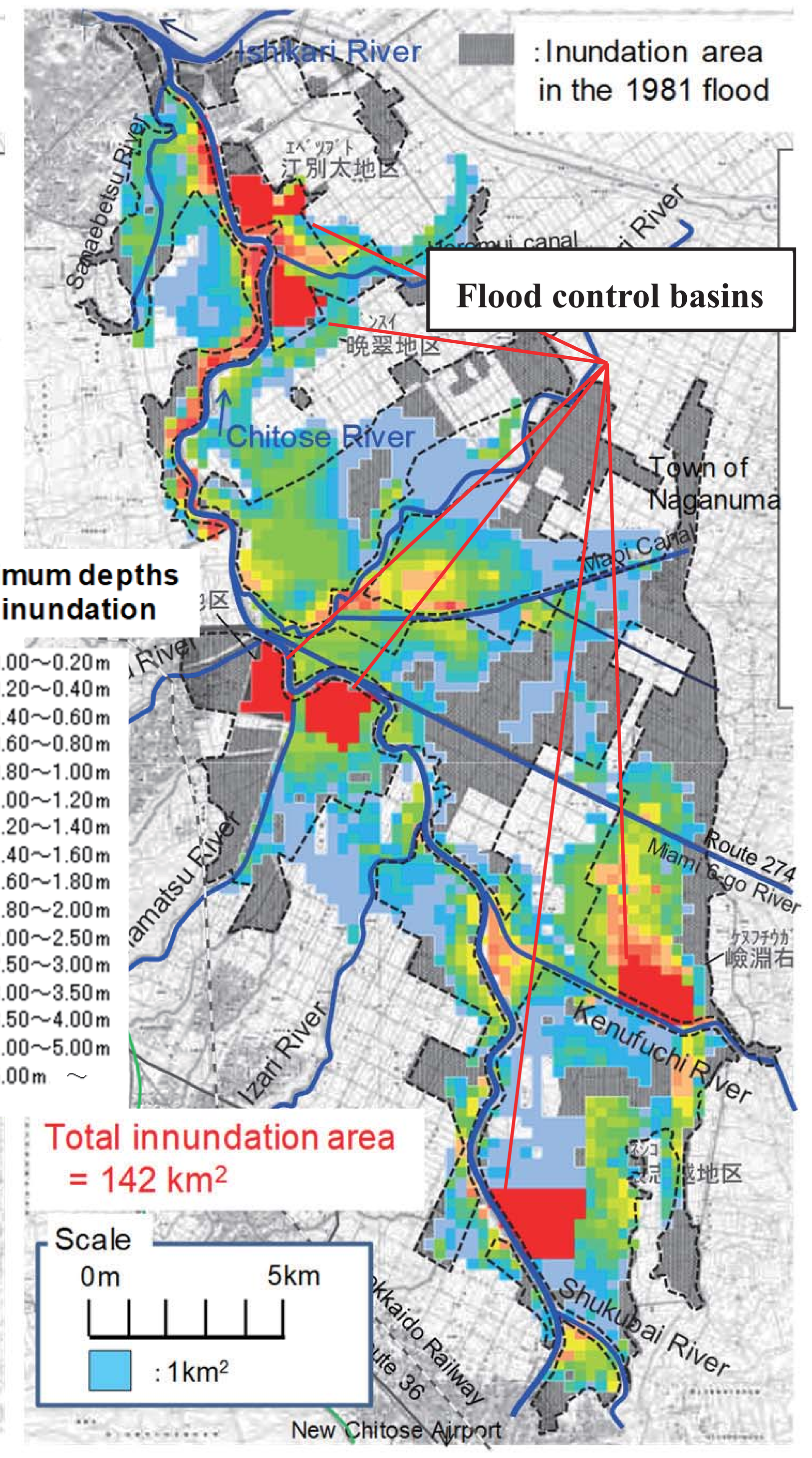


**Figure 5.** Simulation results for maximum depths of inundation(w/ flood control facilities)