Catalogues of Hydrologic Analysis, CHA Workshop

26th IHP Regional Steering Committee Meeting for Asia and the Pacific

3-5 November 2018, Shanghai, China

Purpose of the workshop

- The purpose of the Catalogue of Hydrologic Analysis (CHA) is to share the information on water-related issues such as disaster preparedness, water environment conservation, and water resources management in Asia and Pacific region.
- In this workshop, hazard mapping developed at each country in the region is focused in terms of technologies, theories, experiences, good practice, and lesson learned.
- After presentations on hazard mapping for several countries, we will discuss detailed publication plan to develop CHA.

Program of the workshop

- 15.00-15. 15 Introduction
- 15:15-17:00 Hazard mapping developed in each country
- 17.00-17.30 Break
- 17.30-19.00 Discussion on publication plan to develop CHA
  - ✓ Table of Contents
  - ✓ Publication schedule
  - ✓ Editorial team
  - ✓ Next topic and schedule
  - ✓ Others

Total: 121, 16 countries (6volumes)

http://hywr.kuciv.kyoto-u.ac.jp/ihp/rsc/riverCatalogue.html

Significance of Catalogue of Rivers I-VI

1997-2012: 121 rivers in 16 countries

- When the RSC-SEAP began, information on our region and rivers in our neighboring countries was quite limited.
- Information on rivers are widely scattered in many agencies within a country and difficult to gather all to get an overall picture.
- The activity promoted the global presence of RSC-SEAP.

We have discussed new collaborative activities in Asia and the Pacific.

Catalogue of Rivers

- River information and basic hydrologic data

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- Hydrologic analysis tool sharing such as a rainfall-runoff model, inundation simulation tool, hydrologic frequency analysis tool, and so on

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Catalogue of Hydrologic Analysis

- Hydrologic analysis tool sharing, and
- Our experience of water resources management

Catalogues of Hydrologic Analysis (CHA)

Compile our experiences of water resources management (hazard map, flood forecasting, groundwater, water quality, eco-hydrology etc.) to work together and solve the problems for ourselves and for the world.

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Table of Contents

Publication schedule

Date	
November 3, 2018 RSC	Publication schedule is determined.
April 30, 2019	Deadline for manuscript submission
	Editing work
November 2019 RSC	Publication

Editorial team

- Editor in chief
- …
- …
- RSC Chair
- RSC secretary
- RSC secretariat

Next topic and schedule

Date	Theme 1	Theme 2	Theme 3
Nov. 2018 RSC	Hazard mapping		
Nov 2019 RSC	Deadline for submission	water quality control in lake	
Nov 2020 RSC	Editorial and publication	Deadline for submission	Groundwater
Nov 2021 RSC		Editorial and publication	Deadline for submission

CHA Development Plan

- New activity in AP-RSC followed by Catalogue of Rivers.
- Contents: Compiling methods, technologies, experiences, good practices, lesson learned in each country on water-related disaster preparedness (hazard mapping, flood warning), eco-hydrology (water quality control in lake, water environment conservation), water resources (groundwater, draught) etc., which are related to IHP8 and SDGs.
- Schedule: 2018 to 2027.
- Editorial team: RSC chairperson, secretary, two CHA task force members for each theme.
- Pdf documents are updated on RSC web page and IHP-WINS.
- RSC member countries are encouraged to submit documents.

- A different theme will be selected every year at RSC meeting and papers will be collected at RSC meeting.
- Schedule planed:

Date	Theme 1	Theme 2	Theme 3
Nov. 2018 RSC	Hazard mapping		
Nov 2019 RSC	Deadline for submission	water quality control in lake	
Nov 2020 RSC	Editorial and publication	Deadline for submission	Groundwater
Nov 2021 RSC		Editorial and publication	Deadline for submission

Hazard mapping (example of content for CHA)

Title: Flood hazard mapping in the ABC river

1. Catchment introduction

    Overview of the ABC river. It is desirable to refer Catalogue of Rivers.

2. Method to make flood hazard mapping

    2.1 Theory to make flood hazard map

    Theory, equations, experiences to make flood hazard mapping

    2.2 Tools to make flood hazard map

    Introduction of tools to make flood hazard mapping if some tools used in each country exists.

3. How to use flood hazard map

    Flood waring, dissemination of flood prone are, land use regulations

4. Institution and legal framework if exists
5. Good practice, Lesson learned.
6. References

Flood hazard mapping in the X River Basin

1. Overview of the X River Basin

1.1 X River basin

1.2 Hydrologic Characteristics

2. Flood Hazard Map

2.1 Estimated Flood Inundation Area Map

2.1.1 Assumed External Force

2.1.2 Flood Inundation Model: Shallow Water Equation

2.1.3 Levee Breach Condition

2.1.4 Result: Estimated Flood Inundation Area Map of X River Basin

2.2 Flood Hazard Map by Municipalities

2.2.1 Necessary Information for Hazard Map

2.2.2 Example of Y City

3 Usages of Flood Hazard Map

3.1 Release by Website: Introduction of Portal Site

3.2 Application of Flood Hazard Map

3.3 Combination with Flood Early Warning

4 Administrative and Legal Framework

5 Good Practice and Lesson Learned from Recent Floods

6 References

Flood hazard mapping in the X River Basin

1. **Overview of the X River Basin**

2. **Flood Hazard Map**

3. **Usages of Flood Hazard Map**

4. **Administrative and Legal Framework**

5. **Good Practice and Lesson Learned from Recent Floods**

6. **References**

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Flood hazard mapping in the Yodo River Basin

1. Overview of the Yodo River Basin

1.1 Yodo River basin

The 75 km long Yodo River (Yodo-gawa) system, located in the central part of Japan, is the seventh largest river basin in Japan with a catchment area of 8,240 km^2. Flowing south out of Lake Biwa, the largest lake in Japan, first as the Seta River and then the Uji River, it merges the Kizu River and the Katsura River near the border between Kyoto and Osaka Prefectures. The Yodo River runs through the heartland of the Kinki region and flows into the Osaka Bay.

The Yodo River basin consists of six sub-catchments, which are the Lake Biwa basin (3,802 km^2), the Uji River basin (506 km^2),the Kizu River basin (1,647km^2), the Katsura River basin (1,152 km^2), the lower Yodo River basin (521 km^2) and the Kanzaki River basin (612 km^2).It extends over six prefectures of Shiga, Kyoto, Osaka, Hyogo, Nara and Mie.

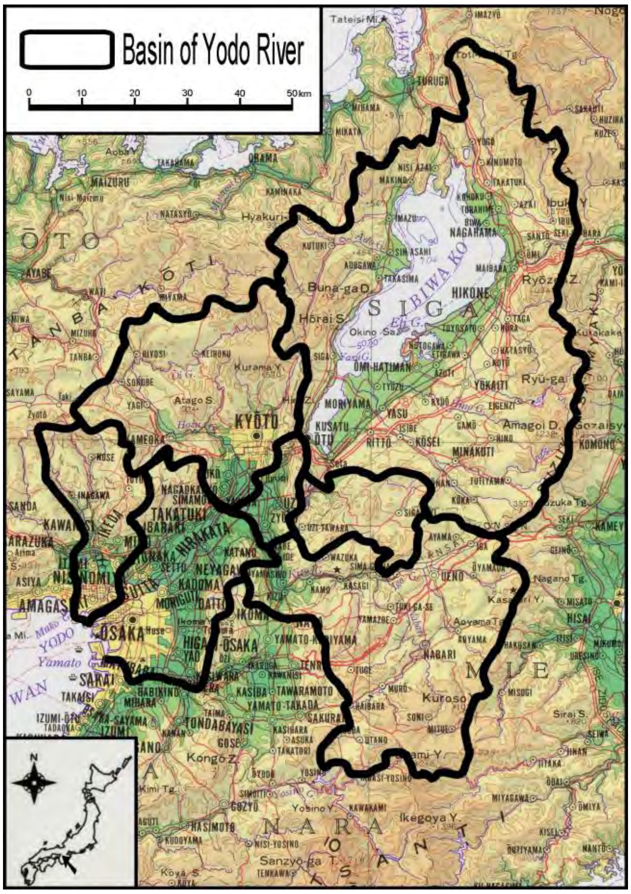

Figure 1: Yodo River basin in Japan.

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City areas spread throughout the basin. Metropolitan areas such as Osaka, Kyoto, Otsu are located along the rivers. The population in the basin is about 10,630,000, which is 9% of the population nationwide and 53% of that in the Kansai region. In the lower Yodo River basin, most of the heavily populated urban developments are located in areas lower than the river water level. In Osaka City, it is estimated that 94.9% of the total metropolitan area is located in the flood-prone area.

Table 1: Basic Data for the Yodo River basin

Name: Yodo-gawa		
Location: Honshu, Japan	N 34° 24′ ~ 35° 44′	E 135° 19′ ~ 136° 29′
Area: 8,240km^2	**Length of main stream:** 37km	
Origin: Lake Biwa	**Highest point:** Mt. Ibuki (1,377m)	
Outlet: Osaka Bay	**Lowest point:** River Mouth (0m)	
Main geological features: andesite, tuff, granite, schist		
Main tributaries: Uji River (506km^2), Katsura River (1,100km^2), Kizu River (1,596km^2)		
Main lakes: Lake Biwa		
Main reservoirs: Takayama (49.2 x10^{6}m^3, 1969), Hiyoshi (58.0 x10^{6}m^3, 1998), Shorenji (23.8 x10^{6}m^3, 1970), Nunome (15.4 x10^{6}m^3, 1992), Hinachi (18.4 x10^{6}m^3, 1999), Murou (14.3 x10^{6}m^3, 1974), Hitokura (30.8 x10^{6}m^3, 1983)		
Mean annual precipitation: 1387.8 mm (1976~2000) at Hirakata		
Mean annual runoff: 270.8 m^3/s (1952~1998) at Hirakata		
Population: 10,630,000 (1994)	**Main cities:** Kyoto, Osaka, Otsu	
Land use: Mountainous area (71.9%), Flat area (28.1%)		

1.2 Hydrologic Characteristics

Precipitation in the basin is widely distributed in time and space. The annual precipitation of the Lake Biwa basin, the Katsura River basin, the Kizu River, and the lower Yodo River basin are about 1,880mm, 1,640mm, 1,590mm, and 1,400mm respectively. The mean annual precipitation of the Yodo River basin is about 1,600 mm. The Lake Biwa basin, the Katsura River basin, and the Kizu River have high flow season in the snow melt season from March to April, the rainy season from June to July, and the typhoon season from September to October, respectively.

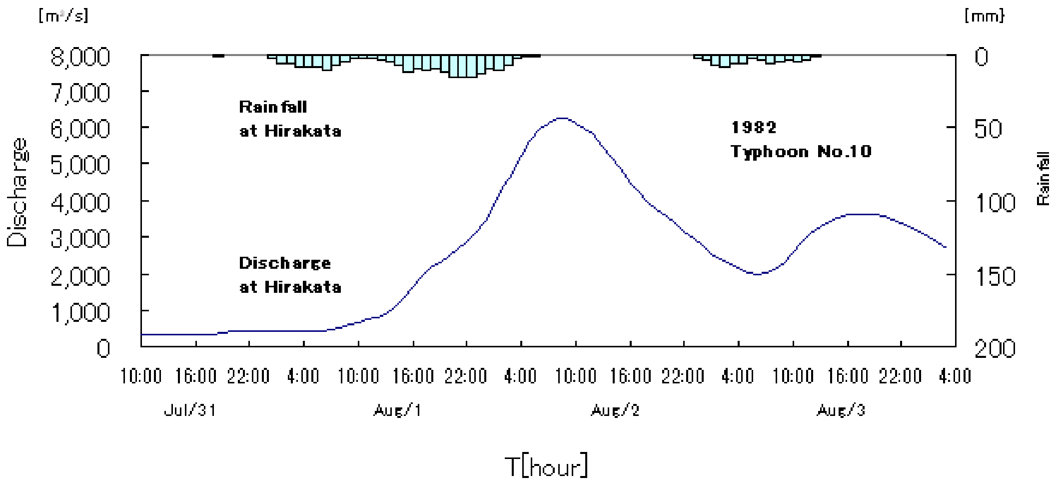

Figure 2: Flood hydrograph for Typhoon No. 10 in 1992.

2. Flood Hazard Map

2.1 Estimated Flood Inundation Area Map

2.1.2 Assumed External Force

The Flood Fighting Act (FCA) amended in 2014 stipulates that two rainfall scenarios should be considered as inputs of inundation simulation to produce estimated flood inundation area maps.

One is design rainfall used also for other river works. In case of the main Yodo River, the design rainfall is prepared equivalent to 200-year return period (261 mm / 24 hours) while the upstream tributaries suppose comparatively smaller return periods; 150-year return period for the Uji (164 mm / 9 hours), Kizu (253 mm / 12 hours) and Katsura (247 mm / 12 hours) Rivers.

The other one so-called the largest-scale scenario to prepare for the worst case. Based on rainfall patterns, the whole Japan was divided into 15 regions and Depth-Area-Duration (DAD) analysis was conducted using recorded maximum rainfall in each region. Basin average rainfall can be estimated from this DAD analysis and typically exceed or equivalent to 1000-year return period. The amount of rainfall by this analysis for the main Yodo River is 360 mm / 24 hours, while they are 356 mm / 9 hours for the Uji, 358 mm / 12 hours for the Kizu and 341 mm / 12 hours for the Katsura Rivers.

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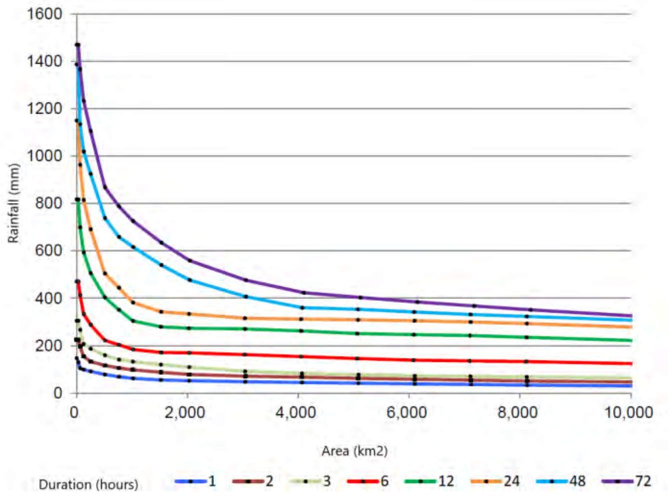

Figure : DAD analysis for the largest-scale scenario (e.g. Kinki Region)

2.1.3 Flood Inundation Model: Shallow Water Equation

A shallow water equation is used as the governing equation for the flood inundation simulation which is described as follows:

$$\gamma\frac{\partial Q_x}{\partial t}+\frac{\partial}{\partial x}\left(\gamma\frac{Q_x^2}{h}\right)+\frac{\partial}{\partial y}\left(\gamma\frac{Q_xQ_y}{h}\right)+g\gamma h\frac{\partial(h+z_b)}{\partial x}+g\gamma n^2\frac{Q_x\sqrt{Q_x^2+Q_y^2}}{h^{7/3}}+\frac{1}{2}C_D'(1-\gamma)\frac{Q_x\sqrt{Q_x^2+Q_y^2}}{h}=0$$

$$\gamma\frac{\partial Q_y}{\partial t}+\frac{\partial}{\partial x}\left(\gamma\frac{Q_xQ_y}{h}\right)+\frac{\partial}{\partial y}\left(\gamma\frac{Q_y^2}{h}\right)+g\gamma h\frac{\partial(h+z_b)}{\partial y}+g\gamma n^2\frac{Q_y\sqrt{Q_x^2+Q_y^2}}{h^{7/3}}+\frac{1}{2}C_D'(1-\gamma)\frac{Q_y\sqrt{Q_x^2+Q_y^2}}{h}=0$$

$$\frac{\partial h}{\partial t}+\frac{\partial(\gamma Q_x)}{\partial x}+\frac{\partial(\gamma Q_y)}{\partial y}=q$$

where Q_x, Q_y are the discharges per unit width, h the water depth, z_b the bed elevation, γ the porosity, q the rainfall, inundation from the sewerage etc., n the roughness coefficient, C_D the drag coefficient.

2.1.4 Levee Breach Condition

The amount of the flow overtopped from the river is estimated using modified Honmma's overflow formula. Assuming levee breach has occurred at two or more locations, and the inundation depth and inundation area of each point is overlapped with that of other points.

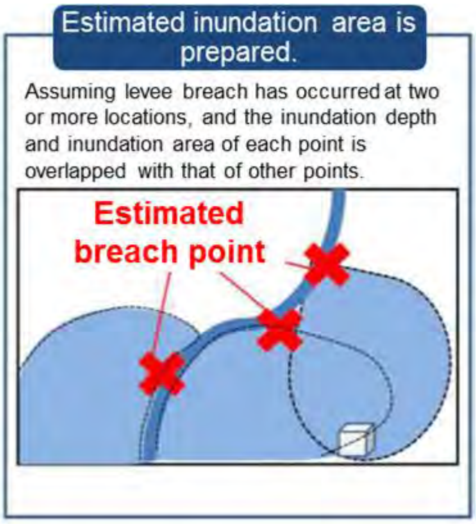

Figure : Schematic diagrame for the consideration of the levee breach

2.1.5 Result: Estimated Flood Inundation Area Map of Yodo River Basin

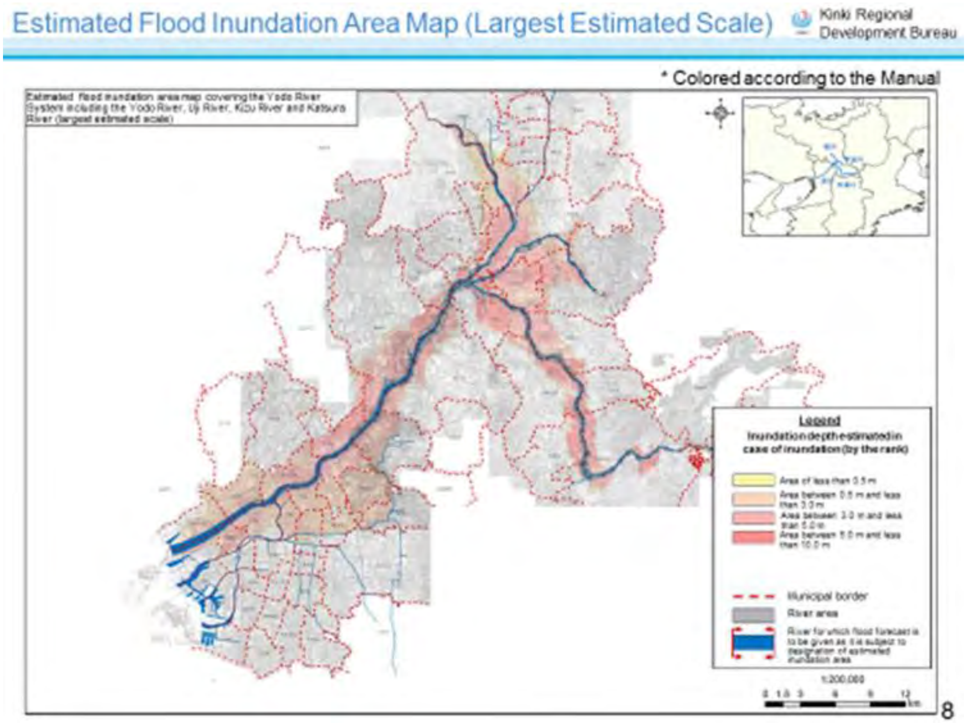

Figure: Estimated flood inundation area map (largest estimated scale) of Yodo River basin by MLIT

2.2 Flood Hazard Map by Municipalities

2.2.1 Necessary Information for Hazard Map

Based on the above described "estimated flood inundation area map" produced by river management authorities including the national government (MLIT) or prefectural

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government, municipal government adds area specific information for safe evacuations to prepare flood hazard map. The added information includes evacuation zones, hospitals, city halls and their contacts. In addition, basic information about flood characteristics, flood warnings and some tips for safe evacuations are also are shown in a flood hazard map.

2.2.2 Example of Kyoto City

Figure shows the example of flood hazard map in one of the wards in Kyoto City. Note that Kyoto city is located in the Yodo River basin, particularly in the Katsura River basin. Although there is no direct impact from the main Yodo River or the Katsura River flooding for this word, the flooding coming from the Kamo River, the tributary of the Katsura River may cause flooding in this area. Hence the flood inundation estimated area shown in the figure (i.e. Sakyo-ku ward in Kyoto city) is prepared for considering the case of overtopping from the Kamo River in this case.

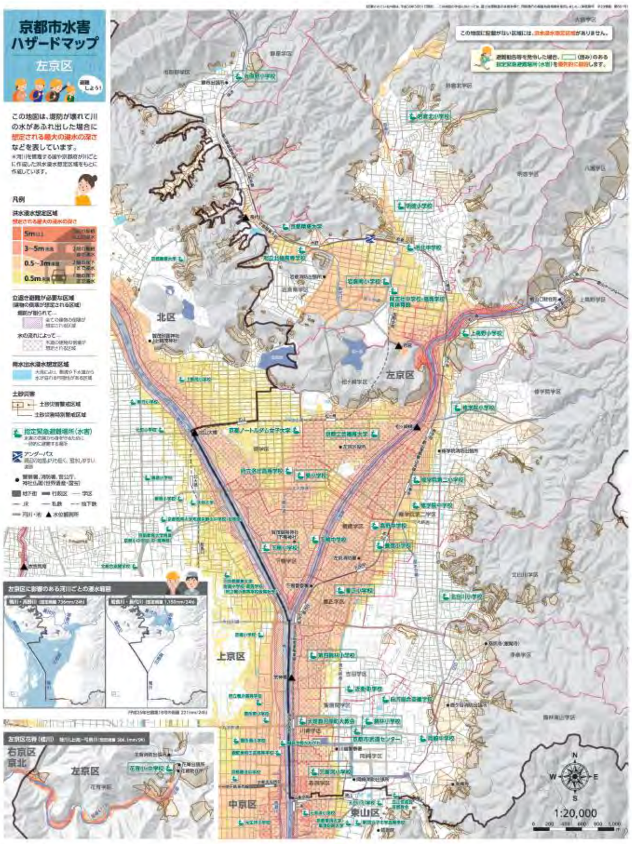

Figure: Flood hazard map of Kyoto City (Sakyo-ku ward) (largest estimated scale) of Yodo River basin by MLIT

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Figure: Basic information added to the flood hazard map for safe evacuation

3 Usages of Flood Hazard Map

3.1 Release by Website: Introduction of Portal Site

Flood hazard maps are widely disseminated in various ways. For example, local governments put the maps in their homepage. Kyoto City provides the Kyoto city flood damage hazard maps from the below address:
http://www.city.kyoto.lg.jp/gyozai/page/0000237021.html

3.2 Application of Flood Hazard Map

Flood hazard mapping is used in various ways. For example, Shiga Prefecture develops local hazard maps for 10-years, 30-years, 50-years, 100-yearsm 200-years, 500-years and 1000-years rainfall. Based on the inundation maps for different magnitude of rainfall intensity, various maps, e.g. fluid force map to show the strength of inundated flow, a probability map for 0.5m inundation occurrence to show the frequency of inundation above floor level were generated.

3.3 Combination with Flood Early Warning

4 Administrative and Legal Framework

The Flood Fighting Act stipulates to estimate inundation areas and discloses the information. The Act was revised in 2015 to provide estimated inundation areas for a

largest-class floods, inland waters and storm surges. According to the revision, a manual for preparation of estimated flood inundation area maps 4th edition was published in 2015. A handbook for preparation of flood damage hazard maps was also revised in 2016.
Local governments need to make flood hazard maps that include the location of emergency evaluation areas and the routs to reach the areas and open to the public. Municipal disaster preparedness plans fully utilize the flood hazard maps to secure evacuation of residents.

5. Good Practice and Lesson Learned from Recent Floods

5.1 Example of Mabi Town

5.2 Large Area Evacuation, Vertical evacuation

5.3 Community-Based Flood Hazard Map in Northern Kyushu Heavy Rain Disaster

5.4 Example of Kinugawa Flooding as the Trigger to Show the House Collapse Hazard Zones

6. References

1. UNESCO IHP Regional Steering Committee for Southeast Asia and the Pacific (2002): Yodo-gawa, Catalogue of rivers for Southeast Asia and the Pacific, Volume IV.
2. MLIT materials (to be specified)
3. and more…