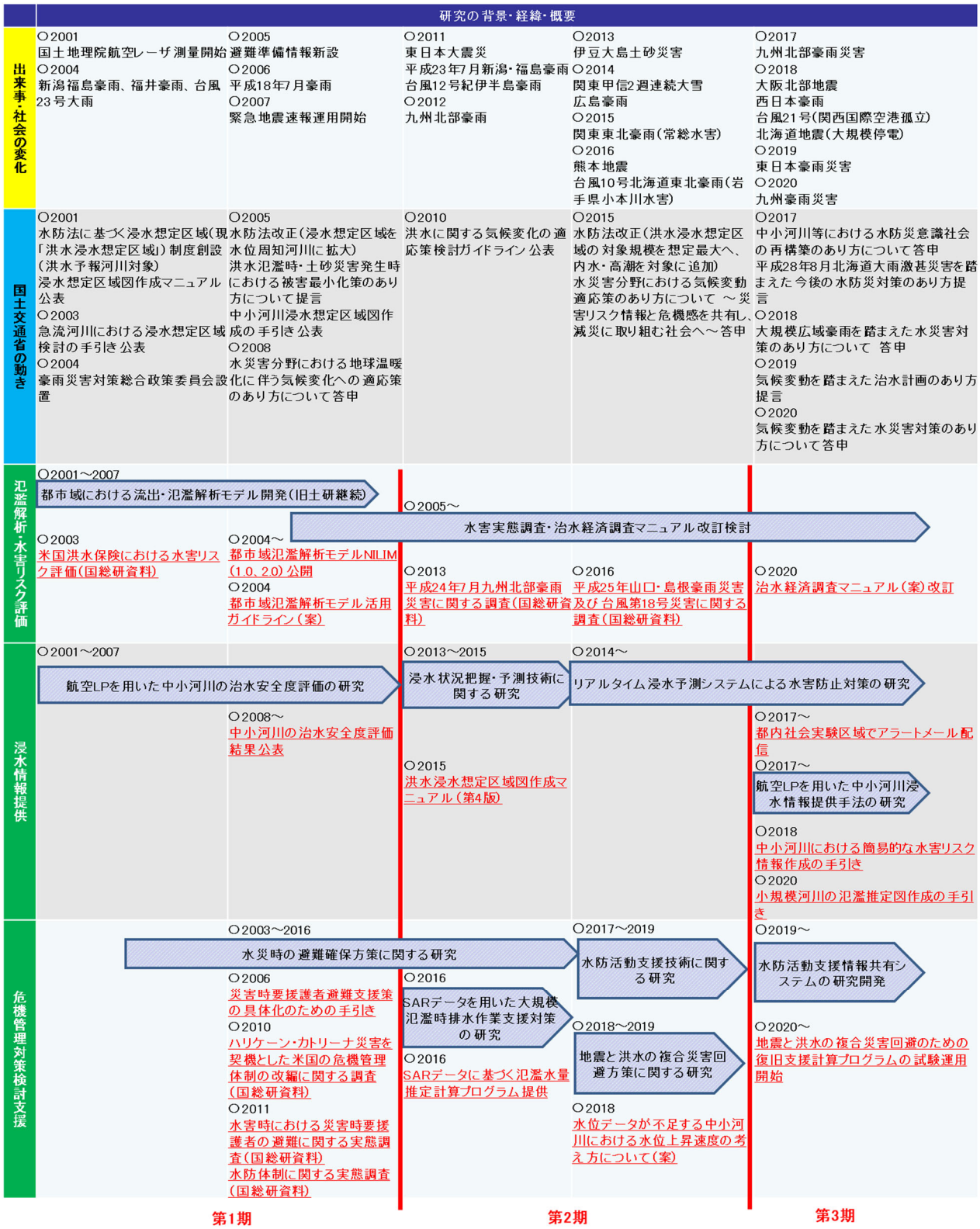
Promotion of flood damage prevention measures using inundation information

1. Outline of Research and Activities



◆Phase 1: Research and development of inundation analysis and inundation information provision

[Background and Issues] In 2001, the Flood Control Act was revised to establish a system of flood assumption areas, and the Geospatial Information Authority of Japan (GSI) began an aerial survey using LP laser scanning. The new technology provided a means to quickly obtain detailed topographical data necessary for establishing the system. On the other hand, the inundation of small- and medium-sized rivers (administered by prefectural governments) occurred more frequently than that of large rivers (administered by the national government), and the promotion of countermeasures against this problem became an important issue.

[Research Summary and Main Results] Based on the inundation analysis model developed by the former Public Works Research Institute, which takes into account the mutual effects of surface inundation and sewerage networks, we developed the NILIM inundation analysis model for urban rivers where the population and assets are concentrated along the river banks and damage is likely to increase during inundation, and we made it public in 2004.[1)] In addition, we created river cross sections from aerial LP data[2)] and conducted a rough assessment of the flood control security distribution[3)] in cooperation with river administrators. This was mainly for small- and medium-sized rivers in Japan, where flood control security assessment had not yet started due to budget and staff shortages, which made it difficult to obtain a vast amount of river channel cross-section data. The assessment results were published in 2008.[4)]

◆Phase 2: Research on flood damage prevention measures using real-time inundation forecast information

[Background and Issues] Since then, river flooding, including urban rivers and small- and medium-sized rivers, has continued to occur frequently. In addition, with the frequent occurrence of heat waves and torrential rains in many areas, which are pointed out as effects of climate change due to global warming, it became increasingly important to steadily improve disaster prevention facilities such as for rivers and sewerage systems, as well as take emergency measures to prevent flood damage when torrential rains and floods exceed the scale of facility improvement.

[Research Summary and Main Results] Research was conducted on measures to prevent and mitigate flood damage by providing flood forecast information in quasi real time through rapid inundation forecast calculations based on advanced weather radar and rainfall forecasting methods under development by another organization, thereby ensuring a longer lead time for vertical evacuation from underground spaces to the ground, and other measures to prevent and mitigate damage from flooding. We constructed a system that calculates inundation forecasts every ten minutes up to one hour ahead using an inundation forecasting calculation model based on the DEM (numerical elevation model) of the Geospatial Information Authority of Japan based on aerial LP data, and automatically sends out alert e-mails. We conducted social experiments such as the test distribution of alert e-mails with the cooperation of local governments, neighborhood associations, and facility managers in the Kanda River basin and other areas in Tokyo for four years from FY2017 to FY2020 to investigate the effectiveness of flood damage prevention measures using flood forecast information and to verify continuous and automatic flood forecast calculation, alert e-mail distribution technology, and flood forecast accuracy.[5),6)] In 2018, in order to support evacuations, etc. using crisis management type water level gauges installed in small- and medium-sized rivers, we published a draft on the concept of water level rise rates in small- and medium-sized rivers where water level data is insufficient[7)] and provided a method for setting provisional water levels in rivers where water level observation data had not yet been accumulated.

◆Phase 3: Research on evaluation methods for inundation hazards along small- and medium-sized rivers and supporting technologies for flood control activities as risk management

[Background and Issues] The importance of appropriate land use based on the susceptibility of each location to flooding and other factors was emphasized in the midst of the annual occurrence of severe floods, including the 2015 Kanto and Tohoku

heavy rains (Joso flood), the 2016 Hokkaido and Tohoku heavy rains, and the 2017 northern Kyushu heavy rains. However, most of the nation's vast number of small- and medium-sized rivers do not provide flood hazard information such as inundation area maps, and with extremely limited budgets and staff, it is difficult to obtain the river channel survey data necessary to create such maps and other information, making it difficult to provide them quickly. Therefore, the development of technology to promptly provide information on the inundation risk around small- and medium-sized rivers by utilizing LP data, etc. was considered an urgent issue.

[Research Summary and Main Results] Utilizing the flood control safety assessment technology developed in the first phase, a method for efficiently illustrating flood hazards along small- and medium-sized rivers was established and published as guidelines in 2018[8] and 2020.[9] Based on the guidelines, inundation estimation maps for small rivers are being prepared nationwide (the term "small rivers" in the 2020 Guidelines and in this section is used for convenience and does not mean that the flood damage is small) and we continue to provide technical support. In addition, based on the actual situation in the field of flood control activities (not limited to activities by flood fighting brigades), which are extremely important for preventing and mitigating flood damage in the region, research and development is being conducted on supporting technologies for flood control activities that utilize ICT technology, which has made remarkable progress in recent years.

2. Main Research Results

◆National small- and medium-sized river flood control safety assessment (Phase 1)

In response to the frequent occurrence of flood damage in small- and medium-sized rivers, we considered methods for evaluating the development status of small- and medium-sized rivers based on LP data from 2004 to 2007. Based on the LP data obtained by each regional development bureau, the cross section of the river channel was estimated[2] (Figure-1), the channel flow capacity was evaluated[3] with the minimum necessary accuracy, and the flow capacity of river sections in 500 m increments was color-coded in three levels (10-year probable rainfall not supported, 10- to 30-year probable rainfall supported, and 30-year or more probable rainfall supported) (Figure-2). The results were published in 2008.[4]

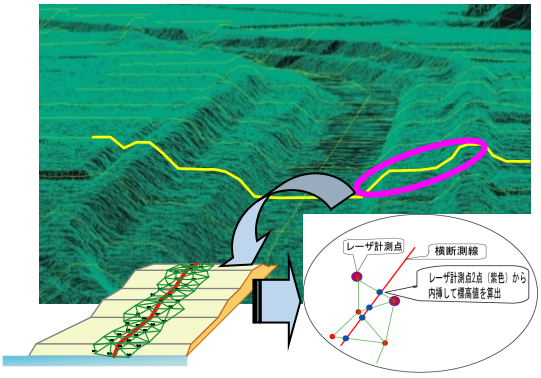


Figure-1 Creation of river channel cross section based on LP data

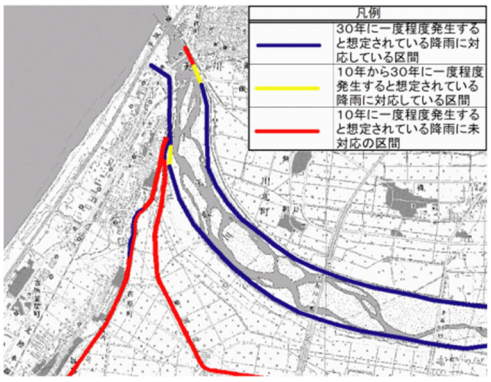


Figure-2 Example of flow capacity evaluation results

◆Real-time inundation prediction system (Phase 2)

This system was developed as part of the Strategic Innovation Program (SIP) of the Cabinet Office over a five-year period from FY2014 to FY2018. Using input data such as rainfall forecast data from the Japan Meteorological Agency's high-resolution precipitation nowcasts, etc. and measured rainfall and river level data from the Ministry of Land, Infrastructure, Transport and Tourism, etc., calculations are performed every ten minutes by linking three models: river, sewer, and ground surface, and predicted flooding depths, etc. are displayed on a 25 m mesh up to one hour ahead (Figure-3). In order to perform processing

such as inundation prediction calculations up to one hour ahead on the cloud server within ten minutes of data acquisition, a certain level of accuracy was confirmed based on the results of reproduction calculations of inundation cases, and in principle, a 25 m mesh for ground surface models and pipes equivalent to a 600 mm inner diameter or larger for sewer pipes were used as modeling targets.[5),6)]

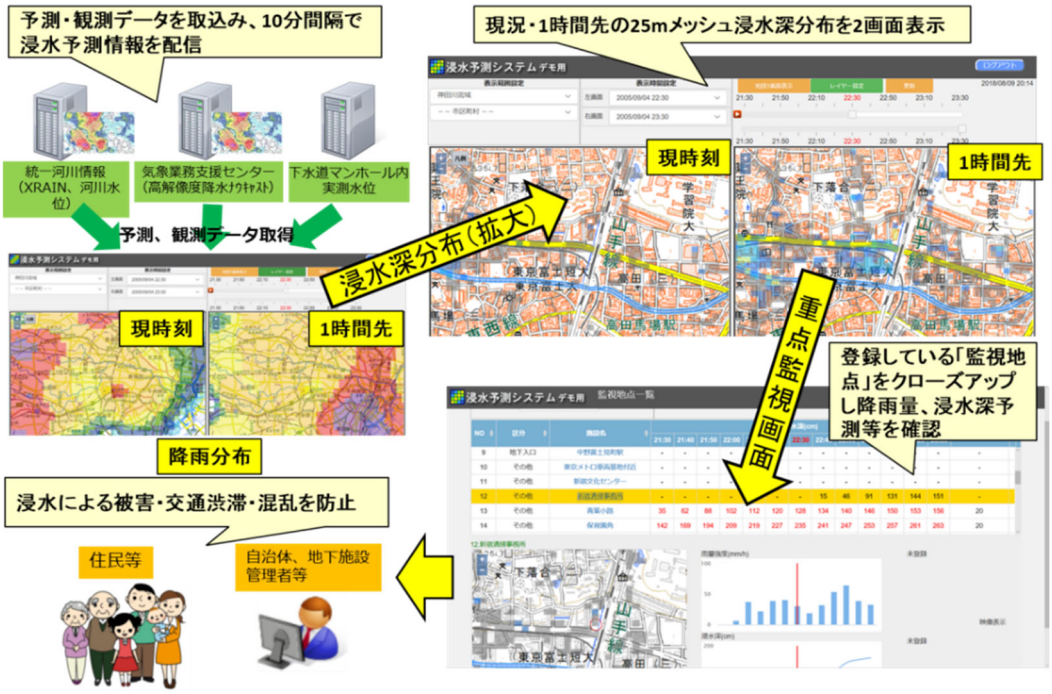


Figure-3 Outline of inundation prediction system

◆Inundation information map to indicate inundation hazards along small- and medium-sized rivers (Phase 3)

Based on LP data, a method to superimpose the inundation extent in a multiscale flood and display the relative inundation susceptibility around small- and medium-sized rivers (preceded by small- and medium-sized rivers that are considered to have a “parallel flow” type of inundation, e.g. flowing through valley bottom plains; Figure-4) was developed and published as guidelines in 2018.[8)]

In 2019, the “Model Project for Investigating Criteria for Issuing Evacuation Advisories, etc. for Small- and Medium-Sized Rivers” (Cabinet Office) conducted a trial application and expanded the display method (Figure-5), which was published as guidelines in 2020 after discussions at a study group that included academics.[9)] Based on the guidelines, flood hazard maps for small rivers are now being prepared in areas without flood hazard information nationwide.

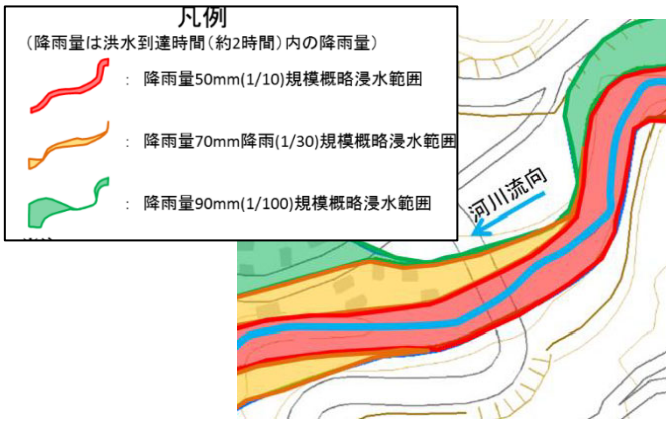


Figure-4 Prototype example of inundation information chart for a multiscale flood

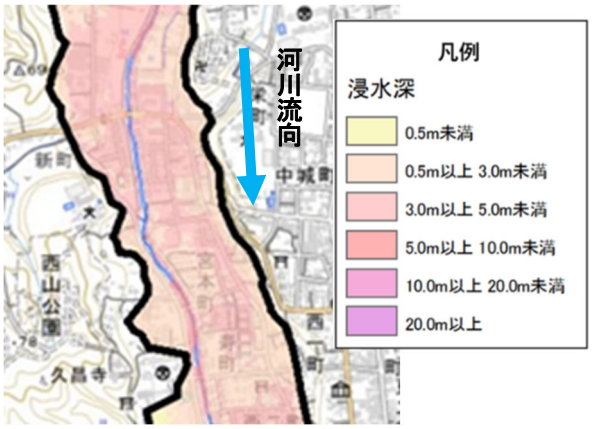


Figure-5 Prototype example of inundation information chart for a hypothetical maximum flood

3. List of Related Reports and Technical Documents

1) NILIM2.0 Urban flooding analysis model, 2012
http://www.nilim.go.jp/lab/rcg/newhp/seika.files/nilim/index.html
2) A Study on the Methodology for Creating River Channel Models for Small- and Medium-Sized Rivers Using Laser Scanner Data, Advances in River Engineering, Vol. 8, pp. 533-538, 2002
3) Small- and Medium-Sized River Flood Control Safety Assessment System (Standard Version) Instruction Manual, Ver. 2.0, 2018
http://www.gis.nilim.go.jp/lab/rcg/newhp/seika.files/pdf/tebiki_3.pdf
4) Flood control safety assessment using aerial laser surveying, 2008
http://www.nilim.go.jp/lab/rcg/newhp/seika.files/lp/eva.html
5) Construction of an inundation forecast information distribution system using a fast computation model, Advances in River Engineering, Vol. 23, pp. 103-108, 2017
6) Inundation forecasting systems to prevent damage and disruption during urban flooding, Civil Engineering Journal, Vol. 62-1, pp. 10-15, 2020
7) Concept of water level rise rate in small- and medium-sized rivers where water level data is insufficient (draft), 2018
http://www.gis.nilim.go.jp/lab/rcg/newhp/seika.files/pdf/tebiki_1-2.pdf
8) Guidelines for preparing simplified flood risk information for small- and medium-sized rivers, 2018
https://www.mlit.go.jp/river/shishin_guideline/pdf/chushou_kaninarisuku_tebiki.pdf
9) Guidelines for preparing inundation estimation maps for small rivers, 2020
https://www.mlit.go.jp/river/shinngikai_blog/tyushokasen/pdf/manual.pdf

4. Future Outlook

The method for generating inundation information by maximizing the use of remote sensing data such as LP data can lead to large errors that are difficult to overlook, and the establishment of utilization methods that take into account the characteristics of the data is an important issue.