Study on Flood Risk Reduction measures based on recent flood disaster cases in Japan

May 30, 2019

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National Institute for Land and Infrastructure Management, MLIT*

Photo：Akatani-gawa River in Fukuoka Prefecture（Aug. 4, 2017）

Contents

Ⅰ　What is NILIM

National Institute for Land and Infrastructure Management (NILIM) is a research institute in Ministry of Land, Infrastructure, Transport and Tourism.

As the only national research organization in the infrastructure/ housing field, it works to create an attractive society that is safer, more secure, and more vigorous, by conducting engineering research and development, and disseminating the results so as to contribute to society now and in the future, by preventing and mitigating disasters, promoting formulating favorable environments, and by utilizing, maintaining, and improving roads, rivers and harbors, etc.

Ref. http://www.nilim.go.jp/english/about/nilim2017e.pdf.

Ⅰ What is NILIM

Roles of the NILIM

① Conducting surveys and research to support planning, proposing, and execution of policies

② Preparing drafts of technology standards under laws and regulations etc.

③ Technological guidance concerning provision of housing and public capital

Tachihara Office

Asahi Office

You are here

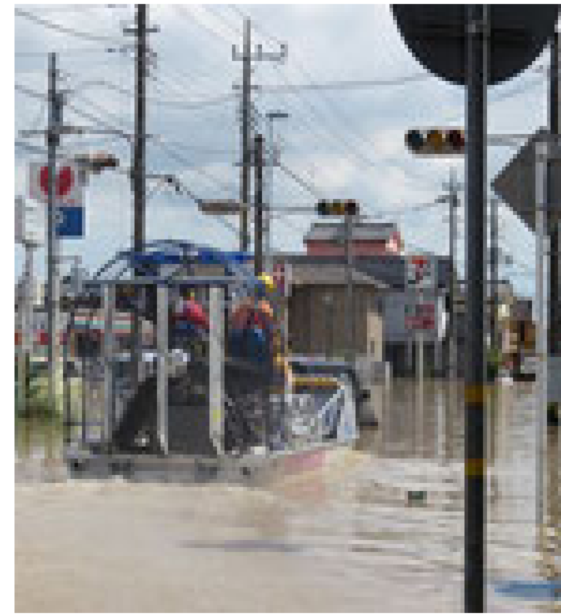
Yokosuka Office

Ⅱ Background of Study

Catastrophic flood disasters are frequently occurring in Japan these years.

Flood disaster by Typhoon No.18 (Etau) in September 2015





Photos: From website of Joso City government, Ibaraki Prefecture.

20 fatalities, 82 injured, 81 residential houses completely destroyed, 7,090 residential houses half destroyed, 384 residential houses partially destroyed, 2,523 residential houses flooded above the floor, 13,259 residential houses flooded below the floor, 37 public buildings damaged, other 1,685 buildings damaged. (As of Oct. 18, 2017, Fire and Disaster Management Agency)

Flood disaster by Typhoon No. 10 (Lionrock) in August 2016

Photo: Geospatial Information Authority of Japan http://www.gsi.go.jp/BOUSAI/H28.taihuu10gou.html

26 fatalities, 3 missing, 14 injured, 518 residential houses completely destroyed, 2,281 residential houses half destroyed, 1,174 residential houses partially destroyed, 279 residential houses flooded above the floor, 1,752 residential houses flooded below the floor, 17 public buildings damaged, other 2,500 buildings damaged (As of Nov. 8, 2017, Fire and Disaster Management Agency)

Flood disaster by seasonal rain front and Typhoon No.3 (Nanmadol) in July 2017.

Photo: Geospatial Information Authority of Japan http://www.gsi.go.jp/BOUSAI/H29hukuoka_ooita-heavyrain.html

42 fatalities, 2 missing, 39 injured, 338 residential houses completely destroyed, 1,101 residential houses half destroyed, 89 residential houses partially destroyed, 223 residential houses flooded above the floor, 2,113 residential houses flooded below the floor, 9 public buildings damaged, other 1,407 buildings damaged. (As of Oct. 31, 2018 Fire and Disaster Management Agency)

Ⅱ Background of Study

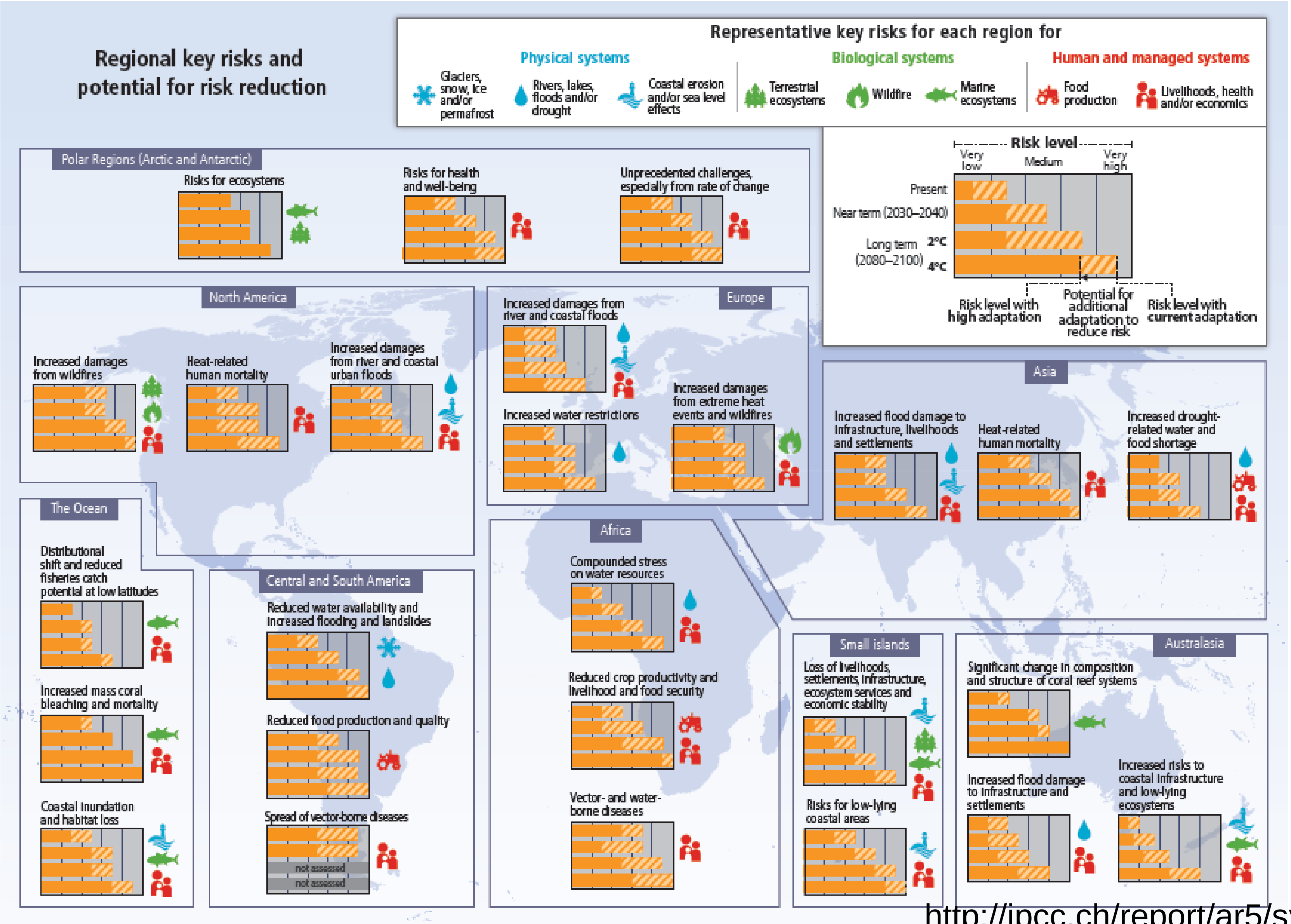
Flood disaster by Torrential rainfall and Typhoon No.12 (Jongdari) in July 2018

237 fatalities, 8 missing, 466 injured, 6,767 residential houses completely destroyed, 11,248 residential houses half destroyed, 4,199 residential houses partially destroyed, 7,173 residential houses flooded above the floor, 21,337 residential houses flooded below the floor, 159 public buildings damaged, other 2,423 buildings damaged. (As of Jan. 9, 2019, Fire and Disaster Management Agency)

Ⅲ Global Climate Change Adaptation study for Flood Risk Reduction

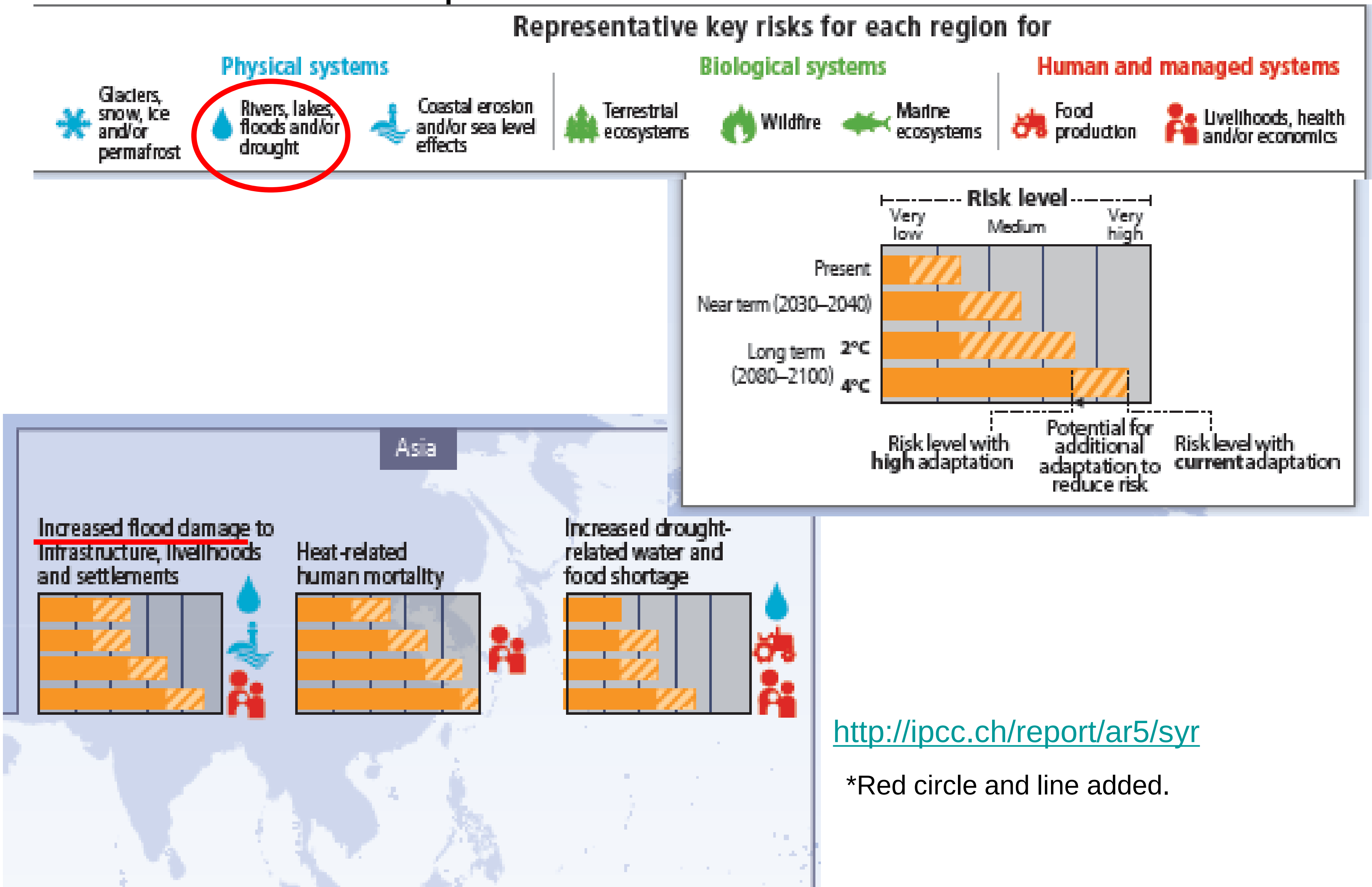
Ⅲ GCC Adaptation Study for FRR

IPCC Assessment Report 5（2014）



http://ipcc.ch/report/ar5/syr

IPCC Assessment Report 5（2014）



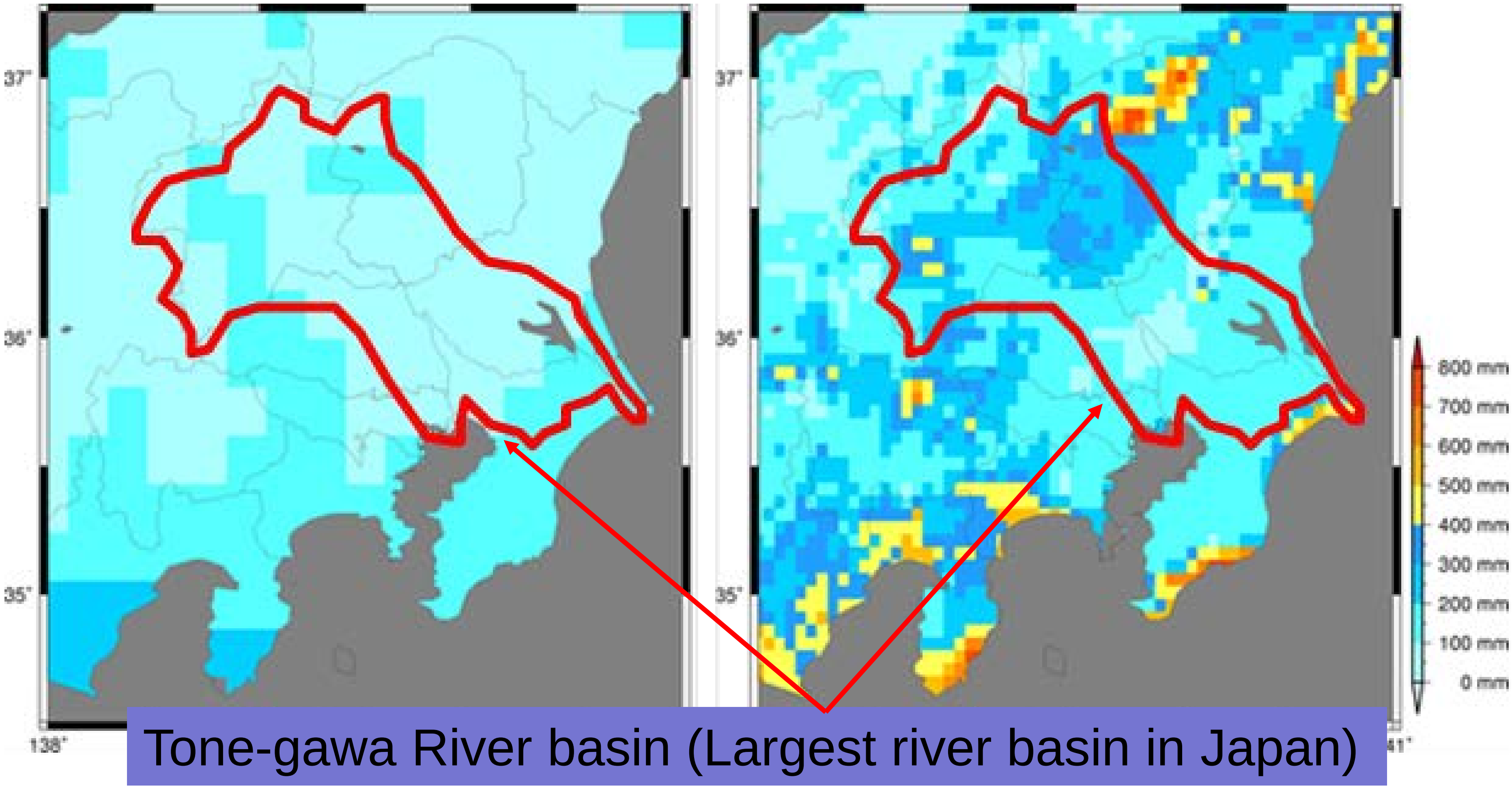
http://ipcc.ch/report/ar5/syr

*Red circle and line added.

Ⅲ GCC Adaptation Study for FRR

Global Circulation Model mesh size around Tokyo (MRI-GCM20* (left), and MRI- RCM5* (right))

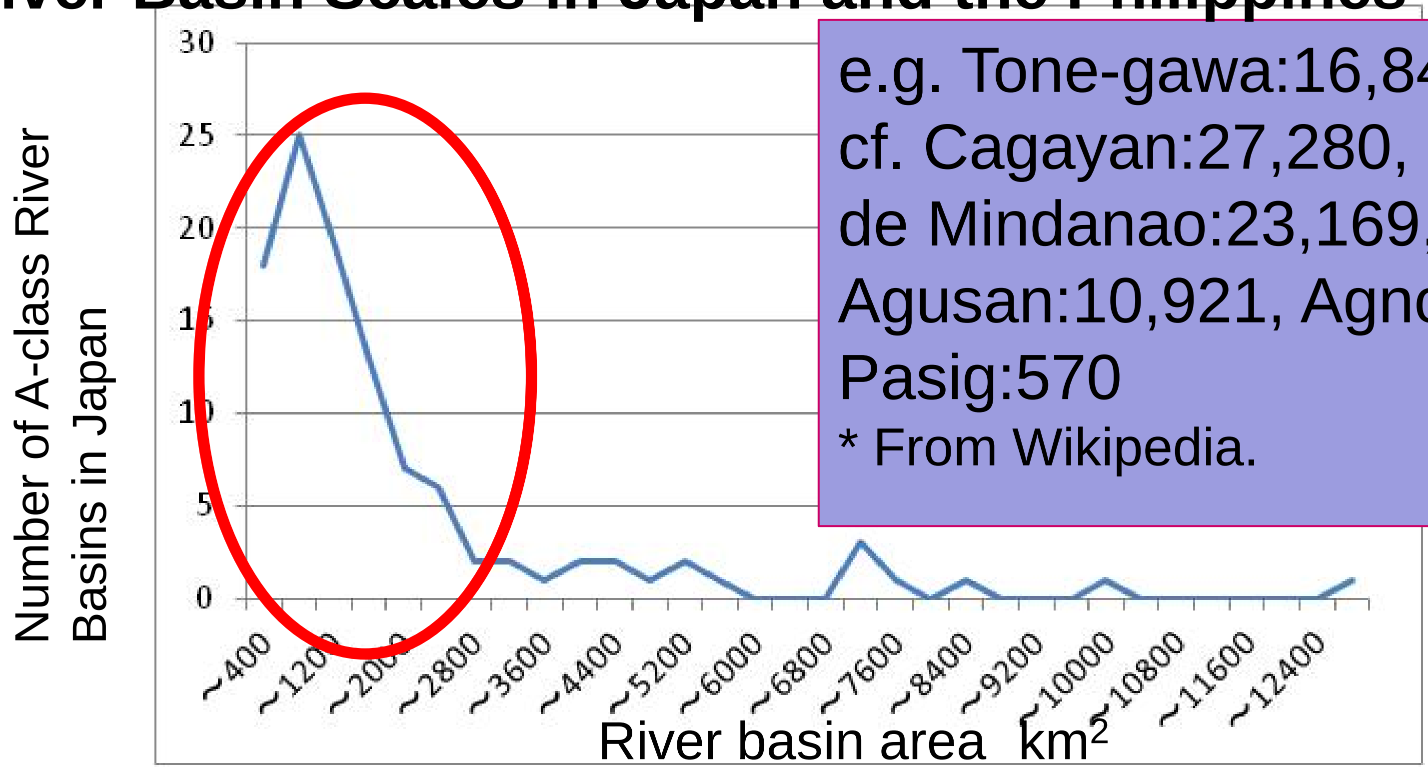
* GCM20: Atmospheric GCM with the horizontal mesh size of about 20km,
RCM5:Regional Climate Model with the horizontal mesh size of about 5km



* NILIM (2013) and retouched.

Ⅲ GCC Adaptation Study for FRR

River Basin Scales in Japan and the Philippines



e.g. Tone-gawa:16,840 (km^2)
cf. Cagayan:27,280, Rio Grande de Mindanao:23,169, Agusan:10,921, Agno:5,952, Pasig:570
* From Wikipedia.

A-class River: 109 rivers managed by the central government of Japan.

High resolution prediction of extreme rainfall is essential for predicting the probability distribution of Floods in each River Basin.

Adopted GCM20 (20km mesh Global Circulation Model), RCM5 (5km mesh Regional Climate Model) by Meteorological Research Institute (MRI).

国総研 国土交通省 国土技術政策総合研究所 NILIM

Framework for CCA against Water-Related Disasters*

Current capacity of hard measures

Disaster Scale for planning/ designing hard measures

Maximum assumed Disaster scale

Scale of rainfall, flood

Smaller

Larger

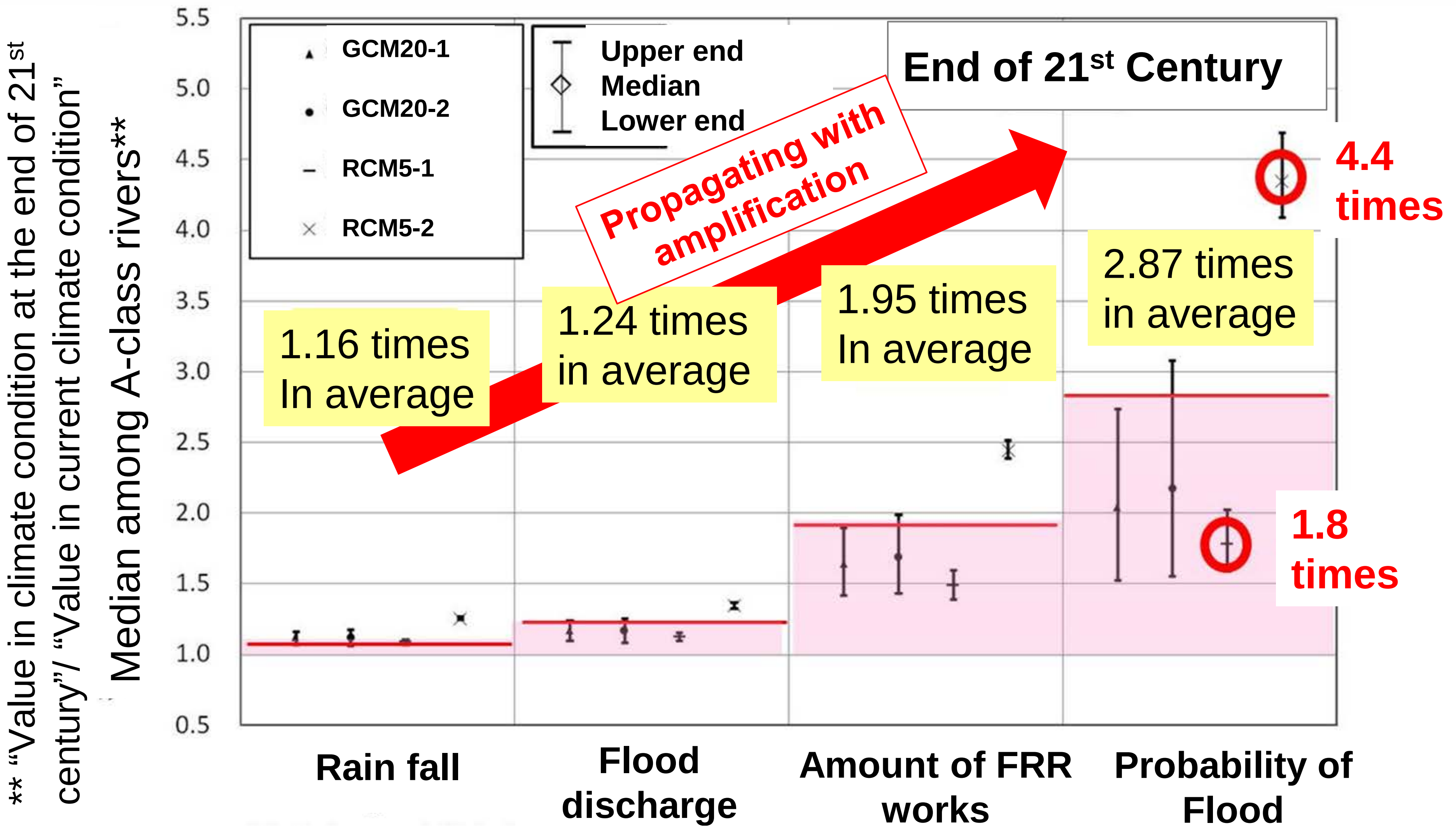
Against comparatively small scale of flood, hard measures are planned and constructed.

Against the extreme/ larger flood than current capacity of hard measures, the portfolio approach is crucial for DRR.

Besides, there are some types of flood, e.g. riverine floods, urban floods, coastal floods.

* From the report on the Framework of Climate Change Adaptation against Water-Related Disasters submitted by Council for Infrastructure Development, MLIT, 2015.

Macro estimation of future Flood Risk in Japan*



* By Kakushin Project, NILIM conducted the analysis based on the result of climate change simulations by MRI Japan. Current：1979～2003, End of 21st Century：2075～2099. 4 Red lines are averages of Median estimates among A-class rivers for 4 models.

* NILIM (2013) and retouched

Ⅳ Simplified Flood Hazard Mapping (for Small and Medium Rivers with LP data)

1. Recent Flood Disasters in Small and Medium Rivers
2. Challenges
3. Simplified Flood Hazard Mapping method
4. Test application examples
5. How to use Simplified Flood Hazard Map
6. Remaining Challenges

1. Recent Flood Disasters in Small and Medium Rivers

(1) Flood Disaster in Omoto-gawa River by Typhoon No. 10 (Lionrock) in August 2016

Photo: Taken by Researcher Yamaji (then) of Water Cycle Div. NILIM on Sept. 2, 2016

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1. Recent Flood Disasters in Small and Medium Rivers

(2) Flood Disaster in Akatani-gawa River during Northern Kyusyu Heavy rainfall in July 2017

Photo: In Asakura City, Fukuoka Pref. on Aug. 4, 2017

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Photo: In Asakura City, Fukuoka Pref., taken by Researcher Nishi (then) on Aug. 4, 2017

2. Challenges

Table 4-1 Length of rivers in Japan

	Managed by the Central Government in thousand km	Managed by Prefecture in thousand km	Total in thousand km
A class river	11	77	88
B class river	0	36	36
Total	11	113	124

Created based on MLIT（http://www.mlit.go.jp/common/001139145.pdf, http://www.mlit.go.jp/common/001139148.pdf）

Huge number/ length of rivers are managed by Prefecture. But Prefectures are in general much facing difficulties with the shortage of budget and engineers/ staffs for managing the rivers.

Difficulty in surveying the cross sections of the rivers, and creating the flood hazard maps in each river.

Low cost Flood Hazard Mapping method is necessary to provide the Flood Hazard Maps of Small and Medium Rivers.

2. Challenges

The Flood Safety Level of Small and Medium Rivers (managed by Prefecture Government) are relatively lower than that of Large Rivers (managed by the Central Government).

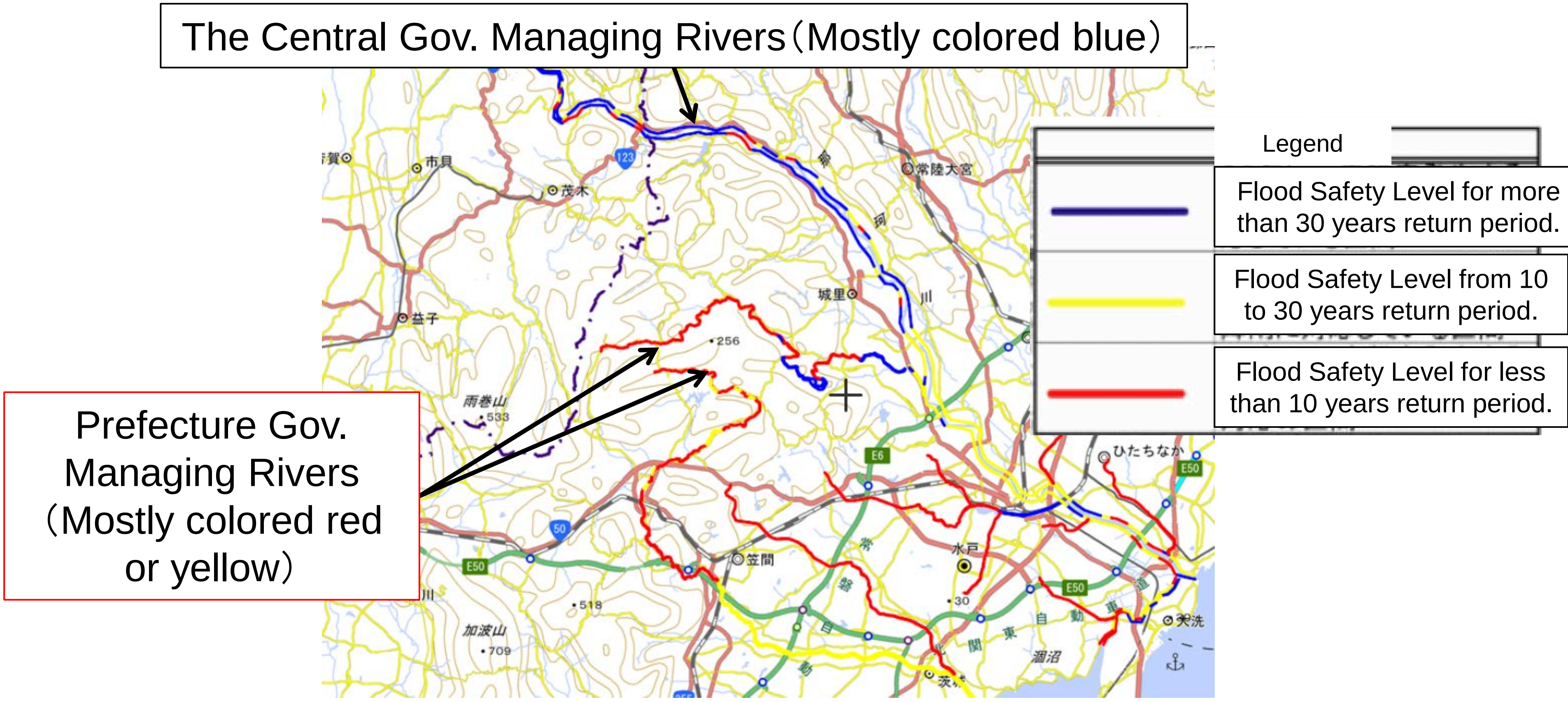


Fig. 4-1 Flood Safety Level Rough Assessment based on LP data conducted by NILIM (as of 2007)
（http://www.nilim.go.jp/lab/rcg/newhp/seika.files/lp/index.html）

2. Challenges

It has been pointed out that flood damage is likely to occur in low places along the river.→ How to share this simple risk information in society?

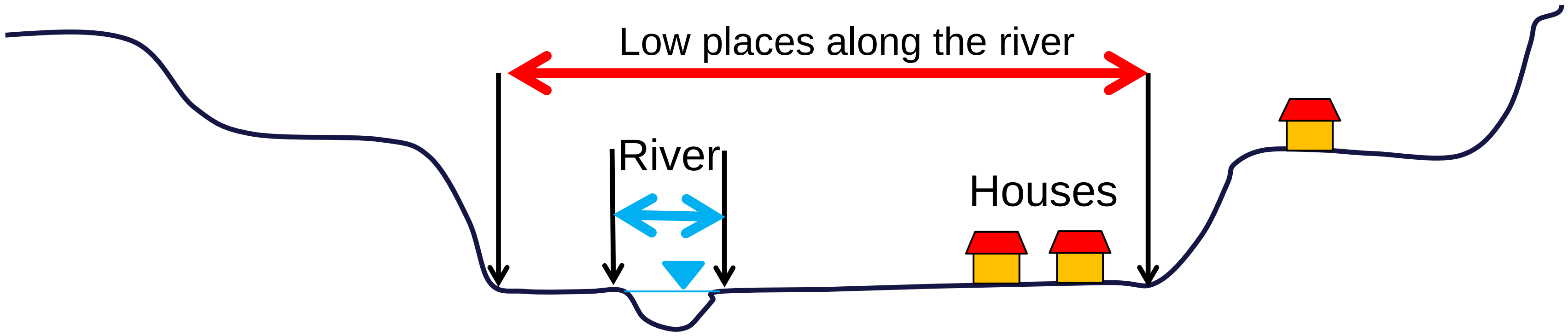


Fig.4-2 Cross sectional image with terrace

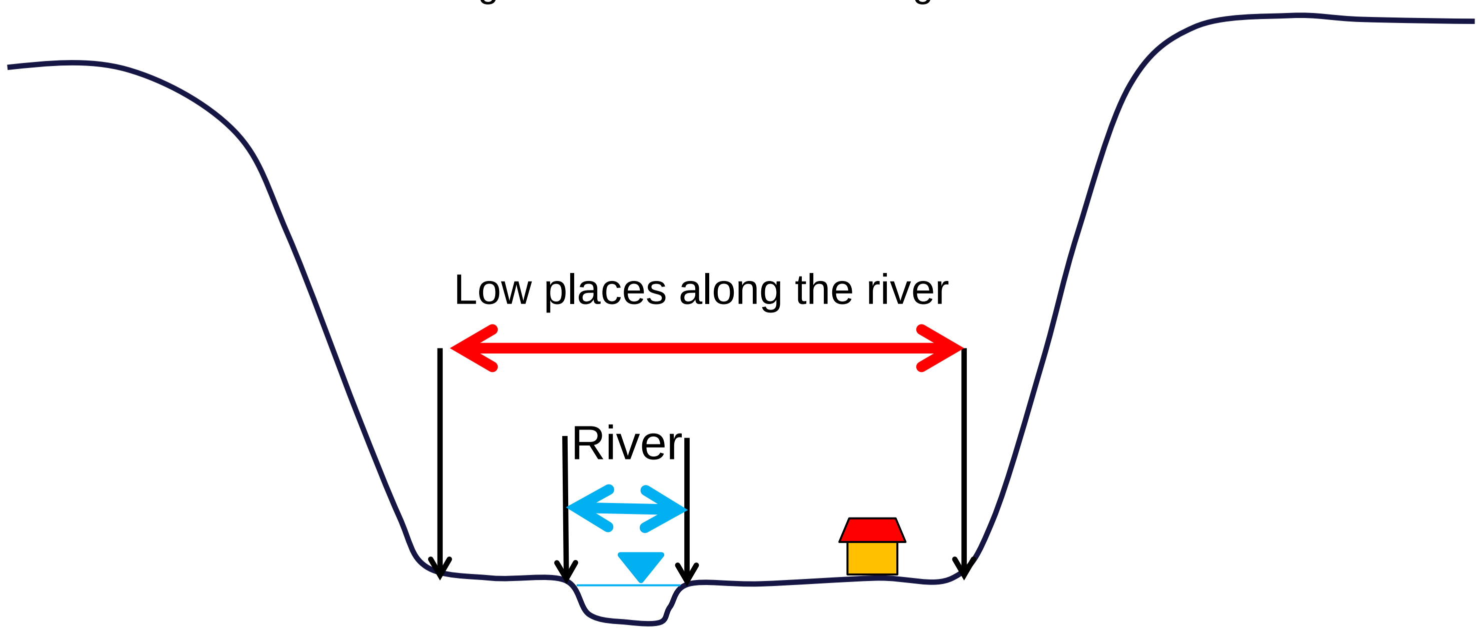


Fig.4-3 Cross sectional image without terrace

3. Simplified Flood Hazard Mapping method

Because of the huge length of the small and medium rivers, and the limitation of the budget and the number of the staffs, it is in general difficult to provide flood hazard maps in small and medium rivers in Japan.
For this reason, Simplified Flood Hazard Mapping method has been developed by NILIM, and notified by MLIT in Dec. 2018.

① Considering the wide range of the scale of possible Flood and GCC, provision of relative Flood Hazard zone was prioritized. It is different from the current general Flood Hazard Map based on a single Flood scale/ scenario.

② Tried to reduce the amount of the necessary data and the time/ resources for creating the FHM through simplifying the flood hazard zone assessment calculation.

③ Tried to contribute to Laver saving by using the existing LP data and “Small and Medium Rivers Flood Safety Assessment System developed by NILIM” (http://www.nilim.go.jp/lab/rcg/newhp/seika.files/lp/abst.html).

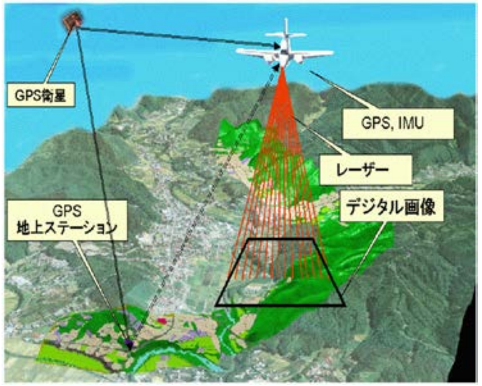


Fig.4-4 LP survey

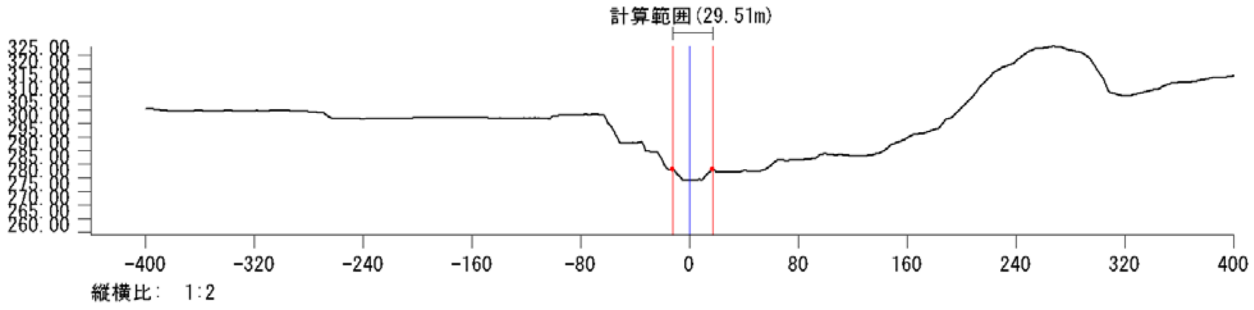


Fig.4-5 Example of presumed river cross section from LP data

3. Simplified Flood Hazard Mapping method

（2）Deriving H-Q equation at each river cross section

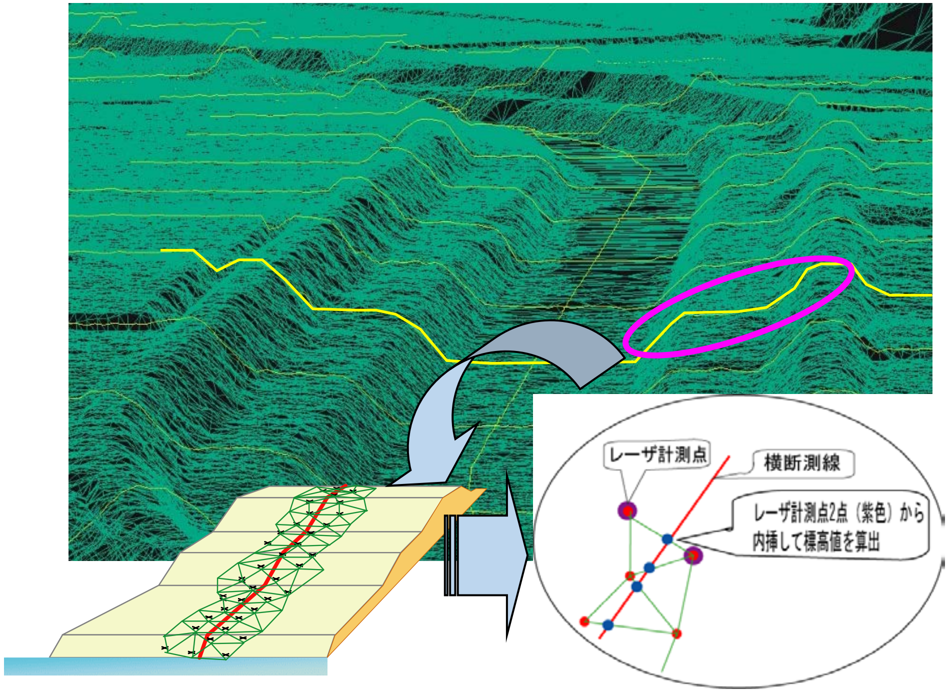


Fig.4-7 Presumption of river cross section from LP data

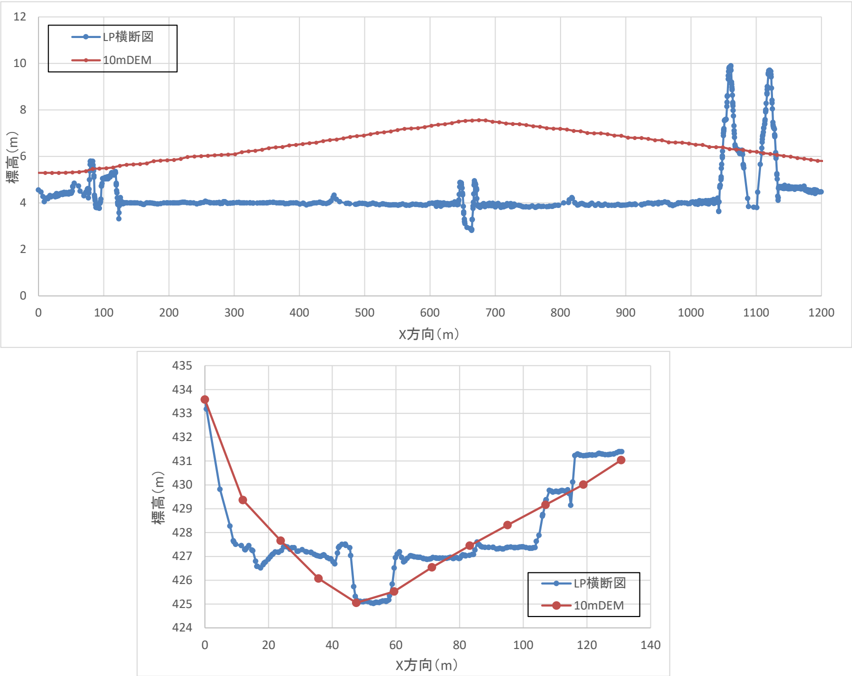


Fig.4-8 Comparison between 10mDEM and LP data

・Roughness coefficient of river channel is always assumed to be 0.033.
・The river water level was calculated with assuming the fixed width of river flowing channel.
・Each H-Q equation is derived from one-dimensional non-uniform flow calculation result with multiple Qs.
(River cross section interval is about 0.1 km, but flexible.)
・"Small and Medium Rivers Flood Safety Assessment System" developed by NILIM
（http://www.nilim.go.jp/lab/rcg/newhp/seika.files/lp/abst.html）was used for laver saving.

（3）Estimation of Flood water level for each heavy rainfall scale

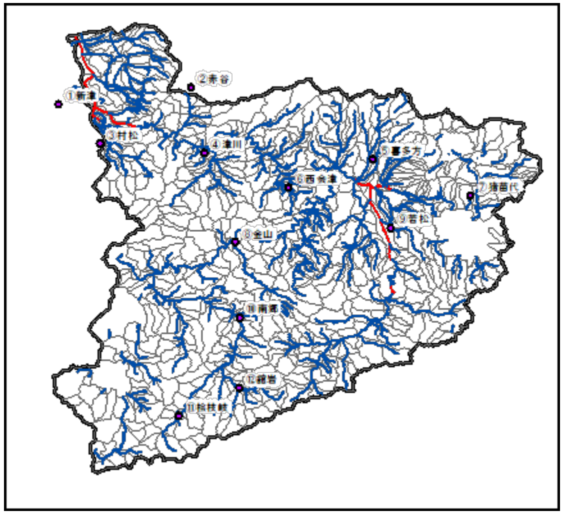
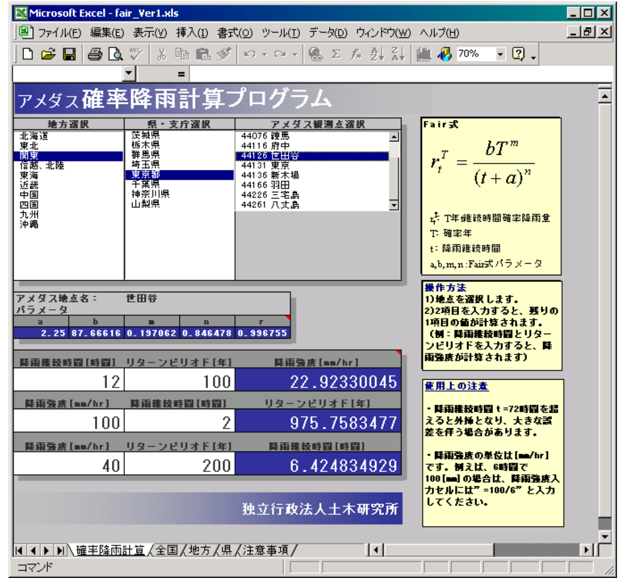


Fig.4-9 Example of distribution of rain gauge stations in a river basin



PWRI（https://www.pwri.go.jp/jpn/results/offer/amedas/sample.htm）

Fig.4-10 Rainfall intensity- Annual Exceedance Probability assessment program provided by PWRI (for rain gauge stations in Japan only)

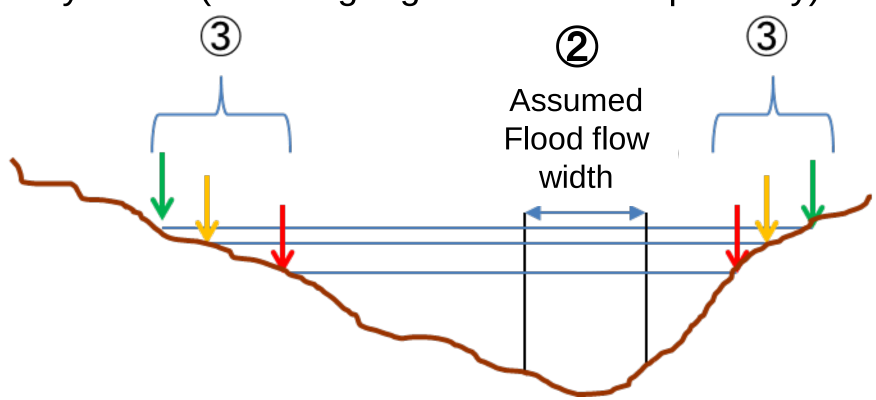


Fig.4-11 River cross sectional image for estimating flood water level and flood prone area

3. Simplified Flood Hazard Mapping method

(4) Delineation of Flood Prone Area for each Flood Scale

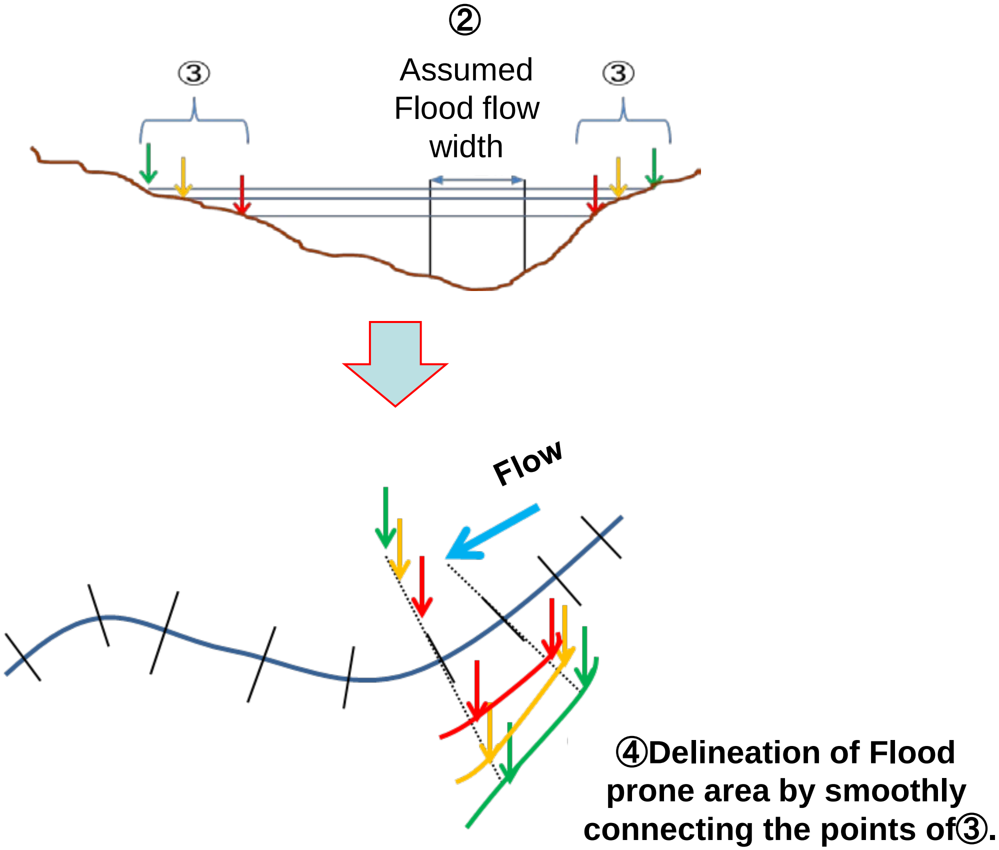


Fig.4-12 Delineation of Flood Prone Area

Legend

*Rainfall intensity in flood arrival time (about 2 hours).

: 50mm (AEP 1/10)

: 70mm (AEP 1/30)

: 90mm (AEP 1/100)

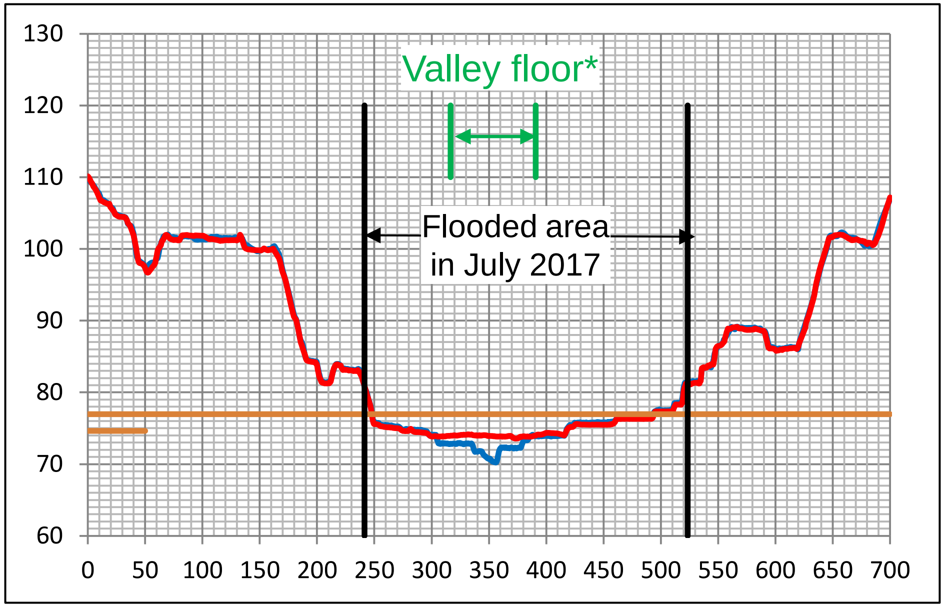
※Note
This figure is created based on rough estimation of Flood Prone Area based on LP data. The colored areas are relatively flood prone areas, and non-colored areas are not necessarily non-flood-prone areas. Besides, other disasters' prone areas, such as sediment disaster prone areas, are not presented in the figure.

Fig.4-13 Example of Simplified Flood Hazard Map

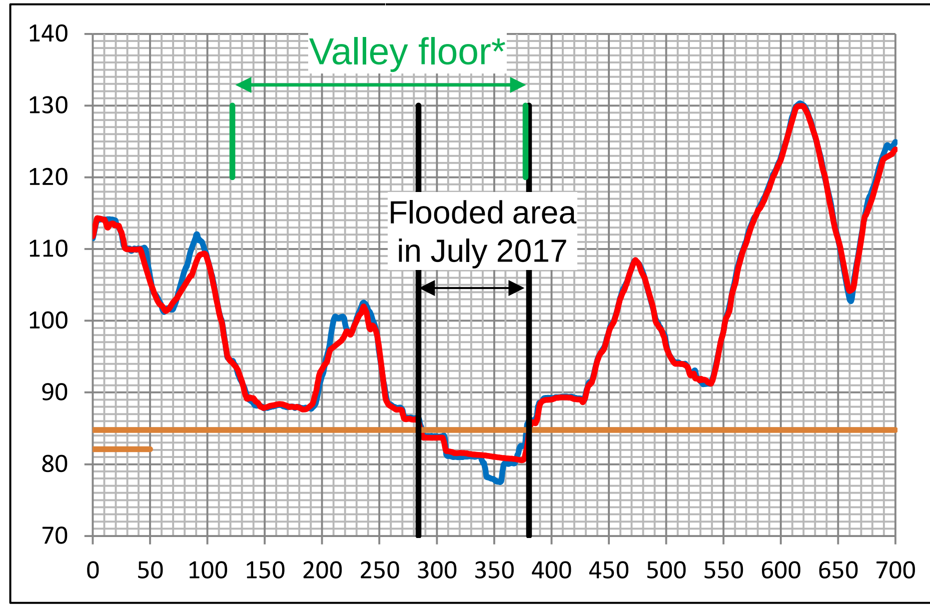
4. Test application examples

Comparison between the estimated flood prone area, actual flooded area in July 2017, and the Valley floor by Terrain classification*.

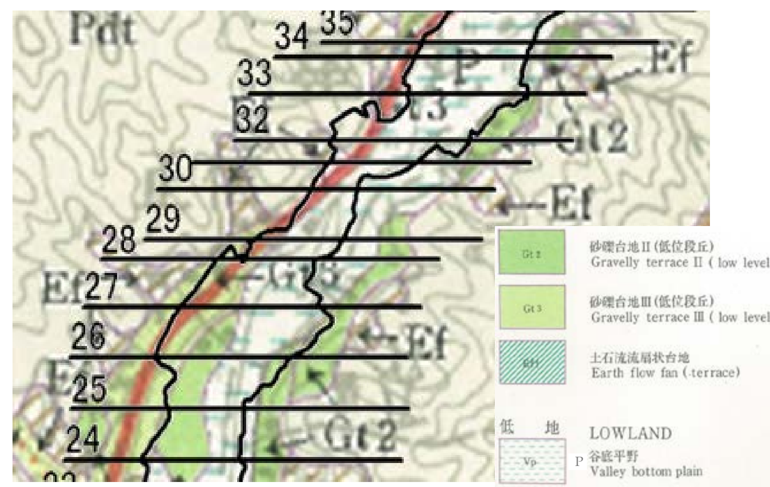
* From Terrain Classification Map（Mar. 1986 Fukuoka Pref.）



① No.26 cross section



② No.30 cross section



Legend

- : Cross section after Flood（as of Aug. 2017)
- : Cross section before Flood（as of Mar. 2017）
- : Estimated flood water level（with rainfall 137mm/hr）
- : Flooded area（roughly estimated from aerial photo）
- : Valley floor*

5. How to use Simplified Flood Hazard Map

e.g. To avoid flood prone areas when selecting the location of evacuation site and the route.

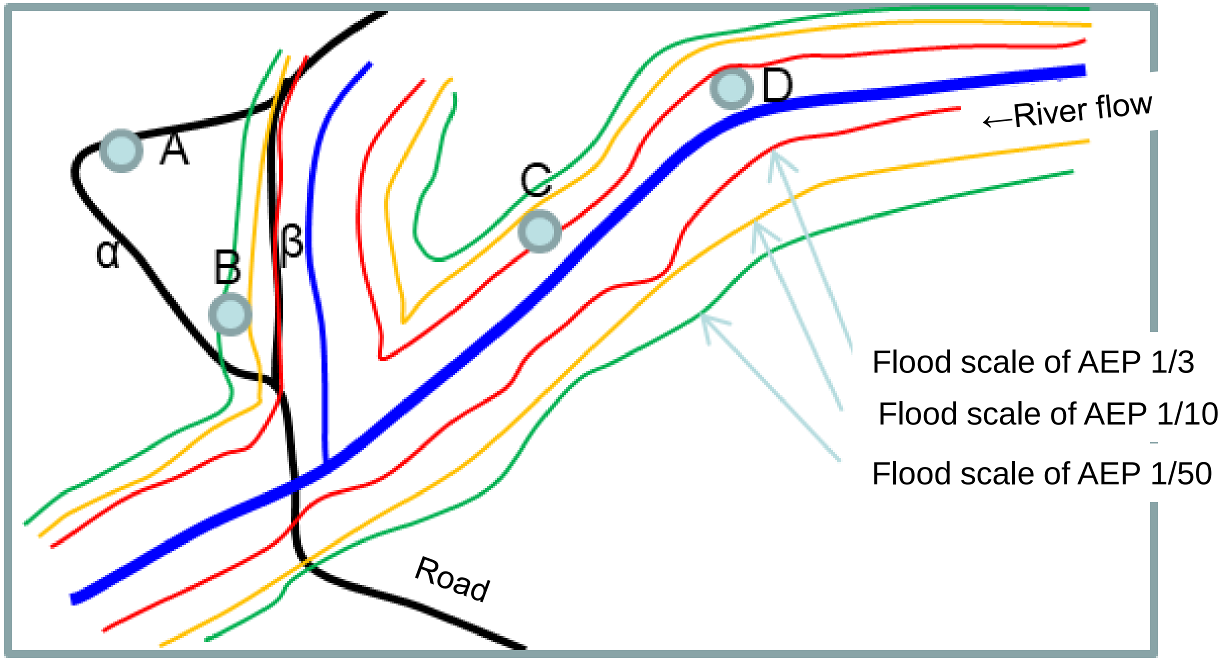


Fig.4-14 Simplified Flood Hazard Map image with the locations of candidate locations of evacuation sites and routes

Relative proneness of flooding of candidate locations for evacuation sites is as follows.

site A<site B<site C<site D

Therefore, site A is relatively less flood prone among those 4 locations.

With assuming the gaps between the road surface and the ground surface are almost the same, relative proneness of flooding of candidate evacuation route is as follows.

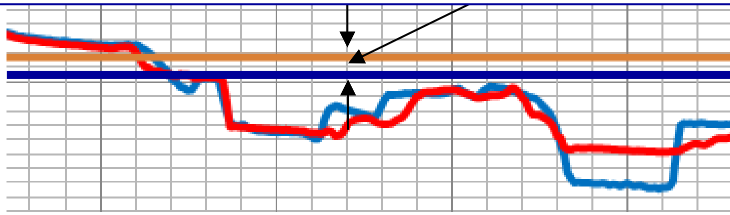
route α<route β

Therefore, route α is less flood prone than route β.

6. Remaining Challenges

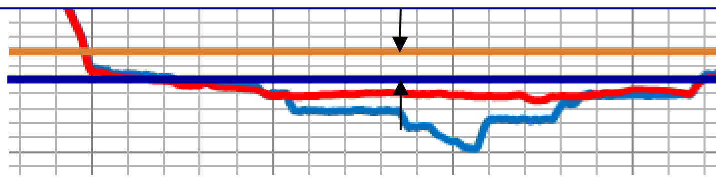
In order to provide Simplified Flood Hazard Map for river reaches where there is a risk of severe sediment deposition during flood event, it is necessary to research and develop methods for considering the flood water level rise caused by the severe deposition.

Flood water level may be higher by 1m or more if sediment deposition changes the river cross section profile at the moment of the flood peak.



Cross section ①

Flood water level may be higher by 2m or more if sediment deposition changes the river cross section profile at the moment of the flood peak.



Cross section ②

NILIM is conducting the research and developing to consider the influence of sediment deposition when creating Simplified Flood Hazard Map.

Legend
Red/ Blue lines : Cross section After/ Before the Flood by LP data.
Orange line : Estimated flood water level with “After Flood” cross section
Navy blue line : Estimated flood water level with “Before Flood” cross section
* Scale interval : Vertical=1m・Horizontal=10m

Fig.4-16 Examples of river bed rise and estimated flood water level rise during Flood in July 2017

Ⅴ Urban Flood Prediction System

1. Necessity of Urban Flood Prediction System
2. Outlines of Urban Flood Prediction System
3. Outlines of Social Experiment
4. Examples of Urban Flood Prediction

1. Necessity of Urban Flood Prediction System

There are frequent urban floods caused by torrential rainfall, and it is crucial to continue developing rivers and sewerage systems. But it is difficult to develop them enough against such torrential rainfall events. Considering the impact of GCC, it is necessary to provide and utilize Early Warning System against Urban Flood necessary for emergency response such as evacuation from the underground floor, damage prevention/reduction activities.

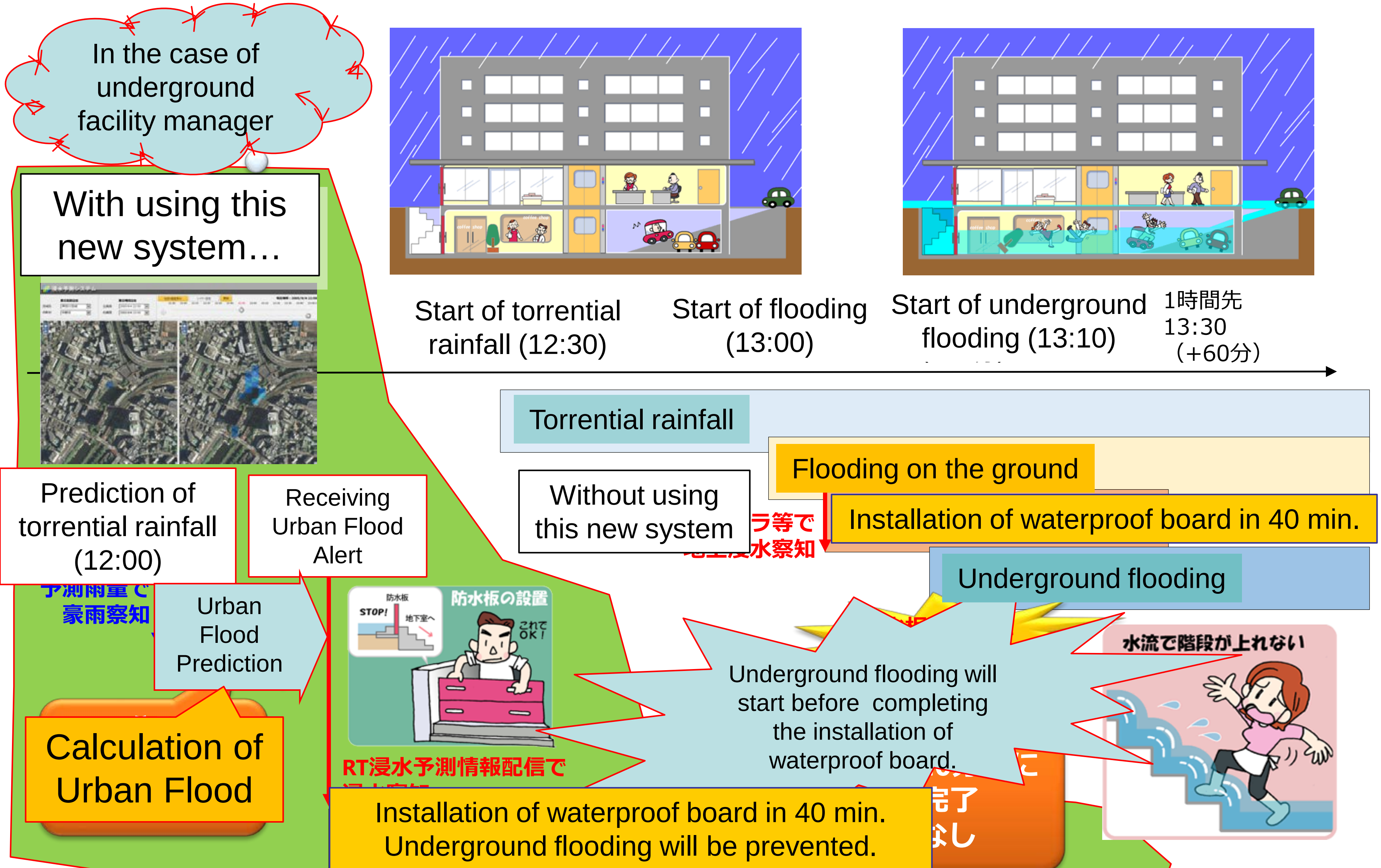
NILIM has developed a system which can promptly predict urban flood area/ depth of inundation based on monitored/ predicted rainfall data etc., and distribute the urban flood alert mail.

Inflow of urban flood water into the underground shopping area in Fukuoka city in June 1999.
Photo: Kyusyu Regional Development Bureau, MLIT

Preparation for preventing flood water from flowing into the subway station.

Flooded Underpass Signage.
Photo: From website of Kanto Regional Development Bureau, MLIT

The Urban Flood Prediction information is up to 1 hr. ahead from the time of the rainfall forecast. After receiving necessary data for the Urban Flood Prediction, i.e. rainfall and river water level observed/ predicted data, it takes 10 min. for the calculation and the alert mail distribution.



2. Outlines of Urban Flood Prediction System

The system is capable of delivering Urban Flood Warning from 40 to 50 minutes before. Social experiment has been conducted in an area of about 100 km^2 in Tokyo.

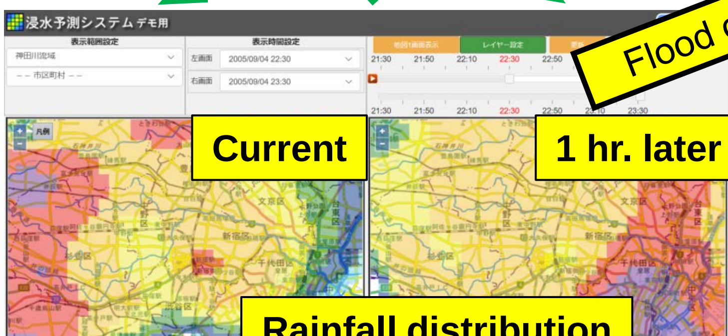
Observation and forecast data is taken into the system and Urban Flood Prediction information is distributed at 10-minute intervals.

統一河川情報等（XRAIN、水位等）

気象業務支援センター（高解像度降水ﾅｳｷｬｽﾄ）

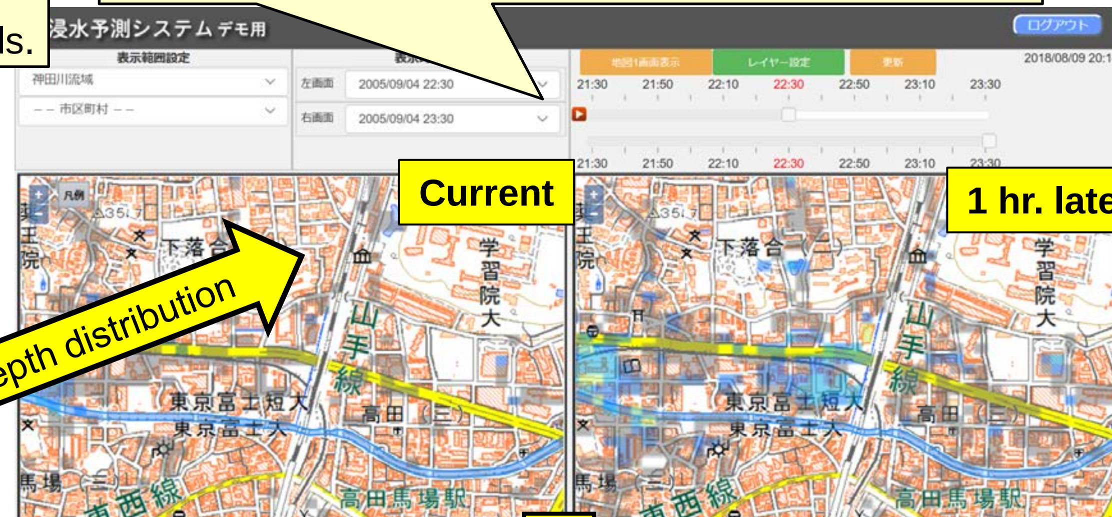
フェイズドアレイレーダ（予定）

予測、観測データ取得

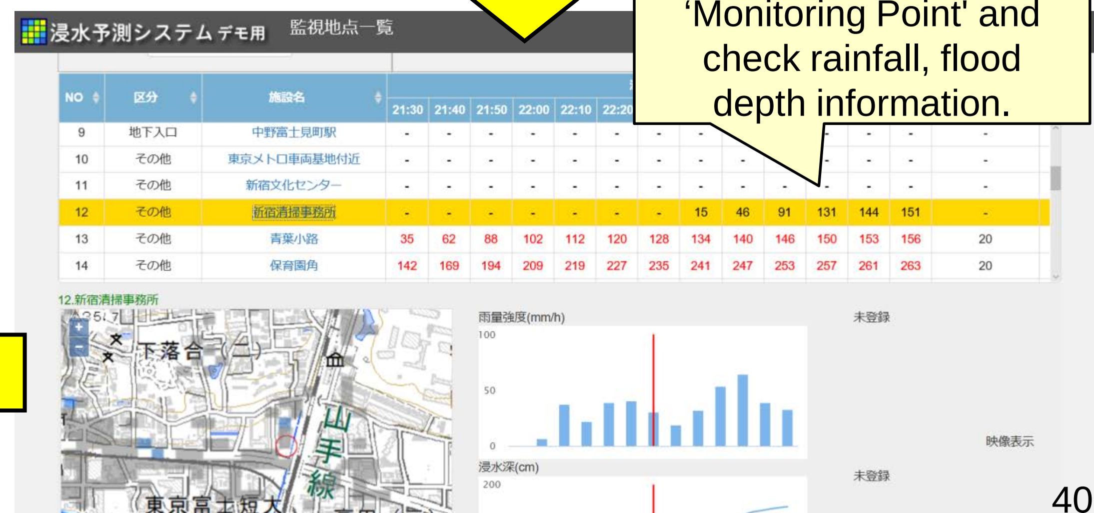


Flood depth distribution

Predicted flood depth of each 25 m mesh is displayed.



Closing up registered 'Monitoring Point' and check rainfall, flood depth information.

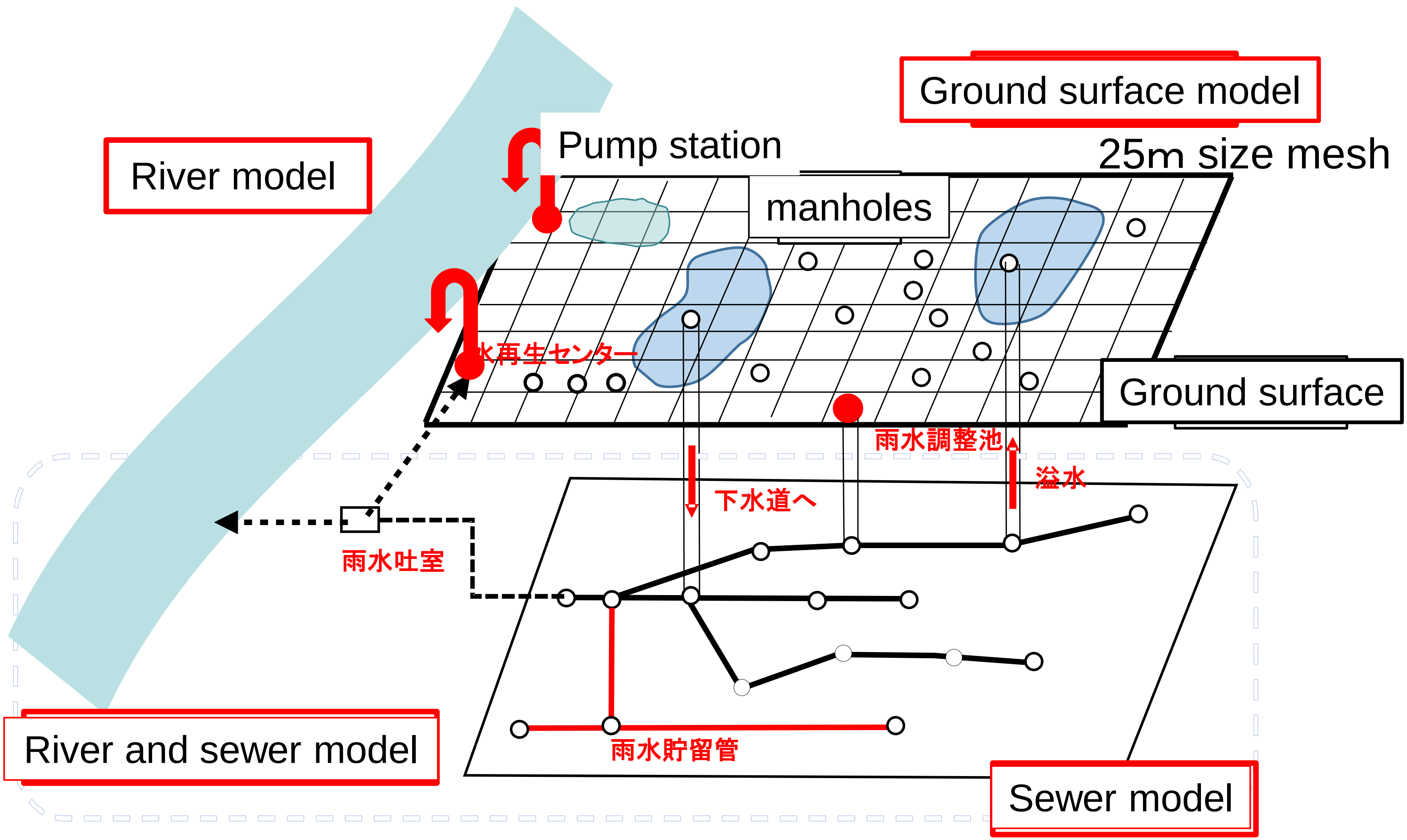


Prevent/ reduce Urban Flood damage

Residents

Emergency responders

2. Outlines of Urban Flood Prediction System



Sewer pipes with diameter of 600 mm or larger are modeled.

3. Outlines of Social Experiment

Purpose： To verify Urban Flood Prediction accuracy, Urban Flood Damage Reduction effect, Usability of the System.

Participants: Persons in charge of Flood Response Activities in LGU, Facility managers, etc.. Approximately 50 people (as of the end of March 2019) in Kanda-gawa River basin in Tokyo.

Experiment Period：From FY 2016

What we learned…

① The contents and accuracy required for Urban Flood Prediction Information differ depending on the his/her position, such as residents, officer in charge of Flood Response in LGU, and facilities management users.

② Some residents prefer to receive information (including evacuation decisions) through the LGU rather than directly receiving the detailed Urban Flood Prediction information.

③ Rainfall forecast accuracy greatly influences on the Urban Flood Prediction accuracy.

④ Even if people received the Urban Flood alert emails, most of the people did not check the relevant information on the web of this system.

4. Examples of Urban Flood Prediction (Aug. 19, 2017)

Urban Flood was predicted, and the alert mails were distributed.

At the site of ****, the flood depth may exceed 30 cm in 27 min.. (Current time is 16:02, Aug. 19, 2017)

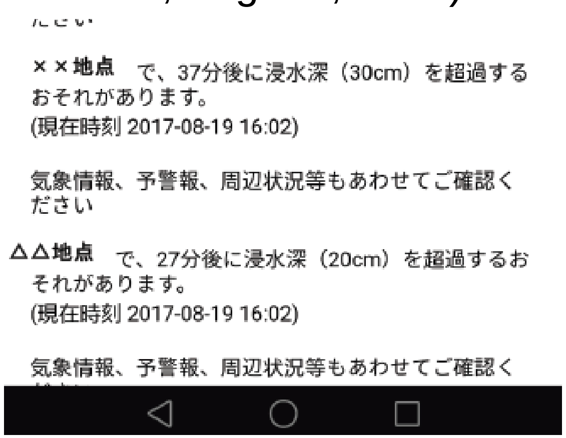


Fig.5-1 Alert mail distributed (actual one was all in Japanese)

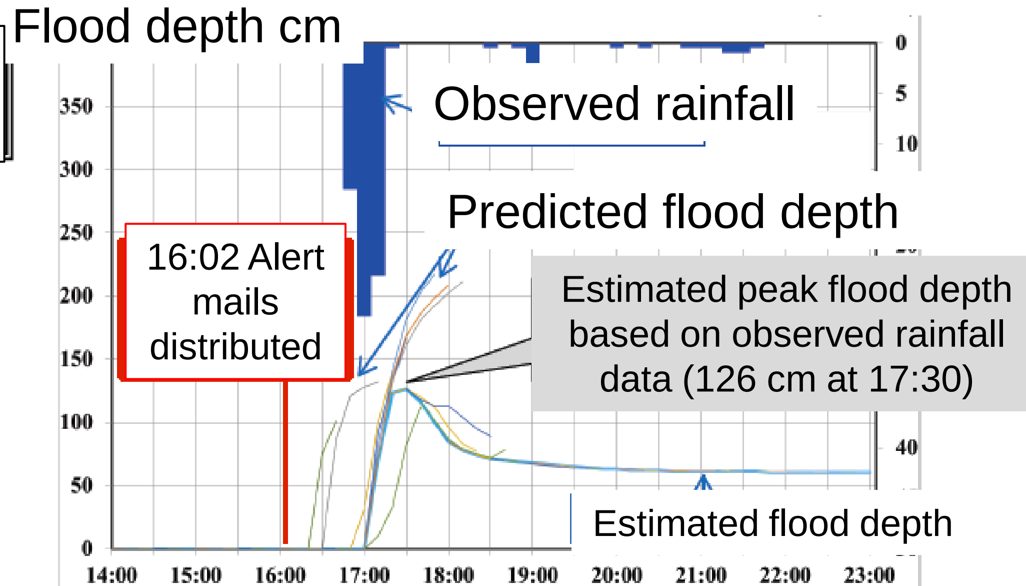


Fig.5-2 Observed rainfall and predicted/ estimated flood depth

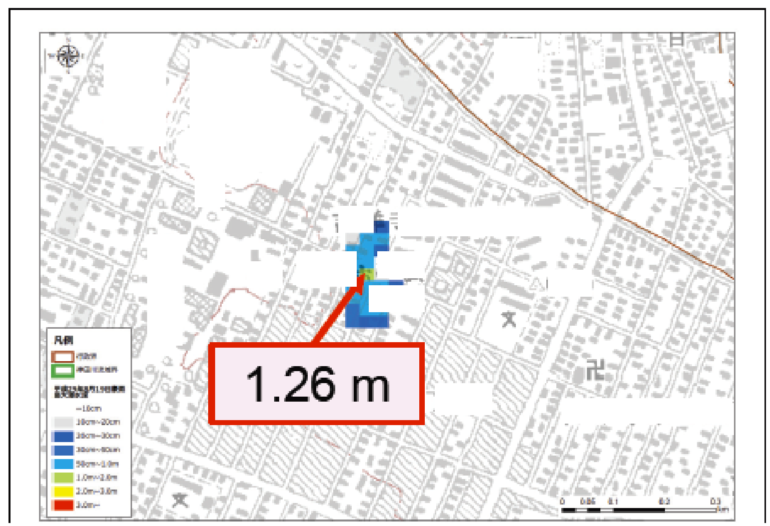
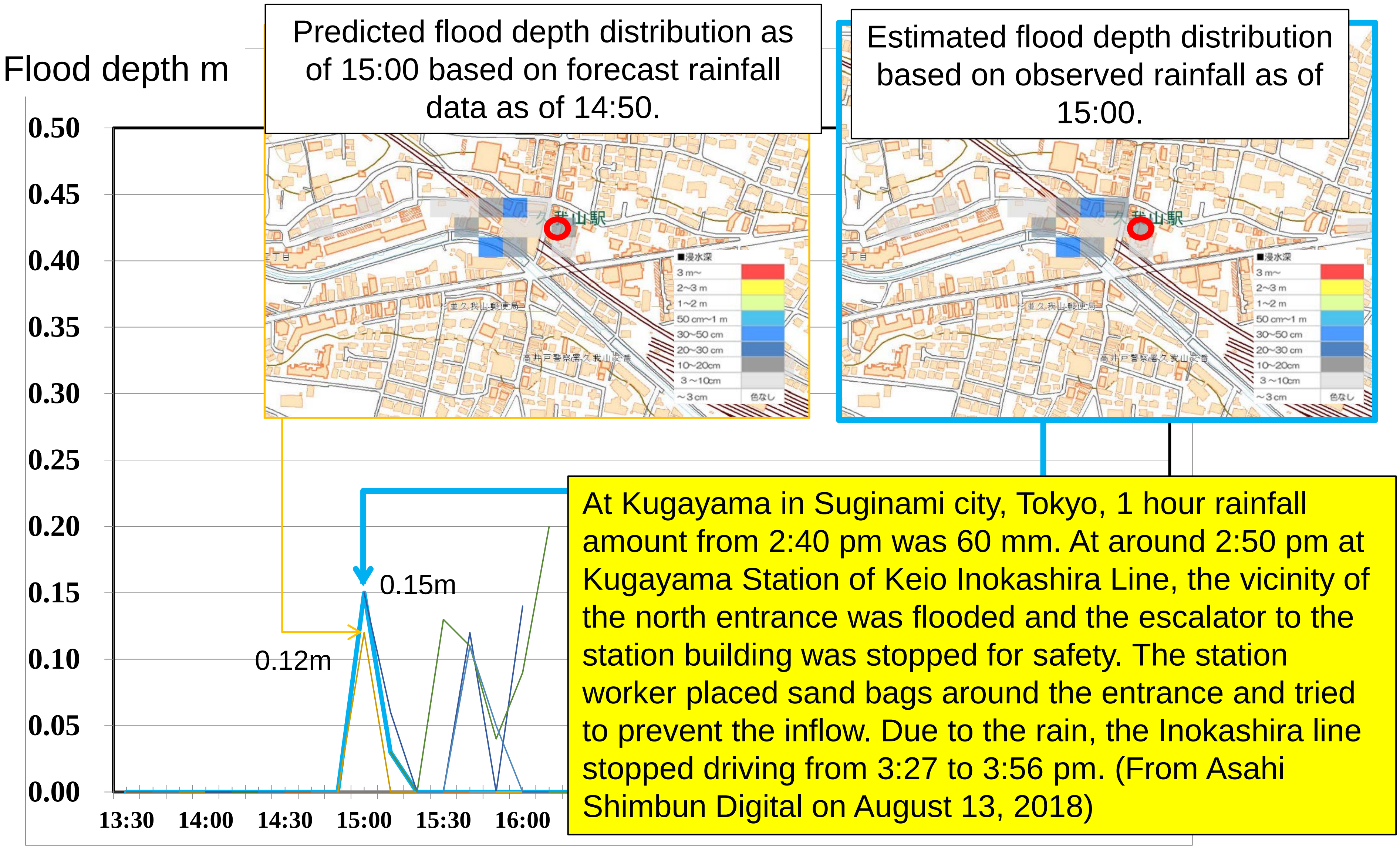


Fig.5-3 Estimated flood depth distribution based on observed rainfall

4. Examples of Urban Flood Prediction (Aug. 13, 2018)

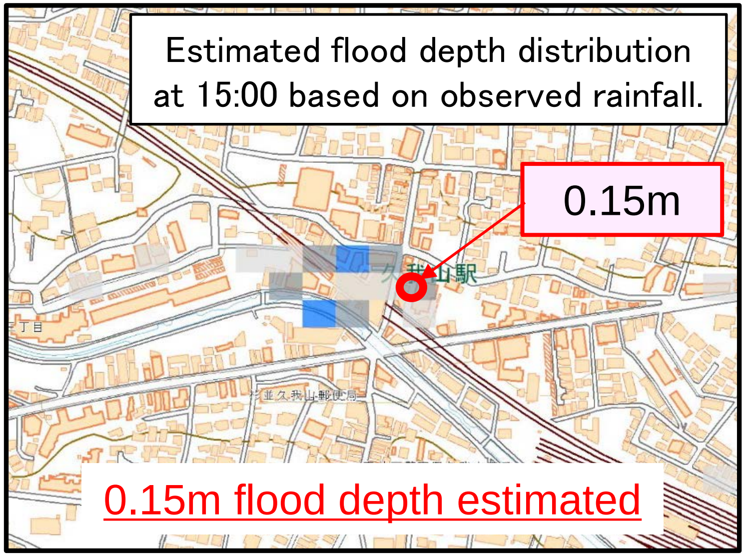
Predicted Urban Flood based on the forecast rainfall data is compared with that estimated based on observed rainfall.→No big difference, but…



At Kugayama in Suginami city, Tokyo, 1 hour rainfall amount from 2:40 pm was 60 mm. At around 2:50 pm at Kugayama Station of Keio Inokashira Line, the vicinity of the north entrance was flooded and the escalator to the station building was stopped for safety. The station worker placed sand bags around the entrance and tried to prevent the inflow. Due to the rain, the Inokashira line stopped driving from 3:27 to 3:56 pm. (From Asahi Shimbun Digital on August 13, 2018)

4. Examples of Urban Flood Prediction (Aug. 13, 2018)

Estimated flood depth at 15:00 on August 13 based on observed rainfall data.

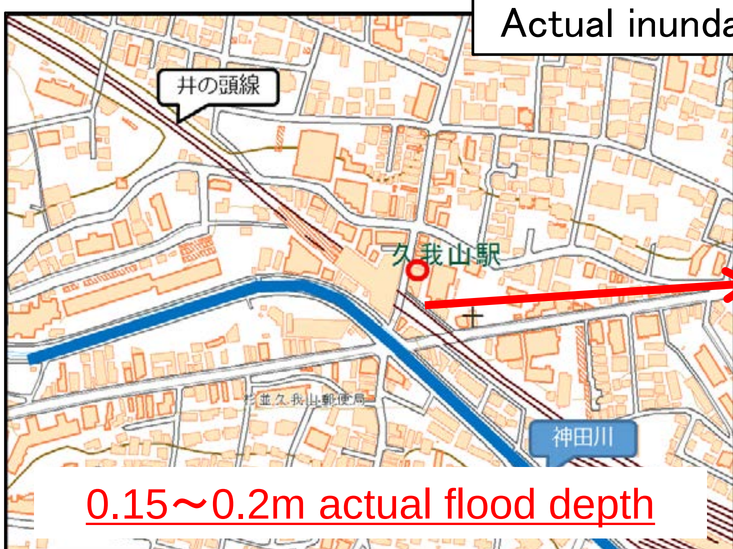


Legend
Inundation depth

3 m~	red
2~3 m	yellow
1~2 m	light green
50 cm~1 m	light blue
30~50 cm	blue
20~30 cm	dark blue
10~20cm	grey
3 ~10cm	light grey
~3 cm	No color

出典:https://twitter.com/kitabatake46

Actual inundation based on the photo.

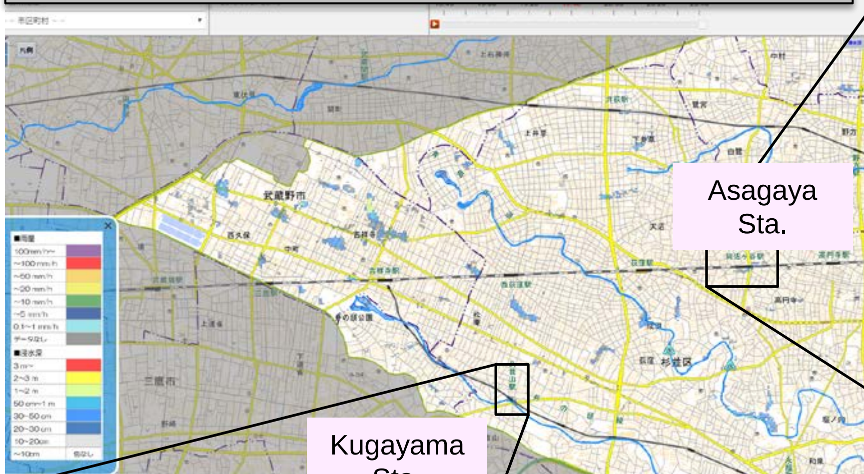


In the vicinity of Kugayama station, approximately 15 ~ 20 cm depth of Urban Flood was estimated based on the photo.

Estimated flood depth: About 15～20cm

4. Examples of Urban Flood Prediction (Aug. 27, 2018)

Urban Flood was predicted based on rainfall forecast data as of 19:50, but…



Asagaya Sta.

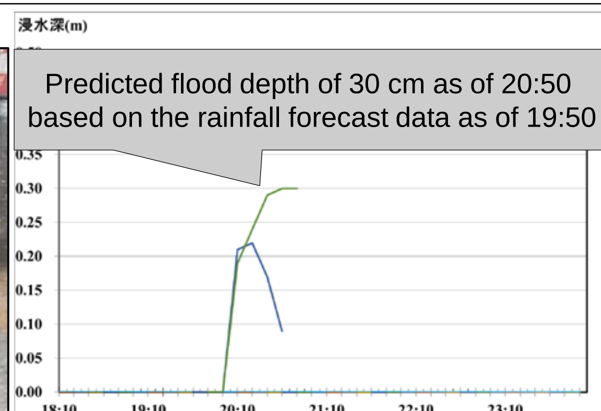
Kugayama Sta.

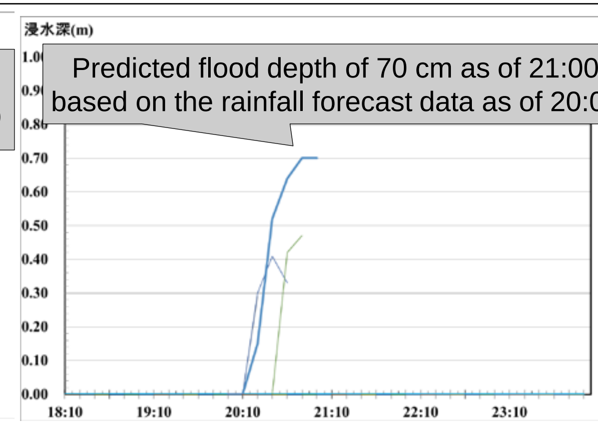
2018.8.27 20:17 返信 リツイート いいね 2018.08.27 20:17:29

pic.twitter.com/22QM8AYbwv

2018.8.27 20:07

Urban Flood occurred near these stations around 20:10.





30 cm depth of Urban Flood near Kugayama Sta. as of 20:50 was predicted based on the rainfall forecast data as of 19:50.

70 cm depth of Urban Flood near Asagaya Sta. as of 21:00 was forecasted based on the rainfall forecast data as of 20:00.

雨 豪雨 20時8分頃の久我山
現在はこの水は流れています
目の前のドトールさんも冠水して
大変なことになっていました pic.twitter.com/7cHTg3IWHJ
— うどう。 (@spgiji19920526h) 2018年8月27日

https://www.businessinsider.jp/post-174098

Ⅵ How to promote in-advance evacuation （Based on the cases during the Western Japan Heavy Rainfall in 2018）

Photo: Mabicho District, Kurashiki City, Okayama Prefecture on July 26, 2018

July 2018 Flood Disaster in Western Japan

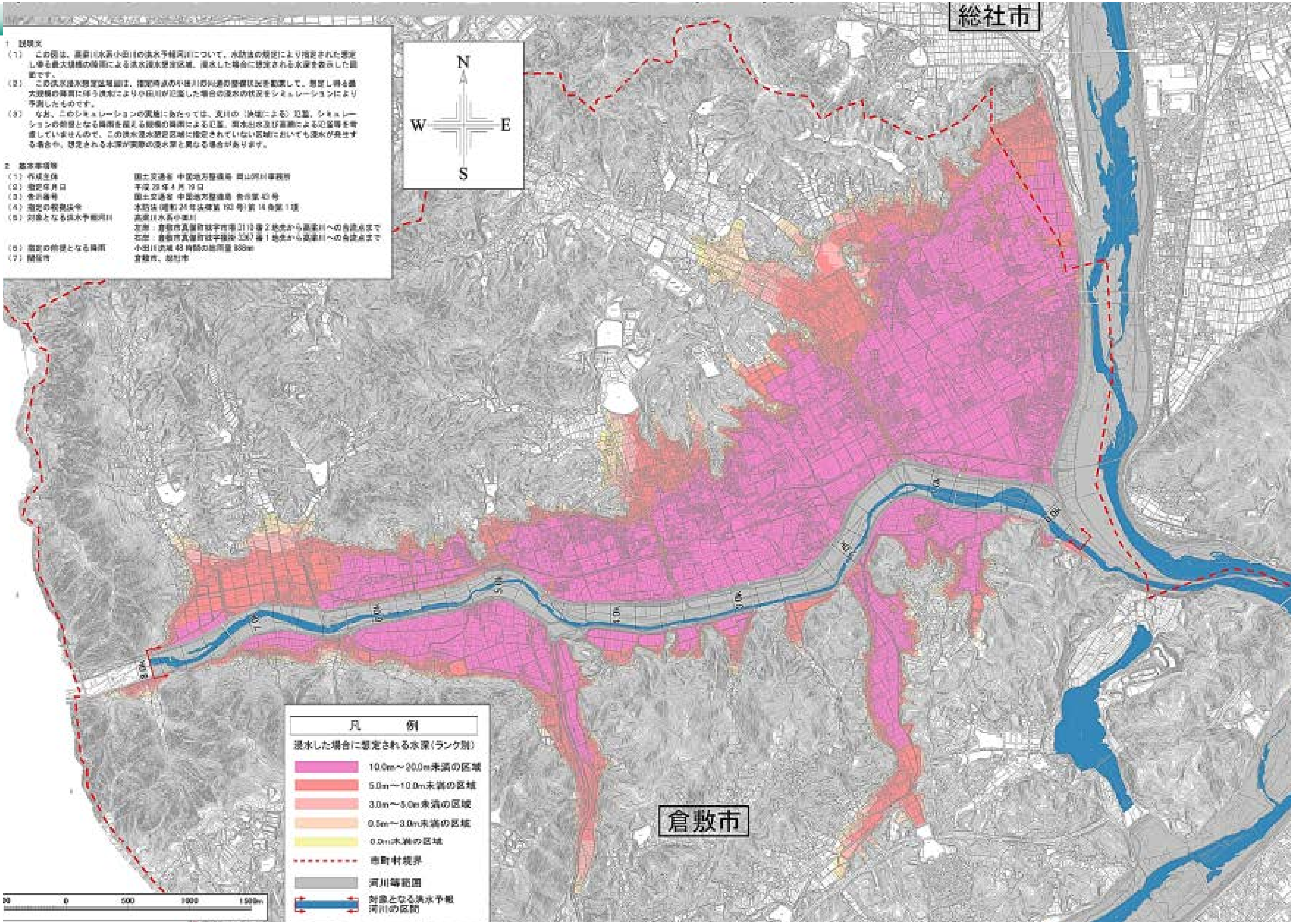
Heavy rainfall in Western Japan from June to July 2018.
2,281 mm rainfall was observed at Ebino rain gauge station in Miyazaki Prefecture, Kyusyu, from 0:00 June 4 to 24:00 July 17.
More than 1,000 mm rainfall was observed at many rain gauge stations in Kyusyu during the same period.
More than 500 mm rainfall was observed at many rain gauge stations in Western Japan.
304 mm/day rainfall was observed at Ohmuta rain gauge station in Fukuoka Prefecture, Kyusyu.
(297 mm/day is estimated to be 200 years return period rainfall at Fukuoka rain gauge station in Fukuoka Prefecture (Japan Meteorological Agency))
150 mm/h rainfall was observed at Kousa rain gauge station in Kumamoto Prefecture, Kyusyu.
(150 mm/h is roughly estimated to be around 780 years return period scale of rainfall (based on PWRI AMeDAS rainfall probability estimation program (https://www.pwri.go.jp/jpn/results/offer/amedas/top.htm))
237 fatalities, 8 missing, 466 injured, 6,767 residential houses completely destroyed, 11,248 residential houses half destroyed, 4,199 residential houses partially destroyed, 7,173 residential houses flooded above the floor, 21,337 residential houses flooded below the floor, 159 public buildings damaged, other 2,423 buildings damaged. (As of Jan. 9, 2019, Fire and Disaster Management Agency)

July 26, 2018 Mabichou-District, Kurashiki-City, Okayama-Prefecture

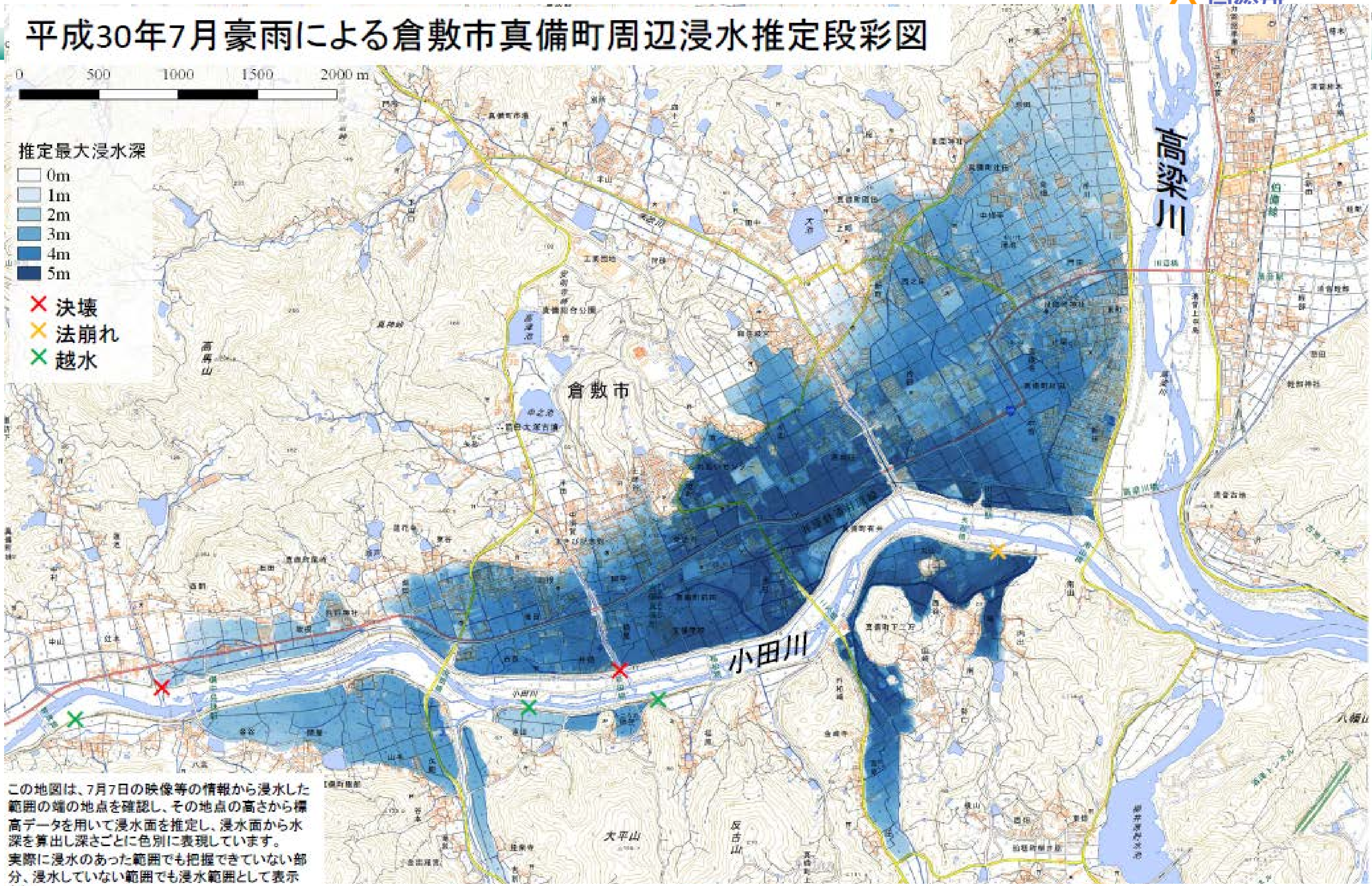
July 26, 2018 Mabichou-District, Kurashiki-City, Okayama-Prefecture

July 26, 2018 Mabichou-District, Kurashiki-City, Okayama-Prefecture

July 26, 2018 Mabichou-District, Kurashiki-City, Okayama-Prefecture



Flood Hazard Map revised by MLIT in April 2017



Estimated flooded area in July 2018 by Geospatial Information Authority, MLIT.

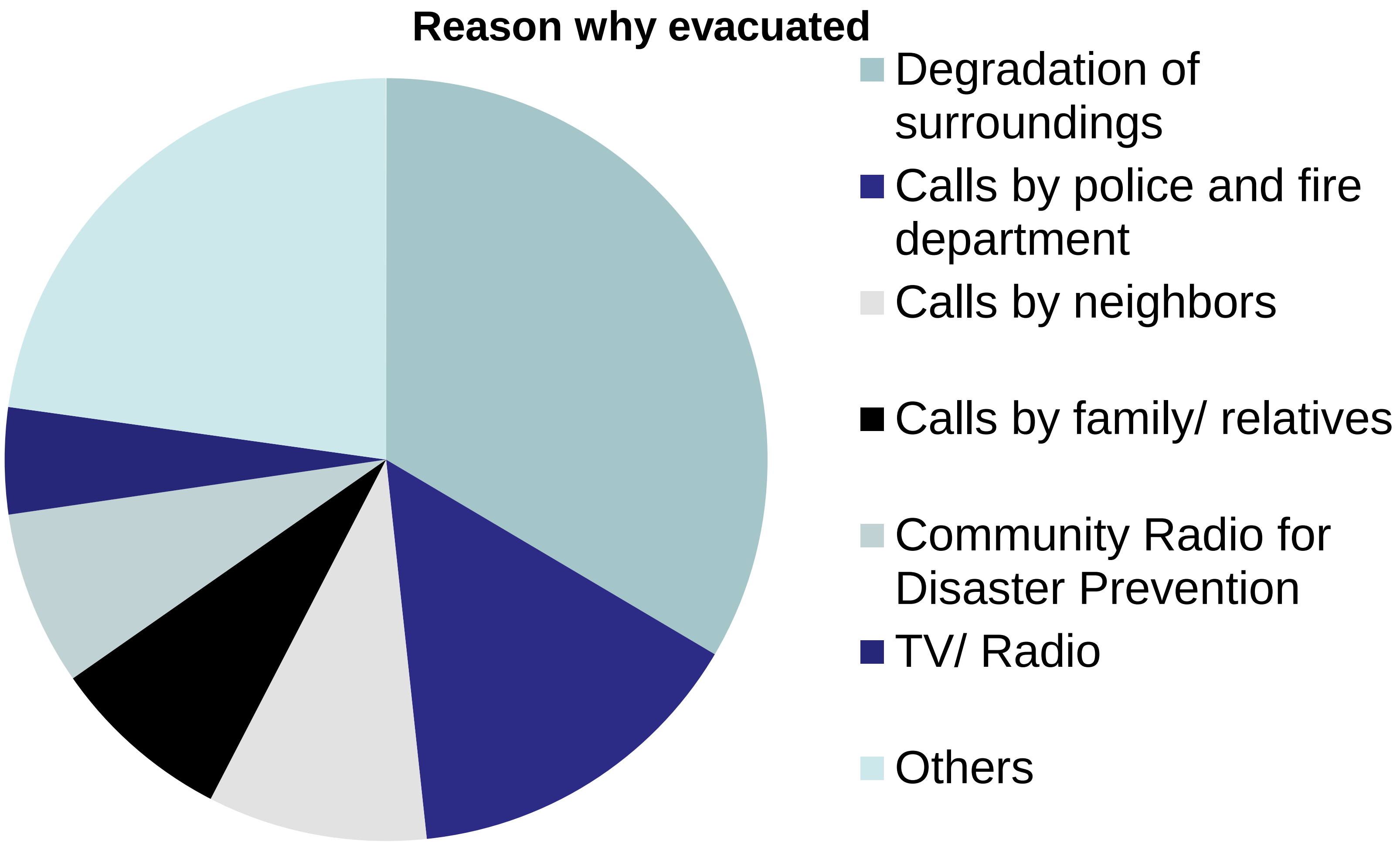
Actual flooded area was almost the same as that on the previously published Flood Hazard Map, but…

Challenges of July 2018 Flood Disaster in Western Japan

Most of the people did not evacuate, e.g. 97% of people equal to or above 60 years old did not evacuate (Research by CeMI). (Sept. 2, 2018 Yomiuri-shimbun newspaper)
48% of the people have not seen the Hazard Maps. (Research by Sompo Japan property insurance company) (Aug. 26, 2018 Yomiuri-shimbun newspaper)
Only 0.5% people evacuated when received evacuation advise or evacuation instruction. (Research by Fire and Disaster Management Agency) (Aug. 7, 2018 Sankei-shimbun newspaper)

Challenges of July 2018 Flood Disaster in Western Japan

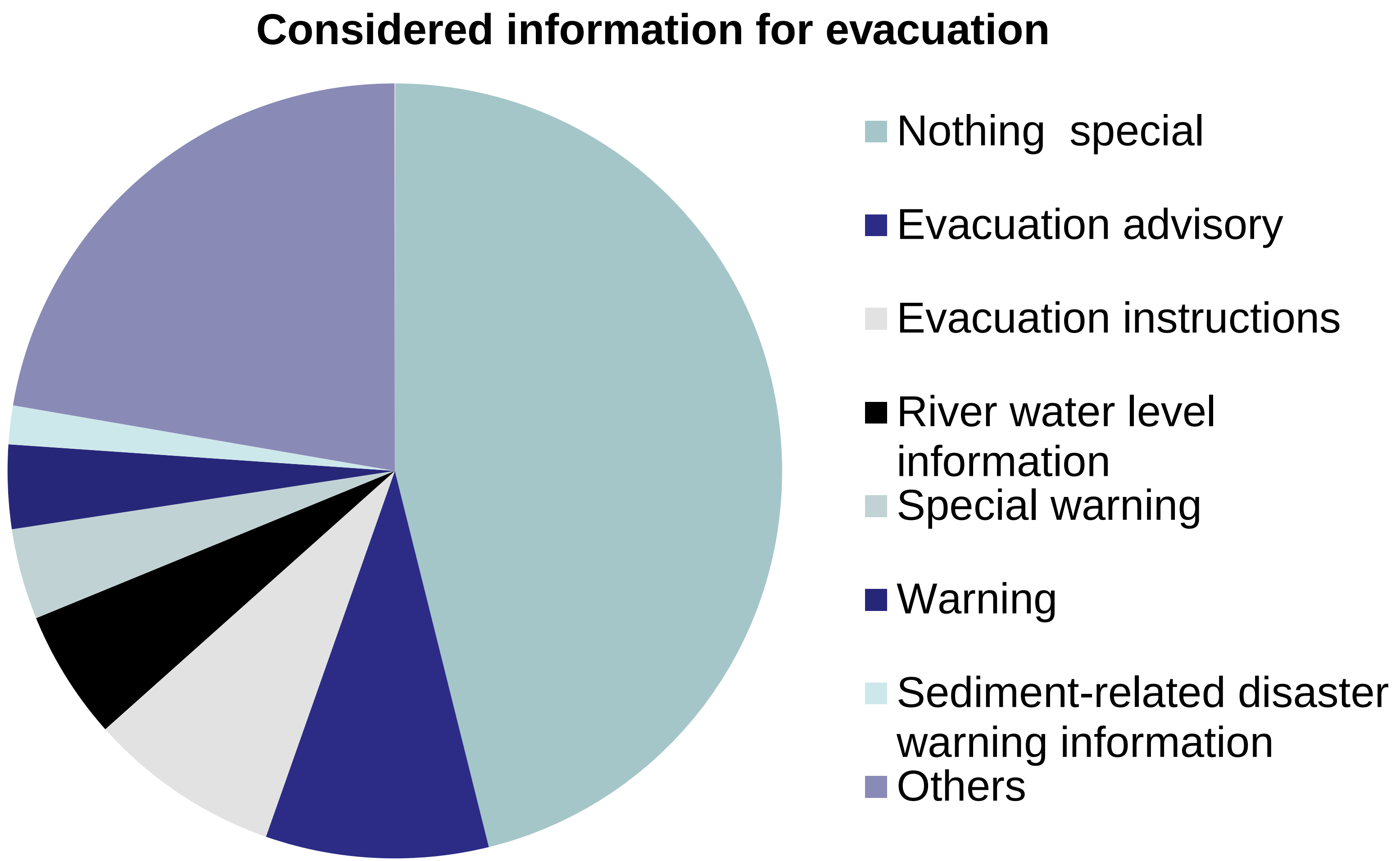
Reasons why one evacuated (Questionnaire survey in Hiroshima, Okayama, and Ehime Prefectures by NHK Aug. 6, 2018)



“Calls” constitutes large proportion of the reasons of evacuation.

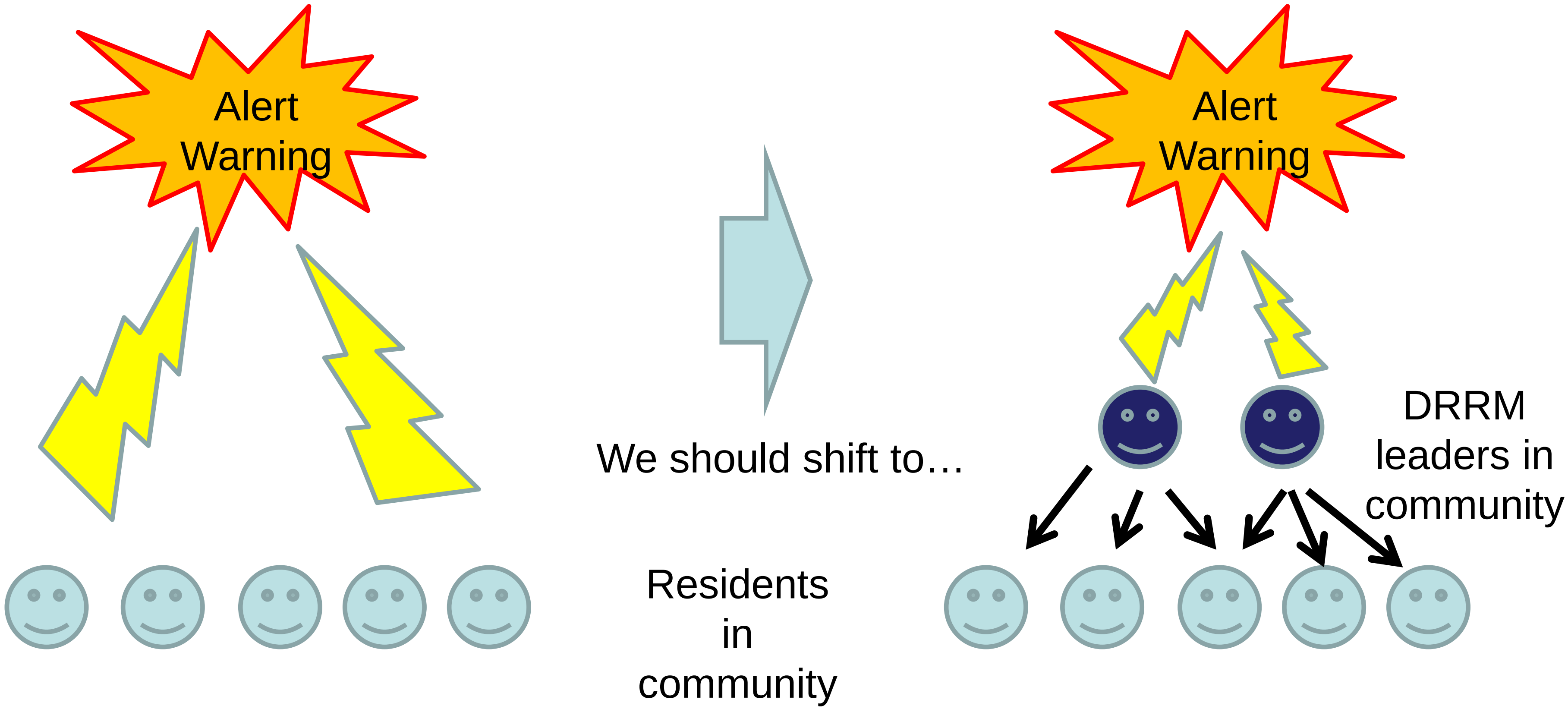
Challenges of July 2018 Flood Disaster in Western Japan

What information was considered when evacuated (Questionnaire survey in Hiroshima, Okayama, and Ehime Prefectures by NHK Aug. 6, 2018)



Evacuation advisory/ instructions, warnings are not considered so much for deciding the evacuation.

Proposal: Shifting from Flat structure to Hierarchy structure for ensuring evacuation in each community so as to prevent fatalities



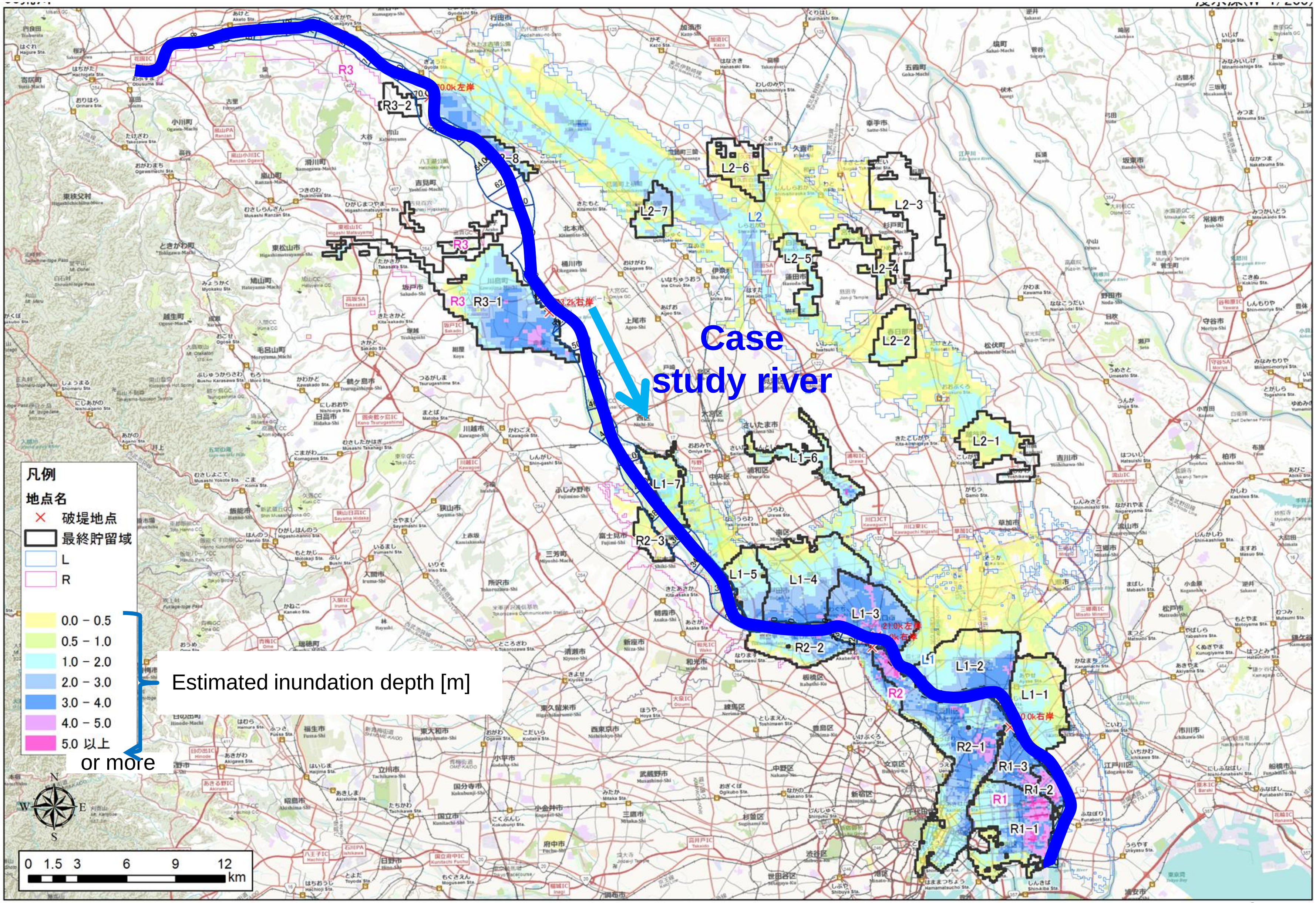
“Flat structure”
Independent, decision making by individual,…
→Difficult to ensure the evacuation.

“Hierarchy structure”
Next to each-other , face-to-face, evacuate together, …
→It matches behavioral characteristics in Japan.

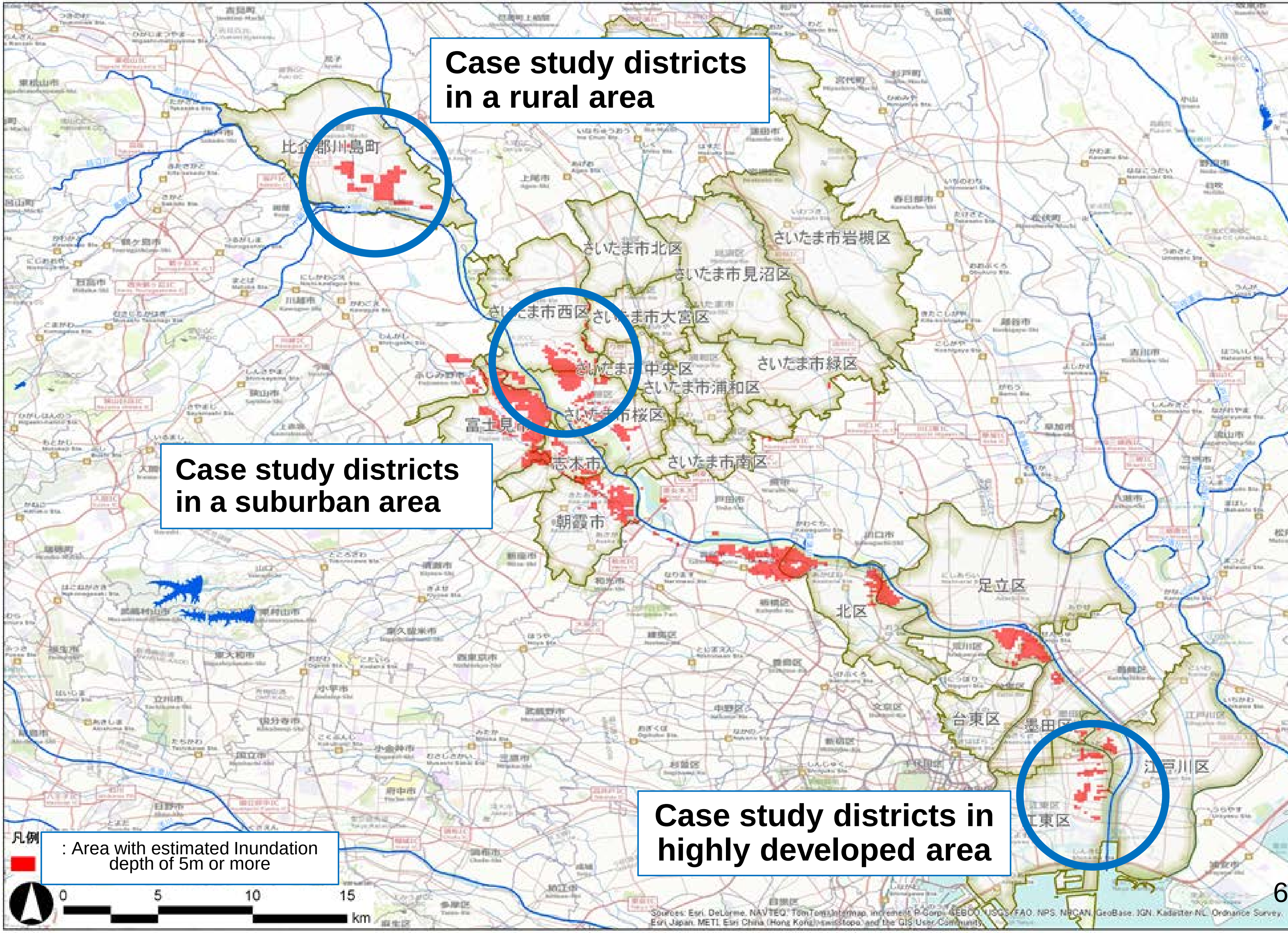
Ⅶ Human Damage Macro Evaluation Method for Catastrophic Flood Disasters (with considering Distribution of Mid-to-High-Rise Buildings in Neighborhood)

- In Japan, not small number of residents would start evacuation when flood inundation was indeed imminent.
- We found that it was important to consider the distribution of mid-to-high-rise buildings in neighborhood when developing and examining specific lifesaving countermeasures against catastrophic flood disaster.

Case study river, with maximum inundation area with AEP 1/200 flood

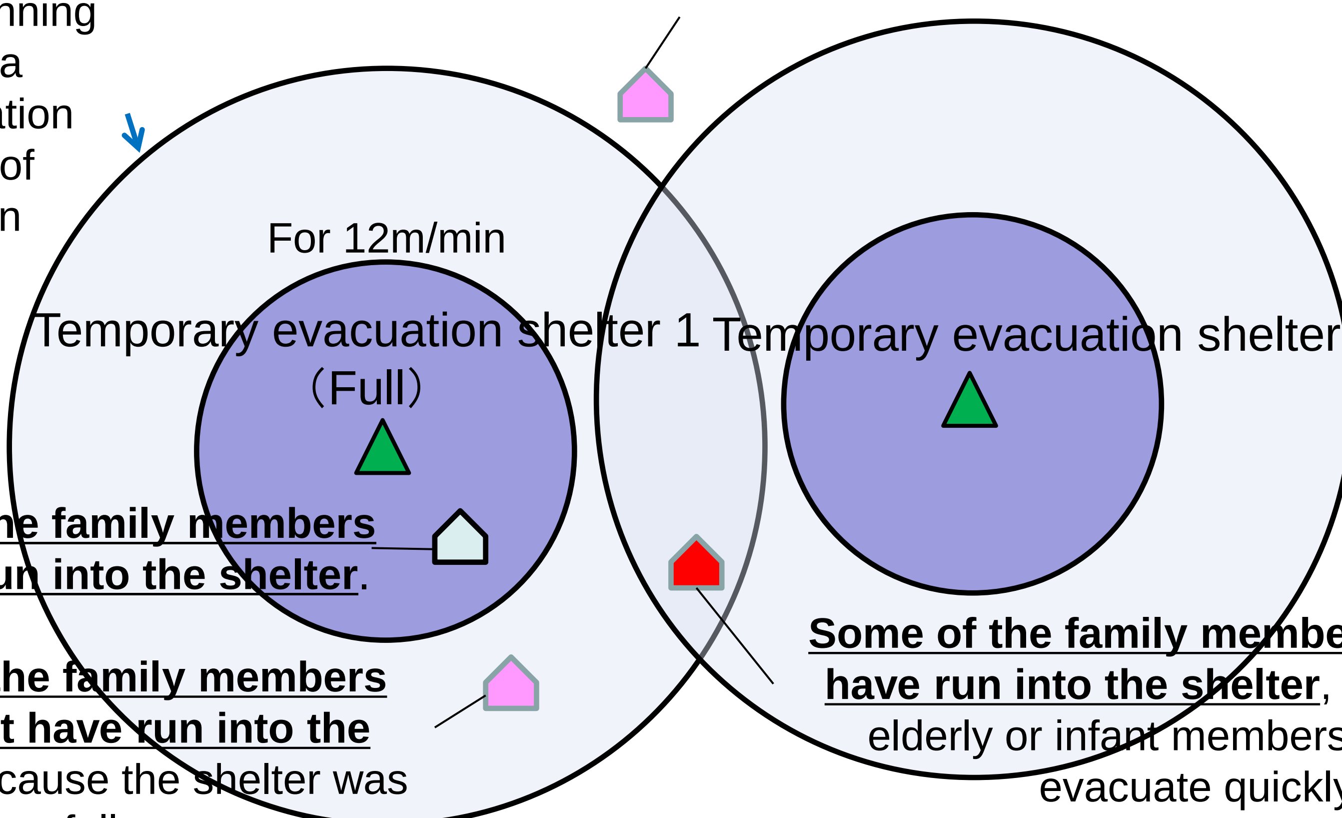


Case study districts



Suggested modeling method of emergency evacuation depending on distribution of temporary evacuation shelters and residential houses.

Some of the family members could not run into the temporary evacuation shelter because the distance from the house to the shelter was too far.



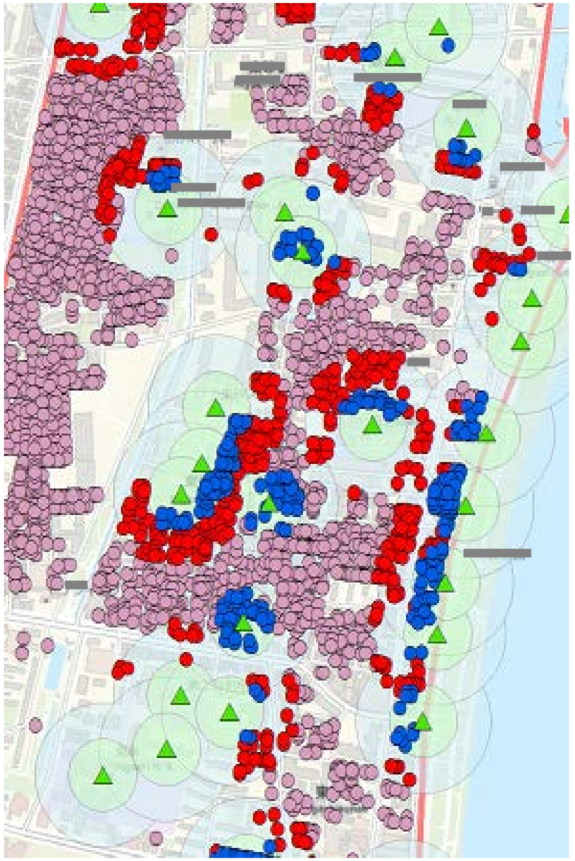
All of the family members have run into the shelter.

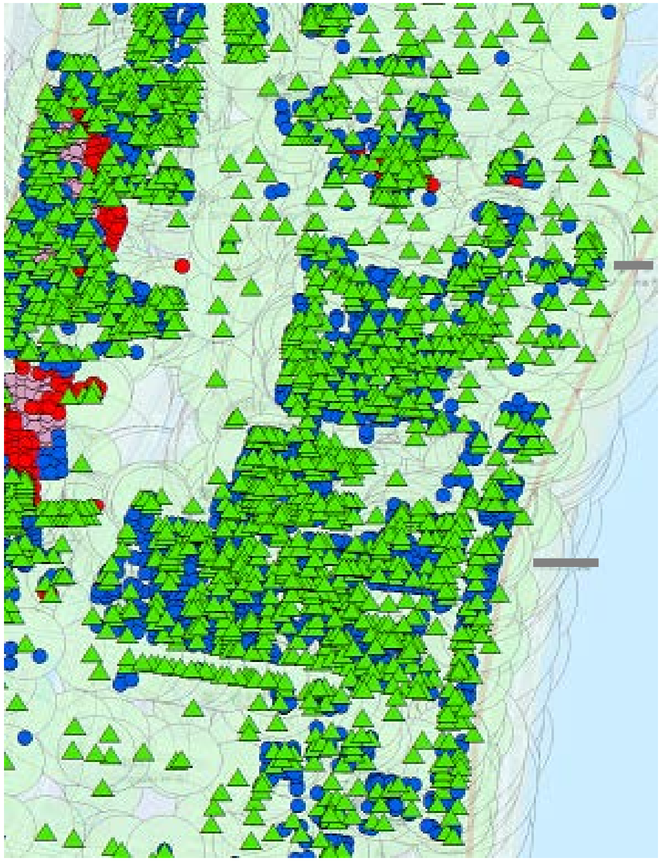
Some of the family members could not have run into the shelter, because the shelter was full.

Some of the family members could not have run into the shelter, because the elderly or infant members could not evacuate quickly.

* The number of the residents having evacuated in advance, for example evacuated just after the flood warning issued, are deducted in advance from this simulation.

Examples of simulation results in highly developed area

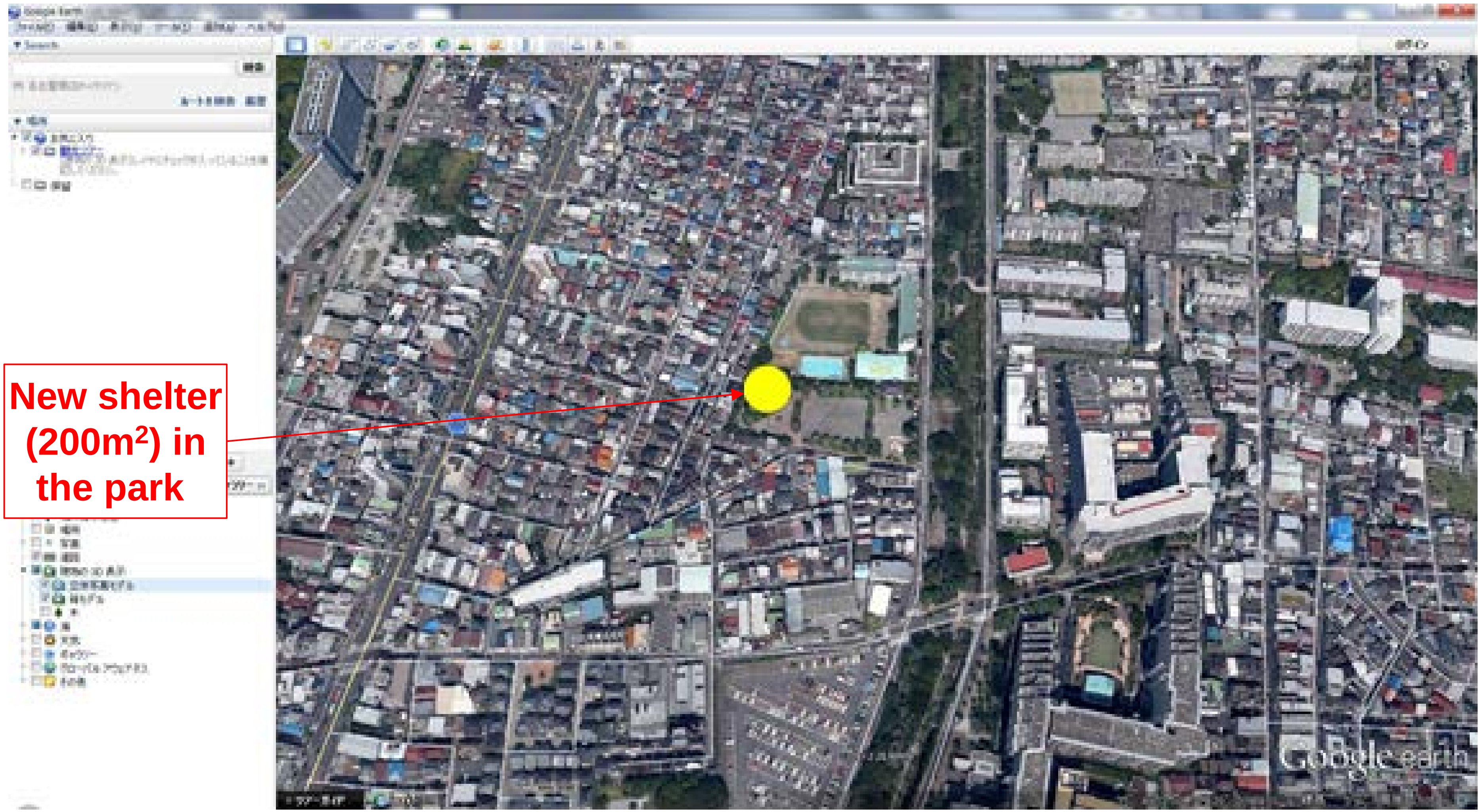




Left: Without using mid-to-high-rise buildings as temporary evacuation shelter

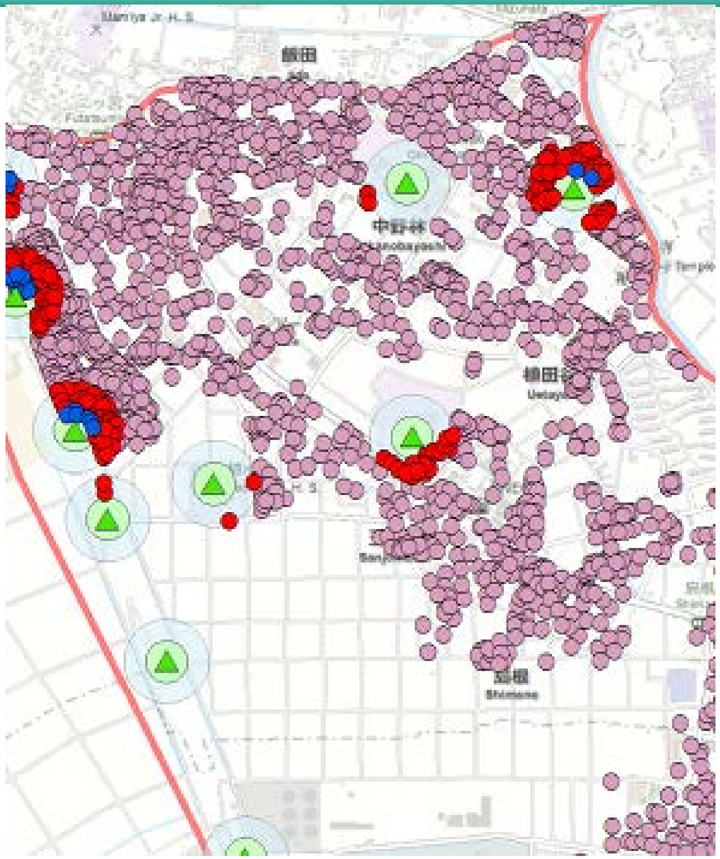
Right: Using mid-to-high-rise buildings as temporary evacuation shelter

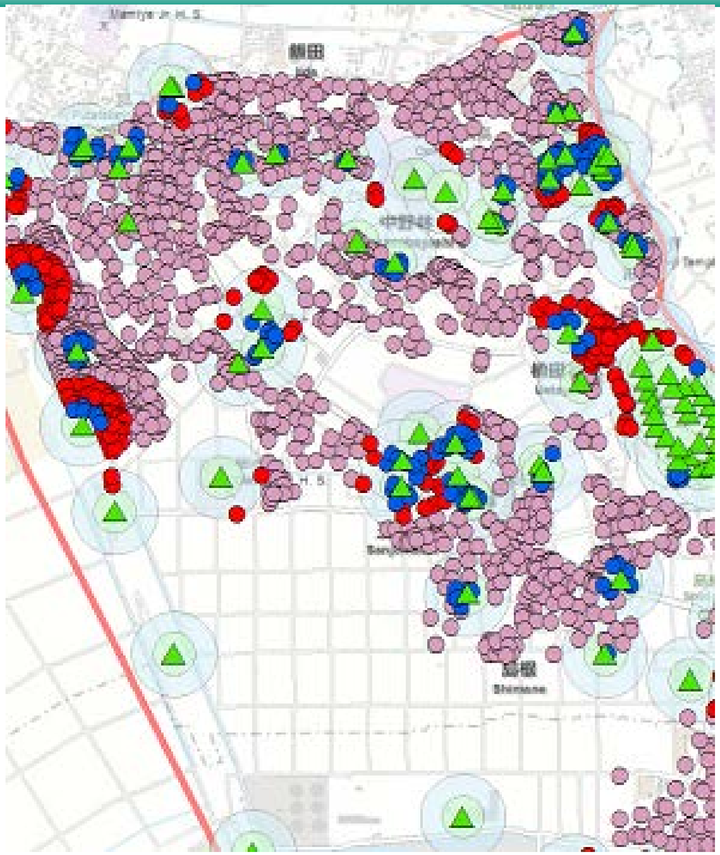
Additional shelter plan in the highly developed area



©Google

Examples of simulation results in suburban area

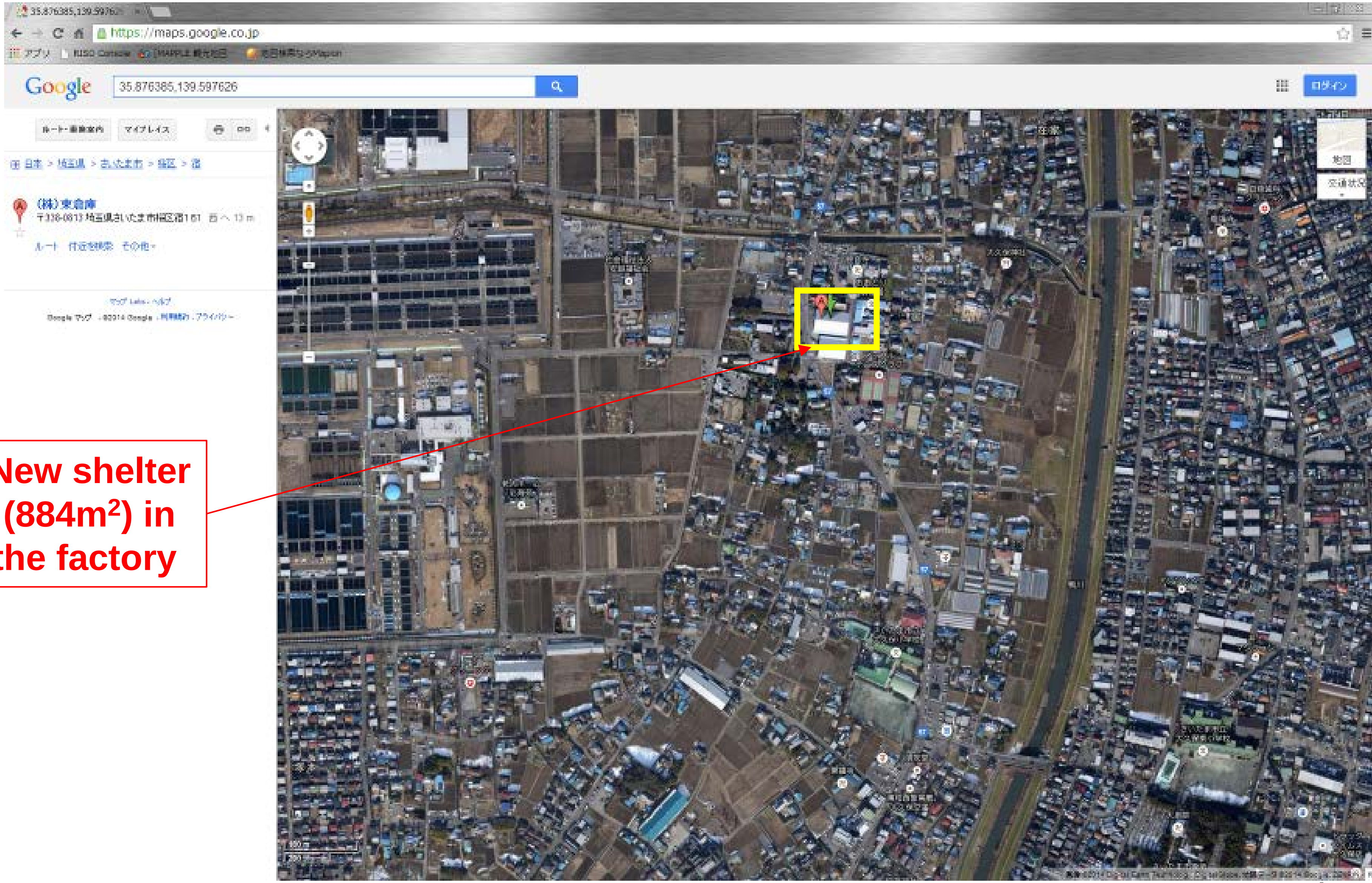




Left: Without using mid-to-high-rise buildings as temporary evacuation shelter

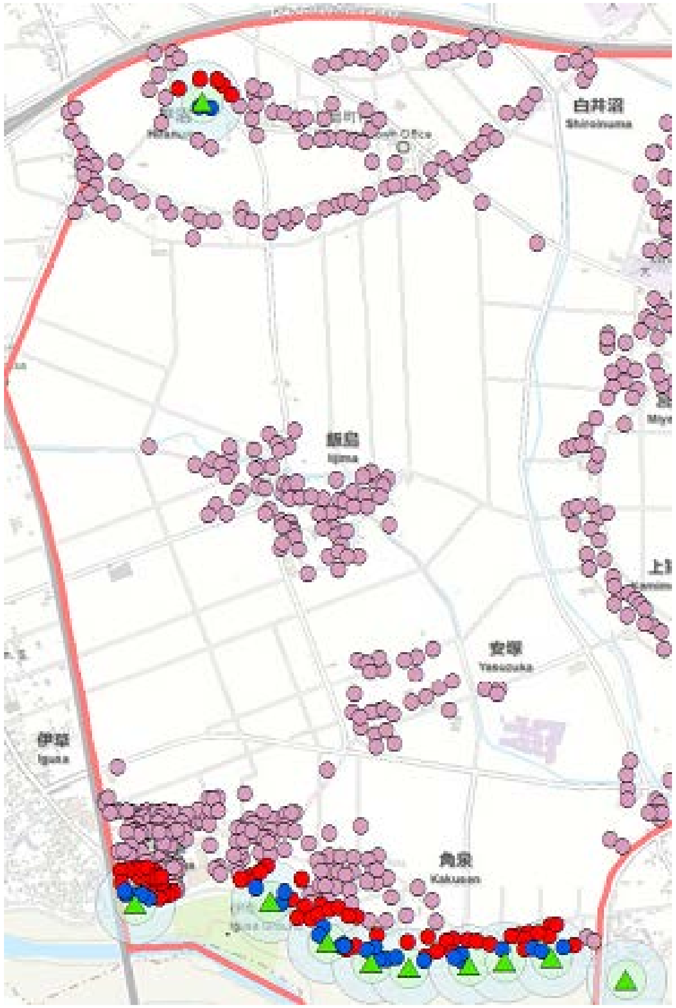
Right: Using mid-to-high-rise buildings as temporary evacuation shelter

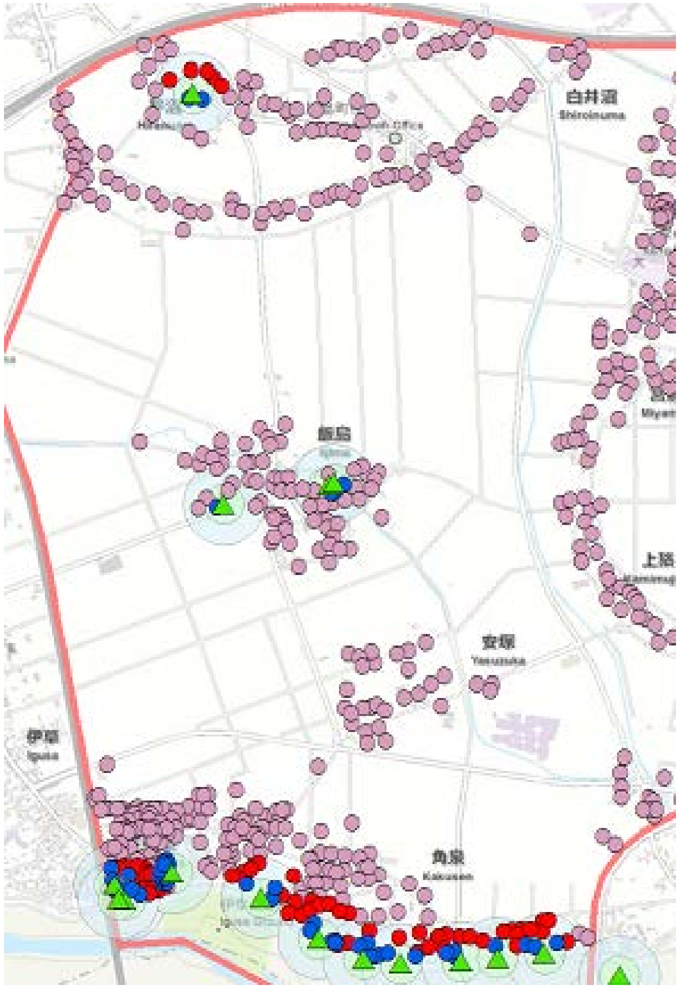
New shelter plan in the suburban area



New shelter ($884m^2$) in the factory

Examples of simulation results in rural area

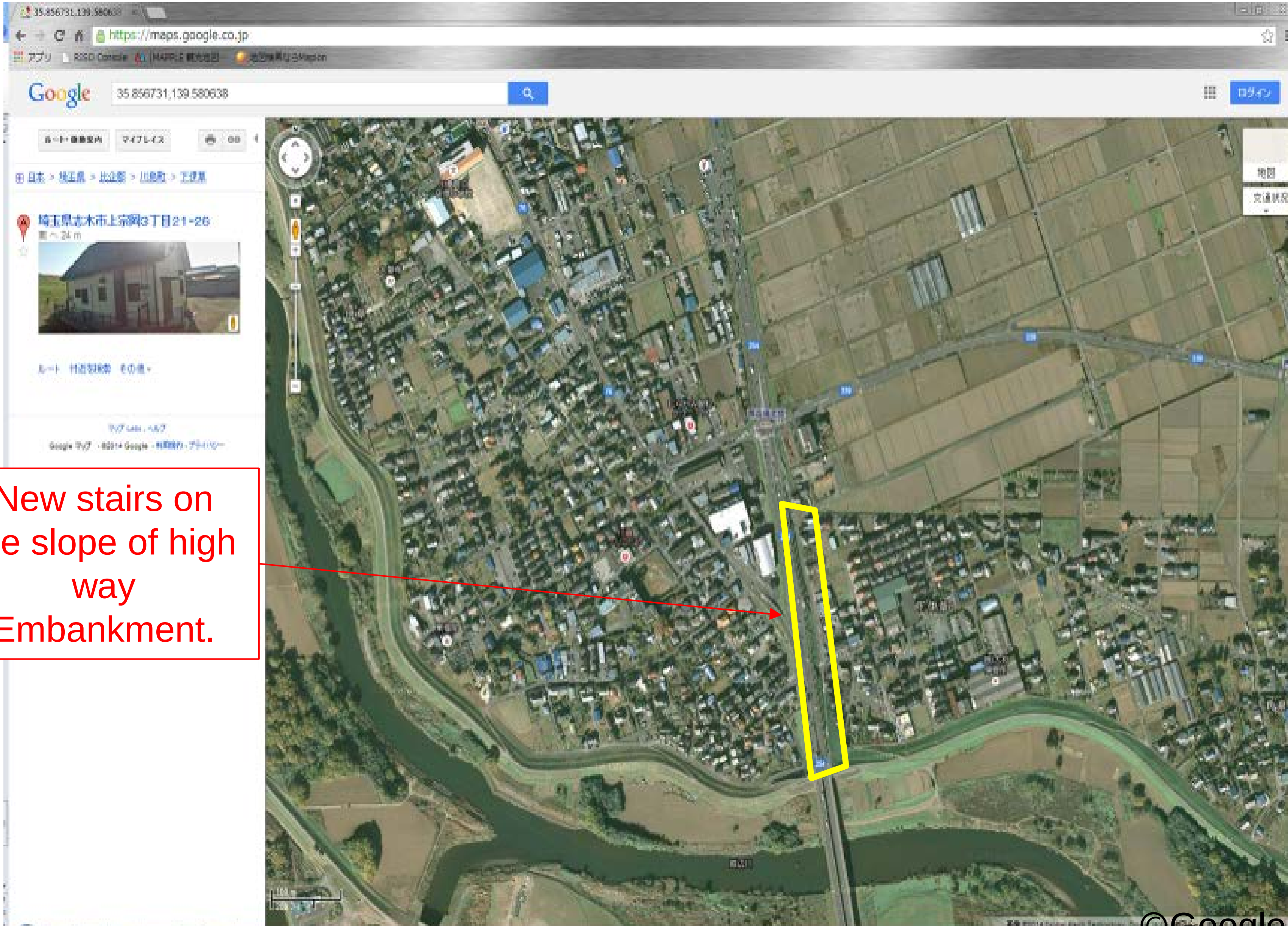




Left: Without using mid-to-high-rise buildings as temporary evacuation shelter

Right: Using mid-to-high-rise buildings as temporary evacuation shelter

Additional shelter plan in the rural area



New stairs on the slope of high way Embankment.

©Google

Macro Assessment of FRR measures

	Possible evacuation minutes	Temporary evacuation shelter case number	Number of people not able to evacuate	Decreasing rate of number of people not abel to evacuate
Highly developed area	5	1	14,700	-
		2	3,130	79%
	15	1	4,115	72%
		2	1,799	88%
Rural area	5	1	6,107	-
		2	6,026	1%
	15	1	5,314	13%
		2	5,239	14%
Suburban Area	5	1	11,789	-
		2	9,382	20%
	15	1	7,266	38%
		2	3,375	71%

Possible to make it longer by warning, education, more resilient defenses etc..

+

Possible to make the number of shelters more by construction, cooperation etc. in the area.

Gradual comprehensive disaster risk reduction.

Ⅷ　What I learned during my stay in the Philippines (from June 2015 to May 2017)

Nice people and places in the Philippines.

Summary of Main Issues and Comments

Main Issues

There are no systematic frameworks for Understanding and Monitoring DRR from concrete DRR implementation point of view.

- Less Incentive for Data Archiving, Sharing and Analyzing for DRR.
- No general frameworks for Integrating Multiple DRR measures among multiple stakeholders / agencies.

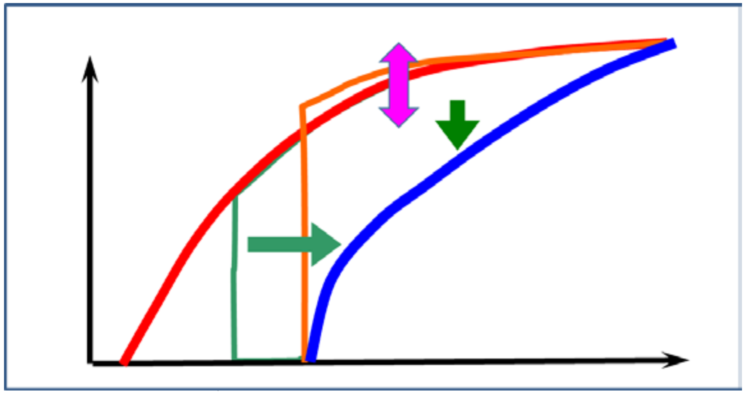
- Weak Implementation of Systematic DRR measures based on Scientific Data from a long term point of view.

Comments

To overcome the issues above, **New Systematic Framework / Method for DRR Understanding and Monitoring in locality** from a concrete execution point of view should be introduced.

Suggestions

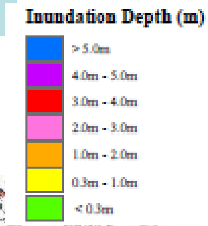
Nationwide systematic mechanism **using "Set of Hazard Maps with multiple scales of predominant Disaster" and "Disaster Risk Graphs"** (tentative name) should be introduced to **N/R/P/C/M/BDRRMC** as appropriate for **concretely realizing DRR to reduce economic damage from a long term point of view** through "Mainstreaming DRR" and "Build Back Better".



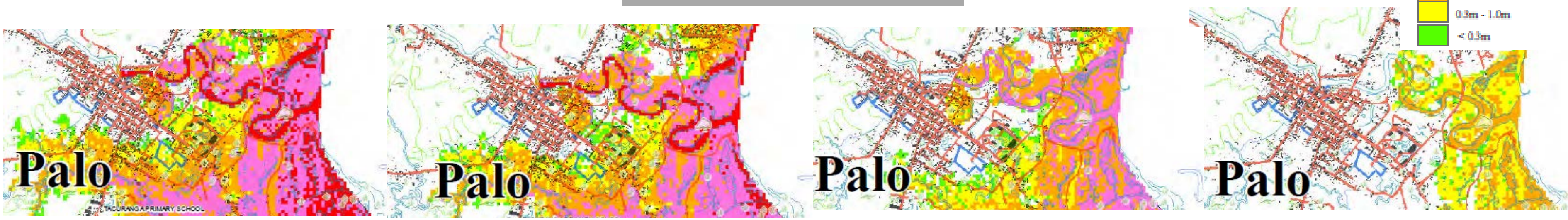
To Understand Disaster Risk in the locality

Suggestion 1: Providing and sharing a Set of Hazard maps with multiple scales of predominant type of disaster among stake holders.

Understanding DR in each area toward feasible DRR measures/Area BCM.



e.g. Storm Surge



>100 yr. return period	50 yr. return period	30 yr. return period	10 yr. return period

Rare event ⟷ Relatively frequent event

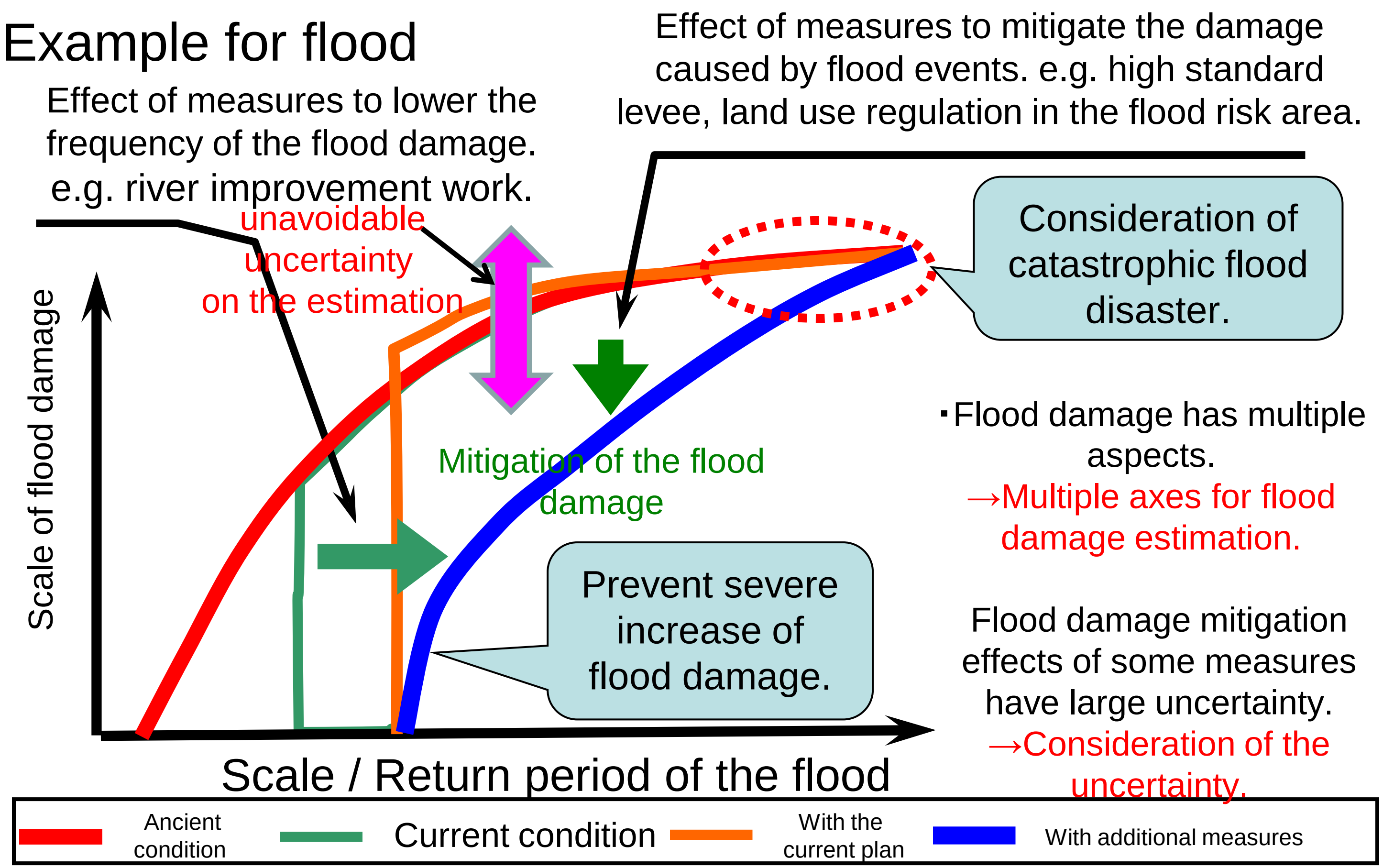
Appropriate for DRR planning against catastrophic disaster situation, but not appropriate for planning against relatively frequent disaster events. e.g. Good for evacuation planning.

⟷

Appropriate for DRR planning against relatively frequent disaster events. e.g. Good for building foundation elevation study for annual average damage reduction.

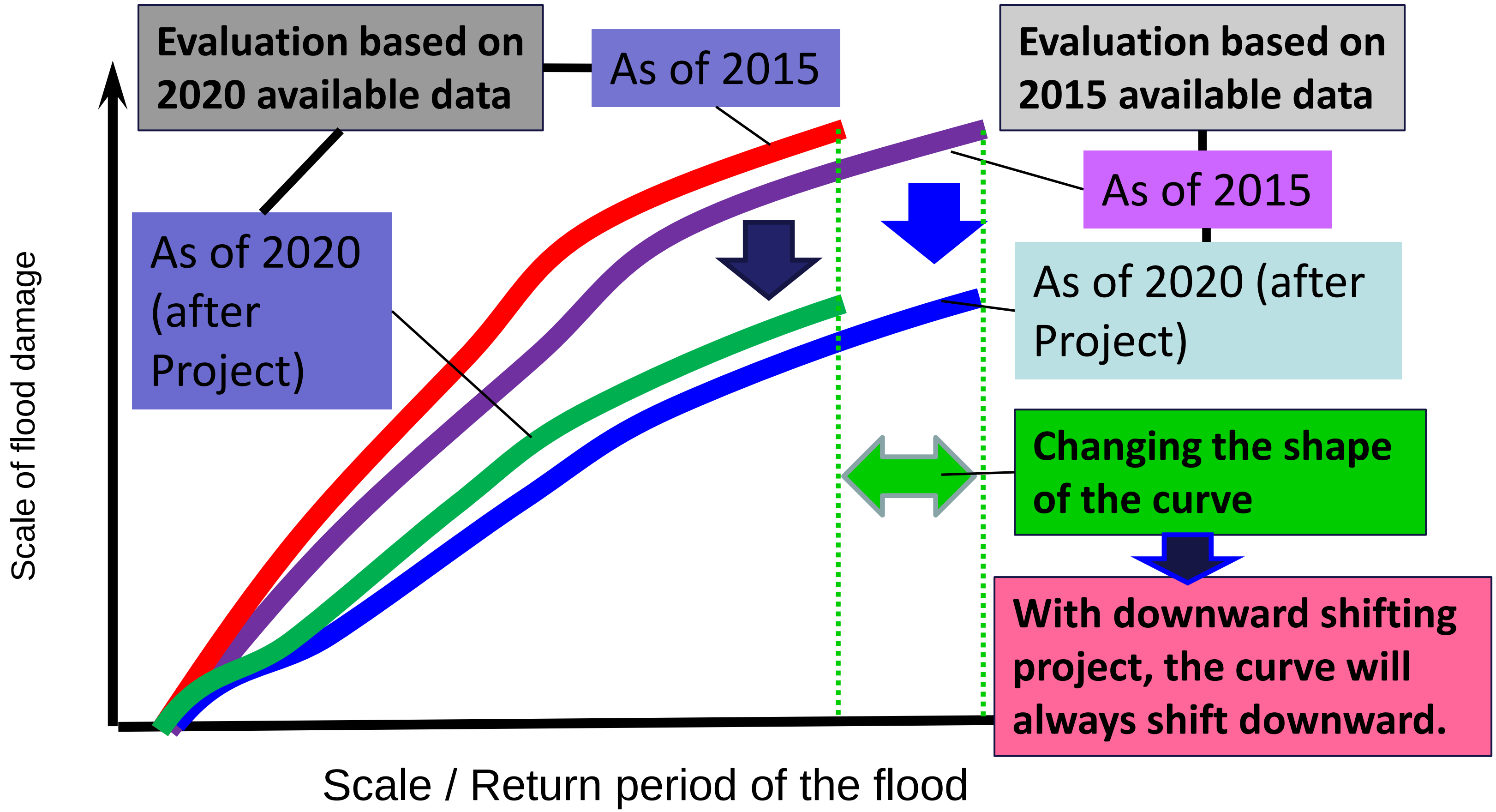
To Monitor DRR in the locality

Suggestion 2: Introducing Disaster Risk Graph (or Profile)* in each area (e.g. LGU) as appropriate.



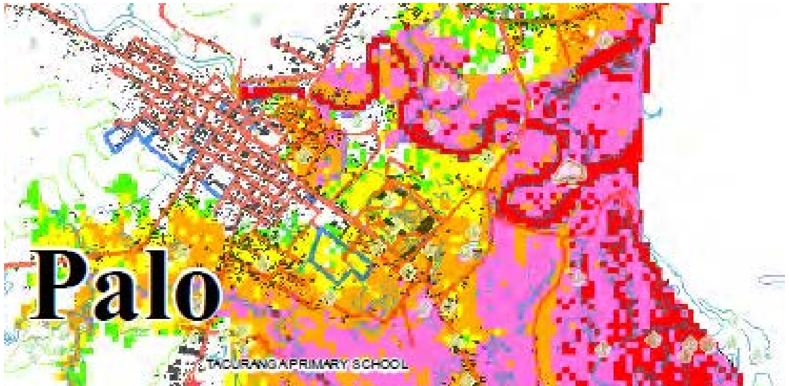
* Tentative naming in English. Based on the research results of National Institute for Land and Infrastructure Management, MLIT, Japan. e.g. http://www.nilim.go.jp/lab/kikou-site/data/info_data/2015_takenaka1.pdf

DRG framework is suitable to apply under GCC

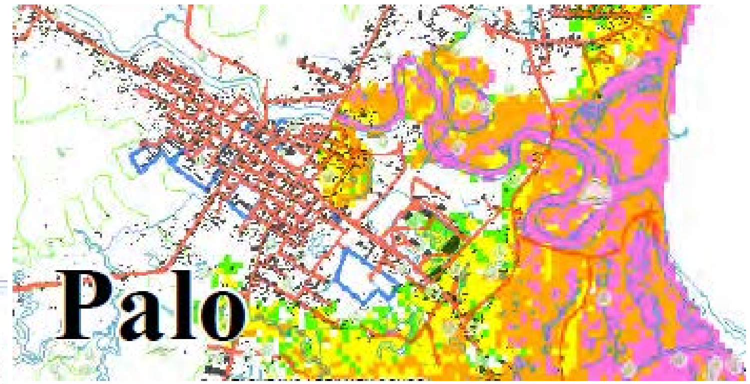


How to draw DRG with limited available data

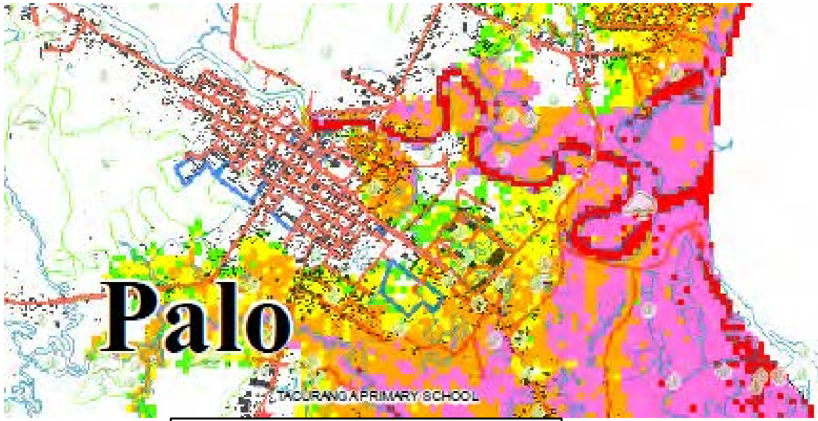
(1) Collect the available data (e.g. Hazard Maps) in the target area.



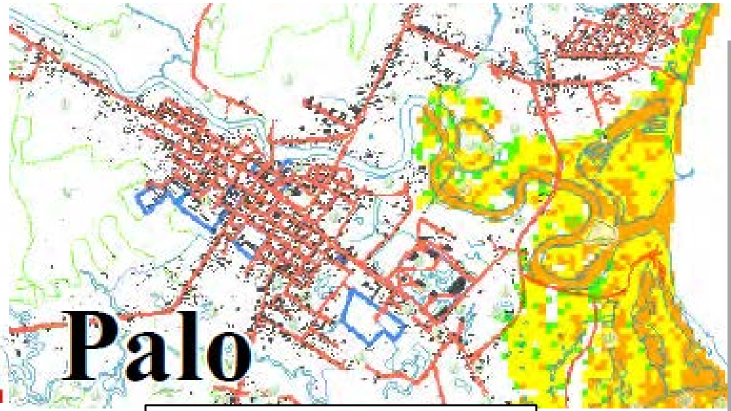
Yolanda (>100 yr)



30 yr. return period



50 yr. return period

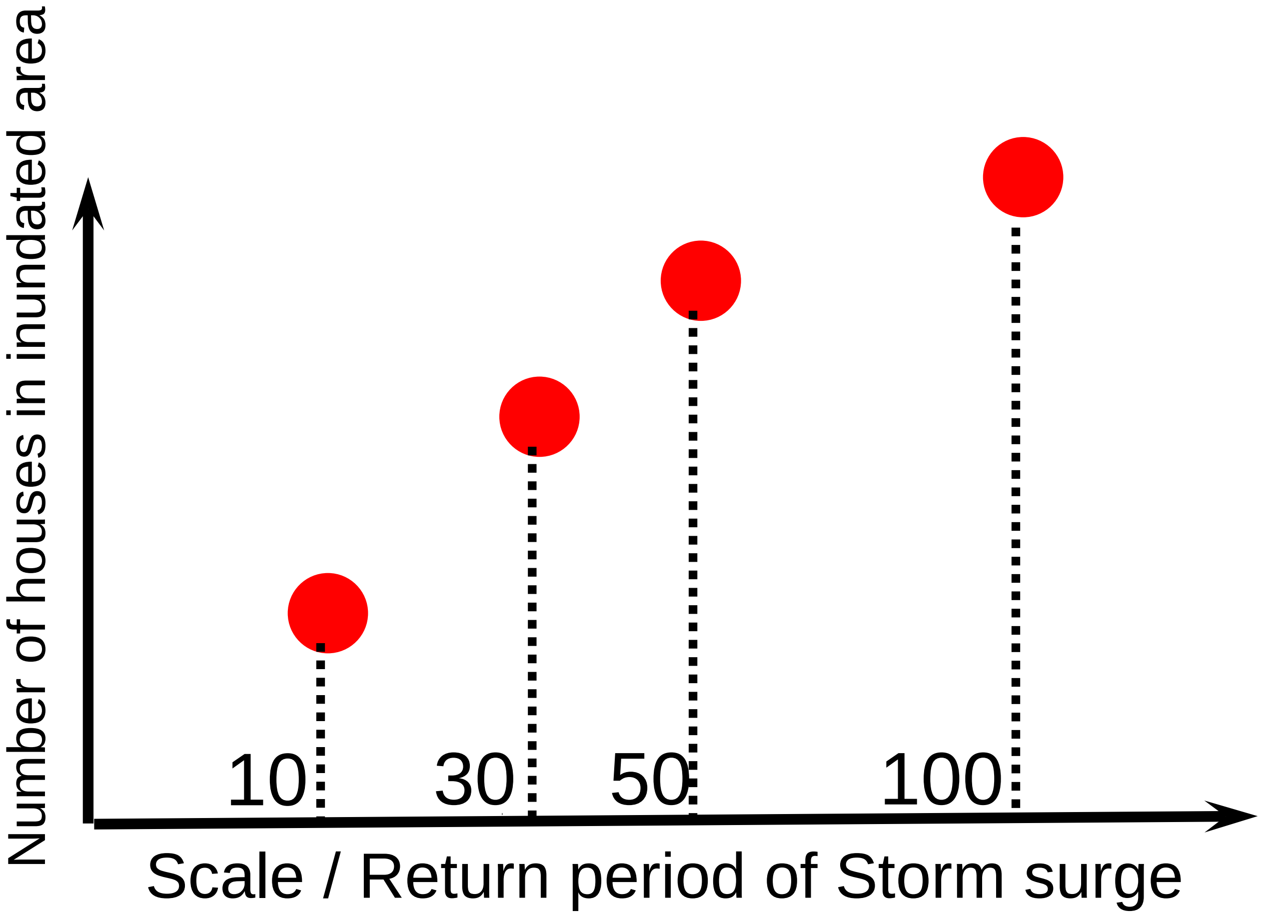


10 yr. return period

*Example on Storm Surge provided by JICA

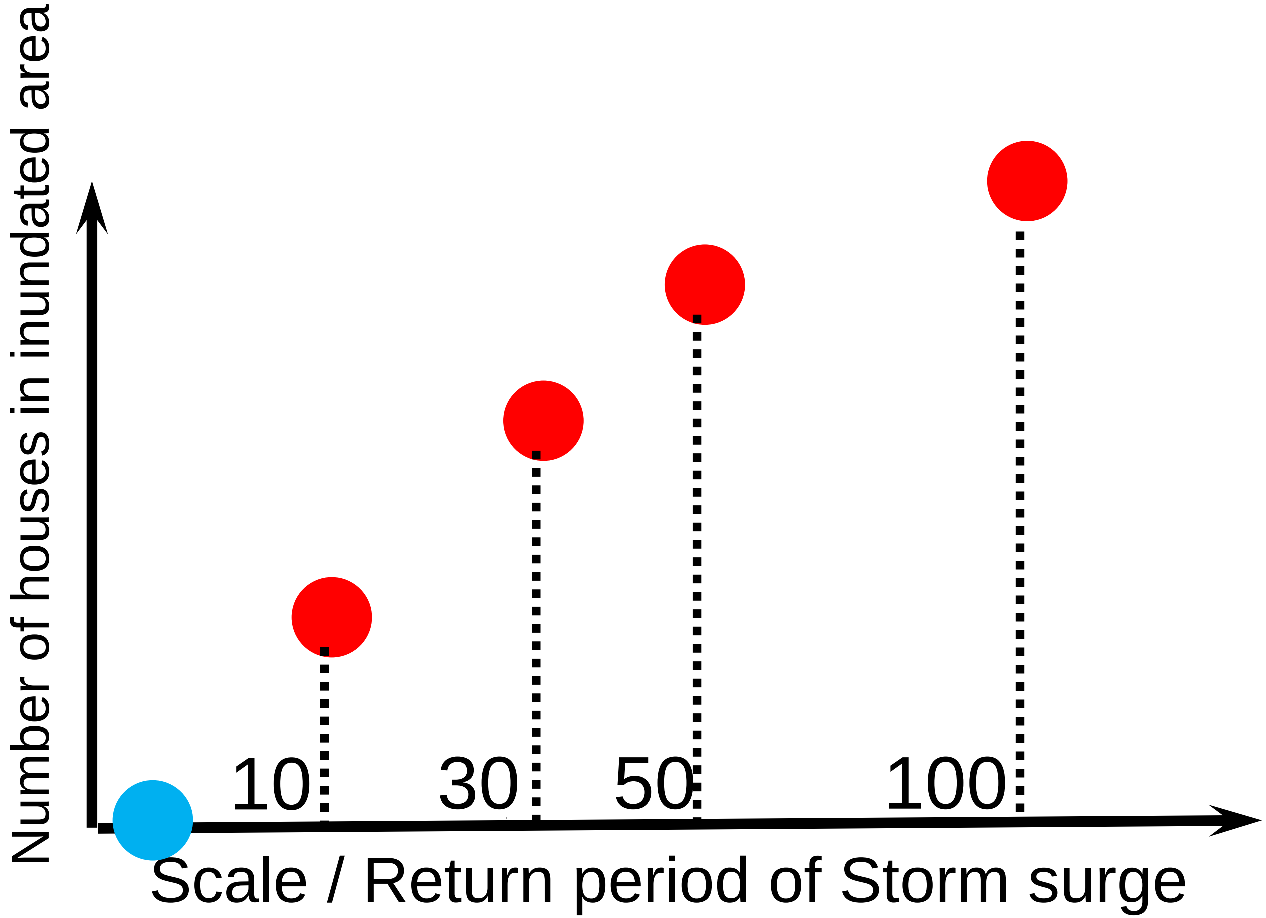
How to draw DRG with limited available data

(2) Count the number of houses in the inundation area on each Hazard Map.



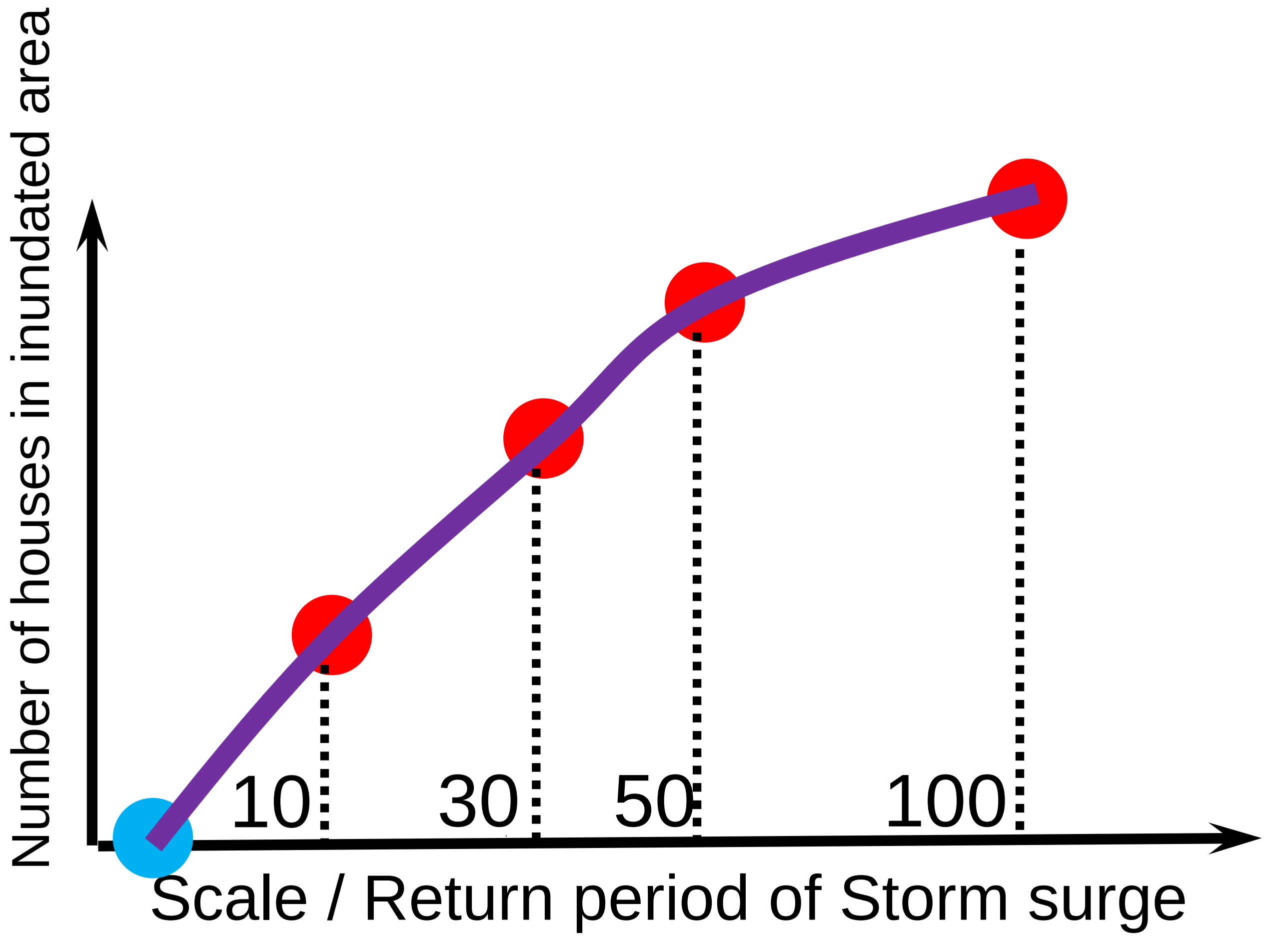
How to draw DRG with limited available data

(3) Judge the intersection with the horizontal axes depending on past experiences or by engineering judgement.



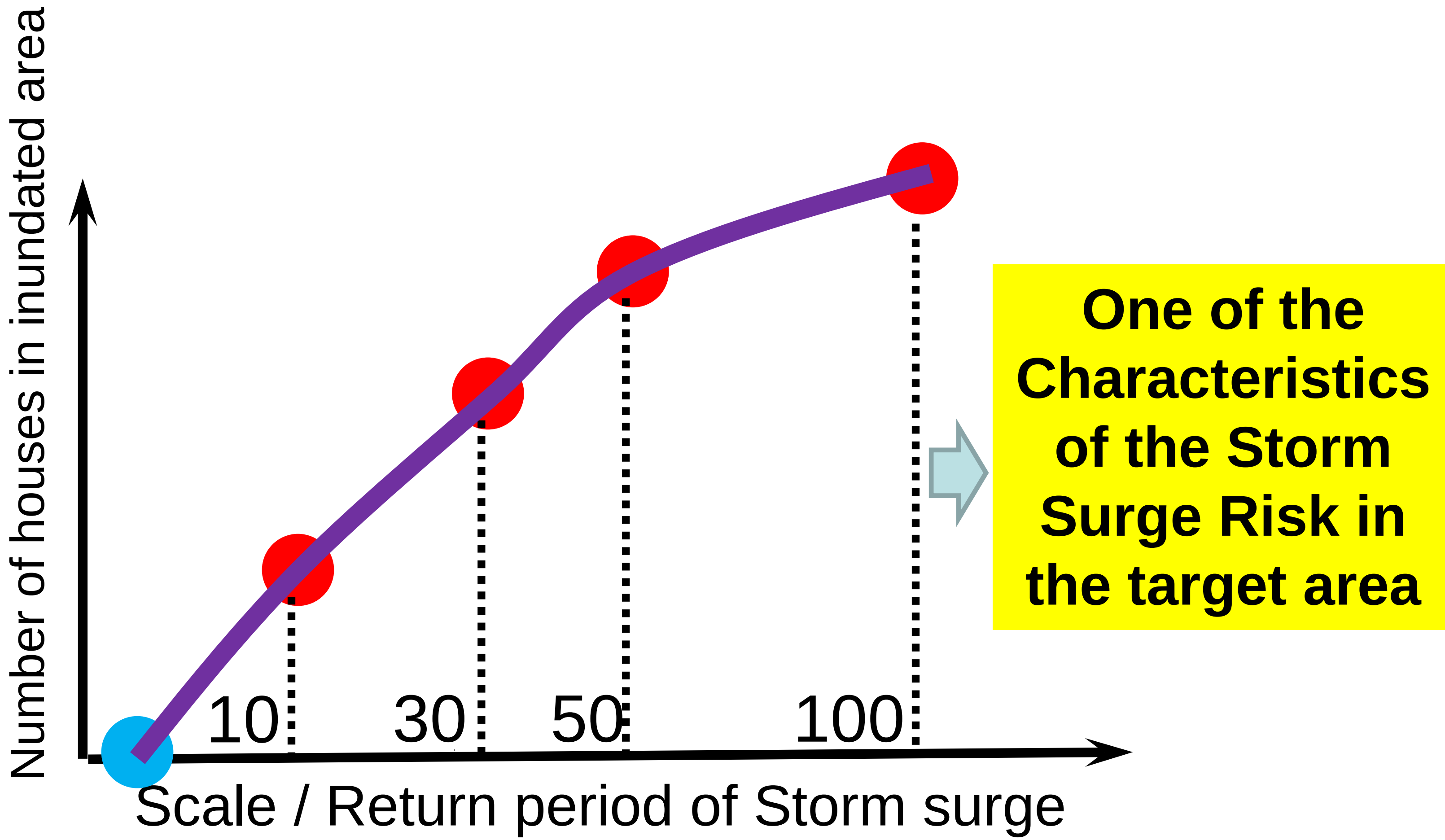
How to draw DRG with limited available data

(4) Draw the curve smoothly connecting the points.



How to draw DRG with limited available data

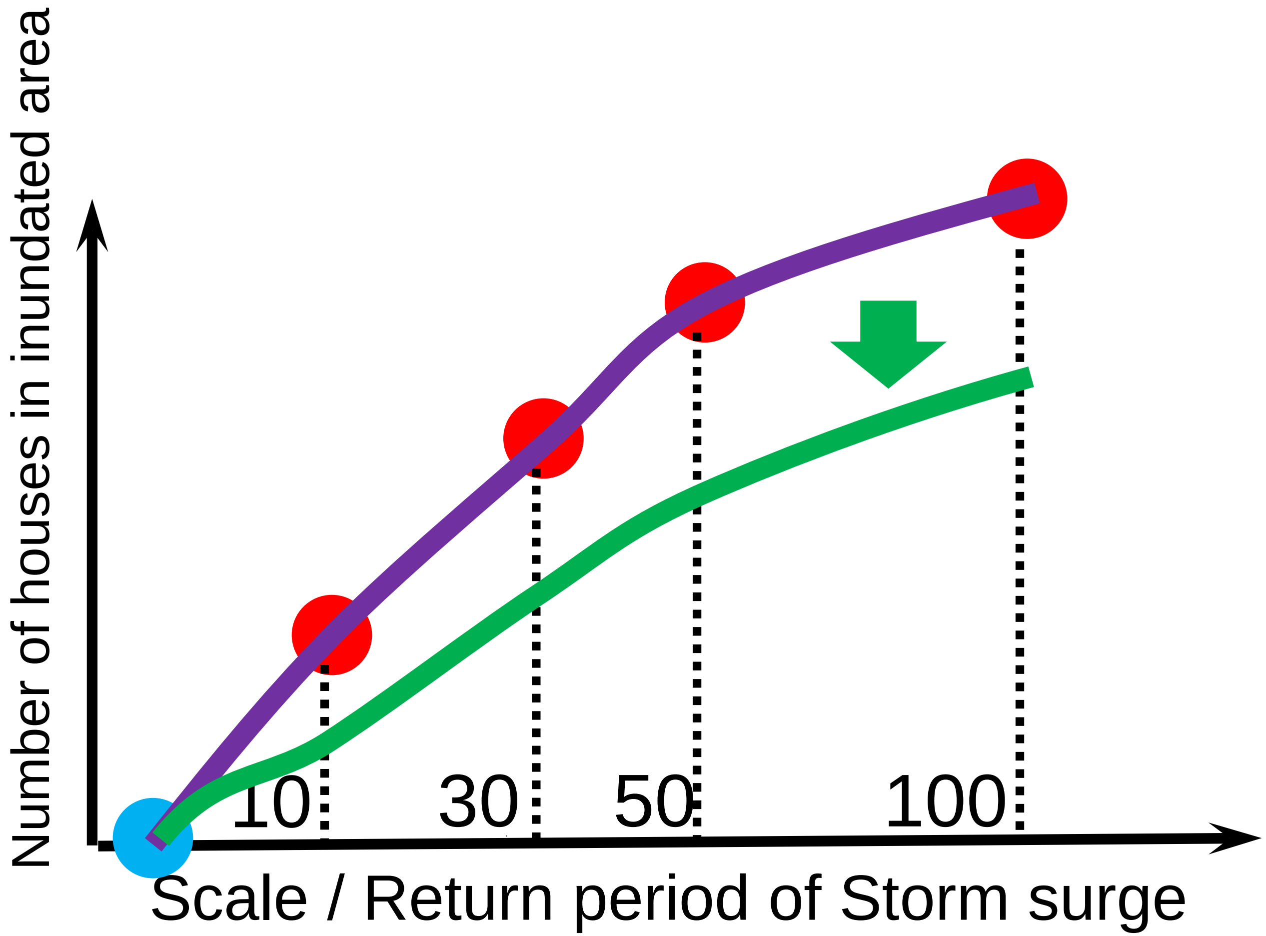
(5) Clearly explain the limit of the DRG below the graph.



*** This graph is tentatively drawn by … depending on limited available data. ….**

How DRG shifts

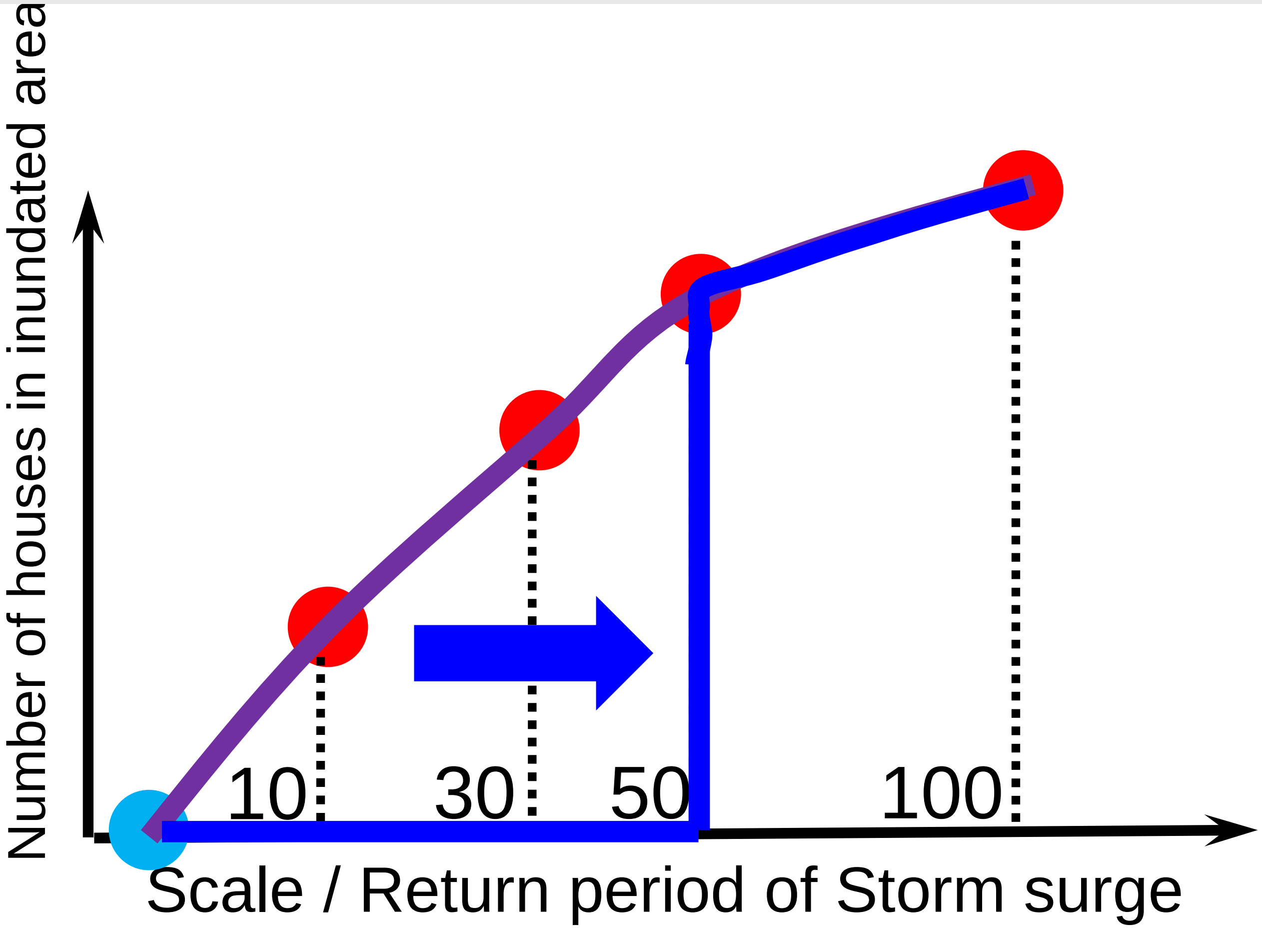
(1) After some relocation projects completed



* This graph is tentatively drawn by … depending on limited available data. ….

How DRG shifts

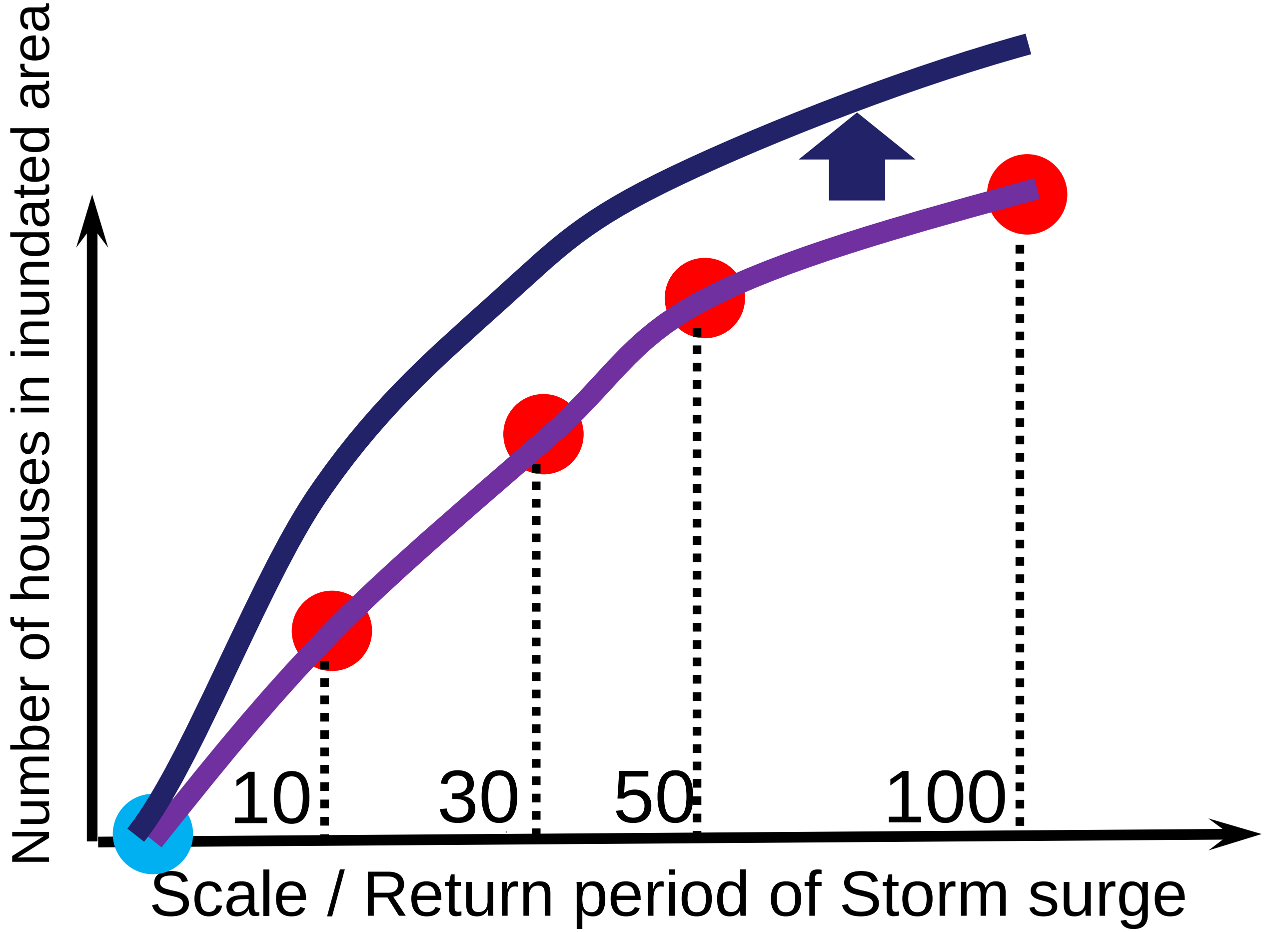
(2) After a new coastal embankment construction project completed



* This graph is tentatively drawn by … depending on limited available data. ….

How DRG shifts

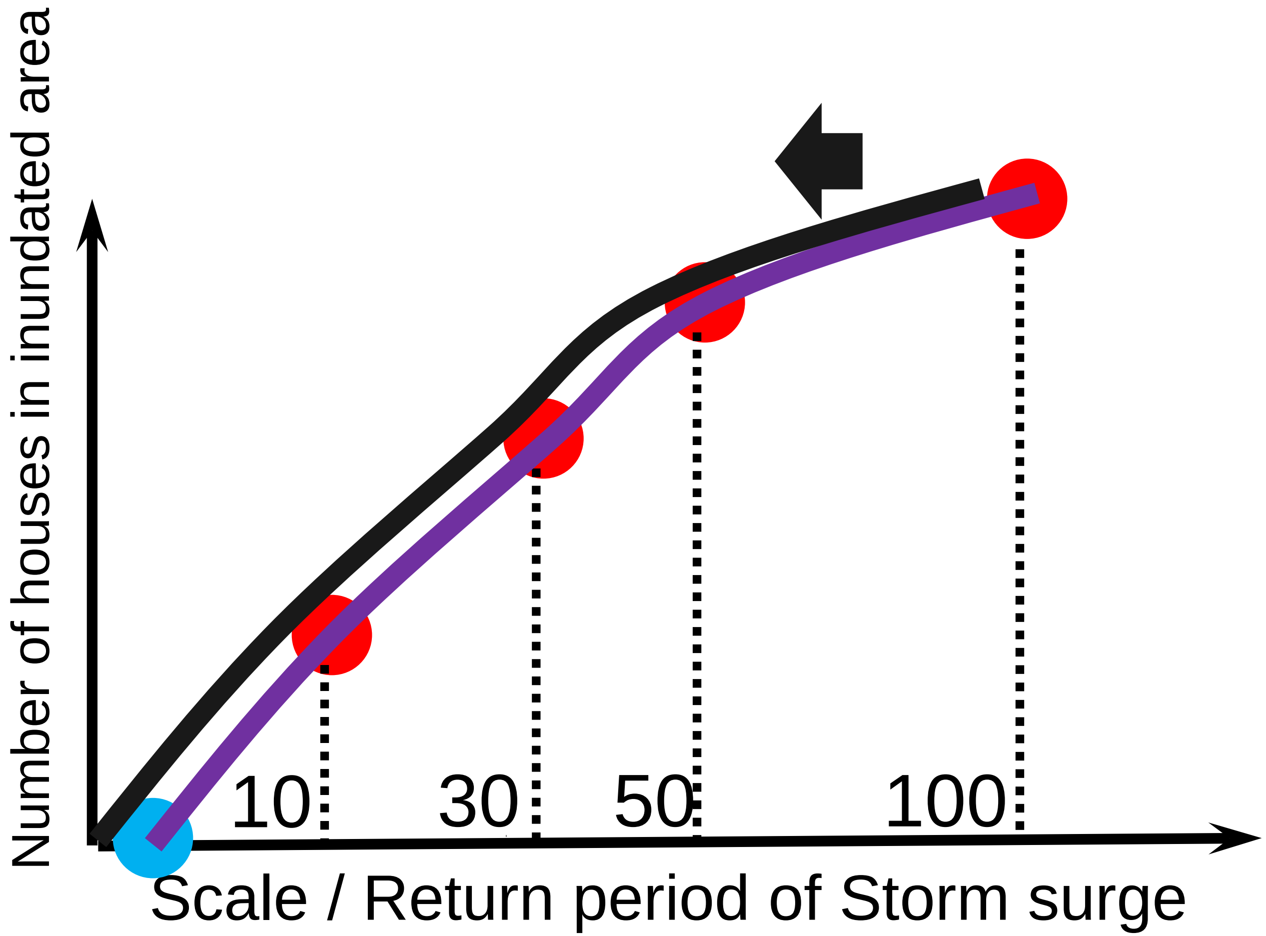
(3) If the number of houses in high risk areas increased



* This graph is tentatively drawn by … depending on limited available data. ….

How DRG shifts

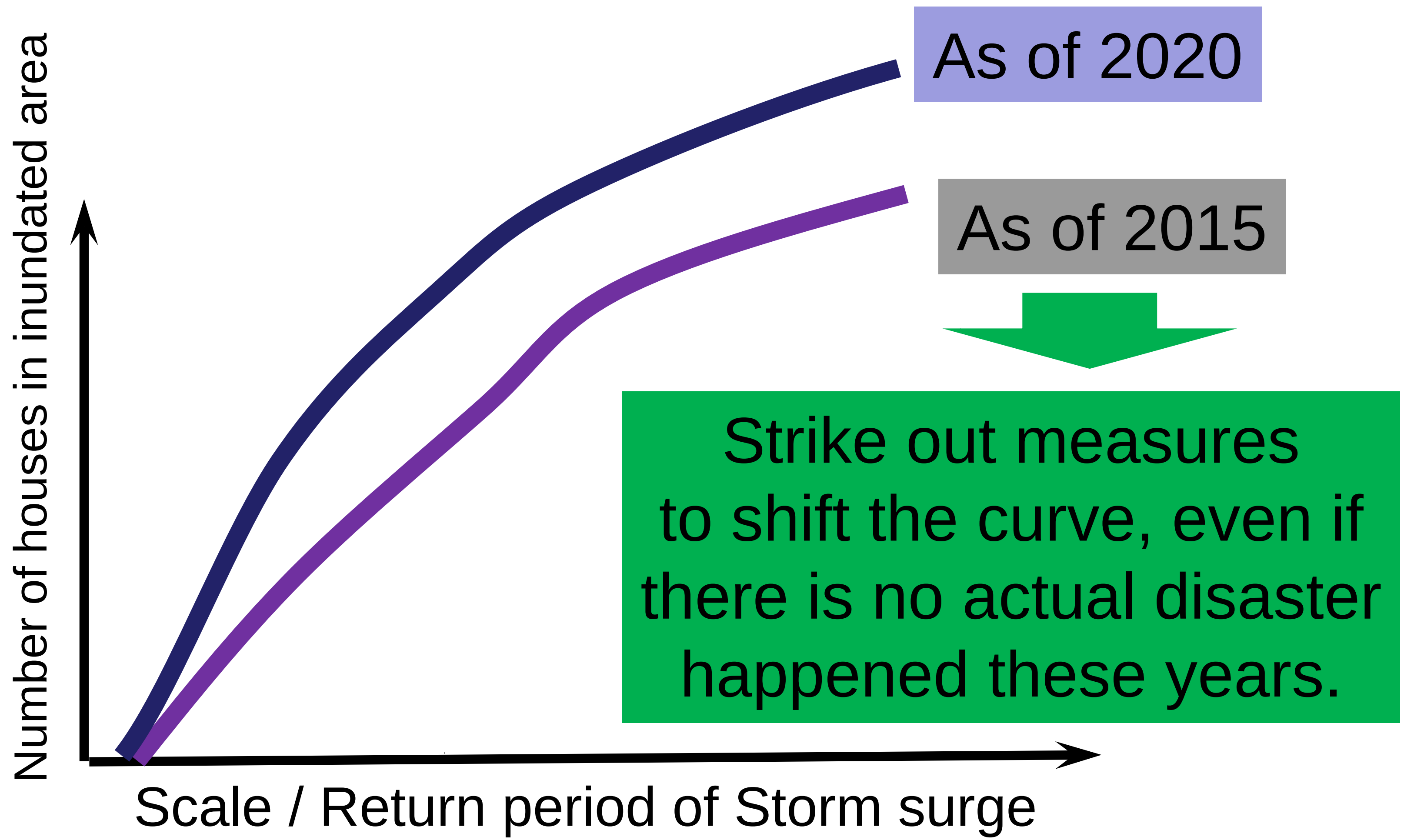
(4) If the effect of climate change is assessed and considered



* This graph is tentatively drawn by … depending on limited available data. ….

How to use DRG

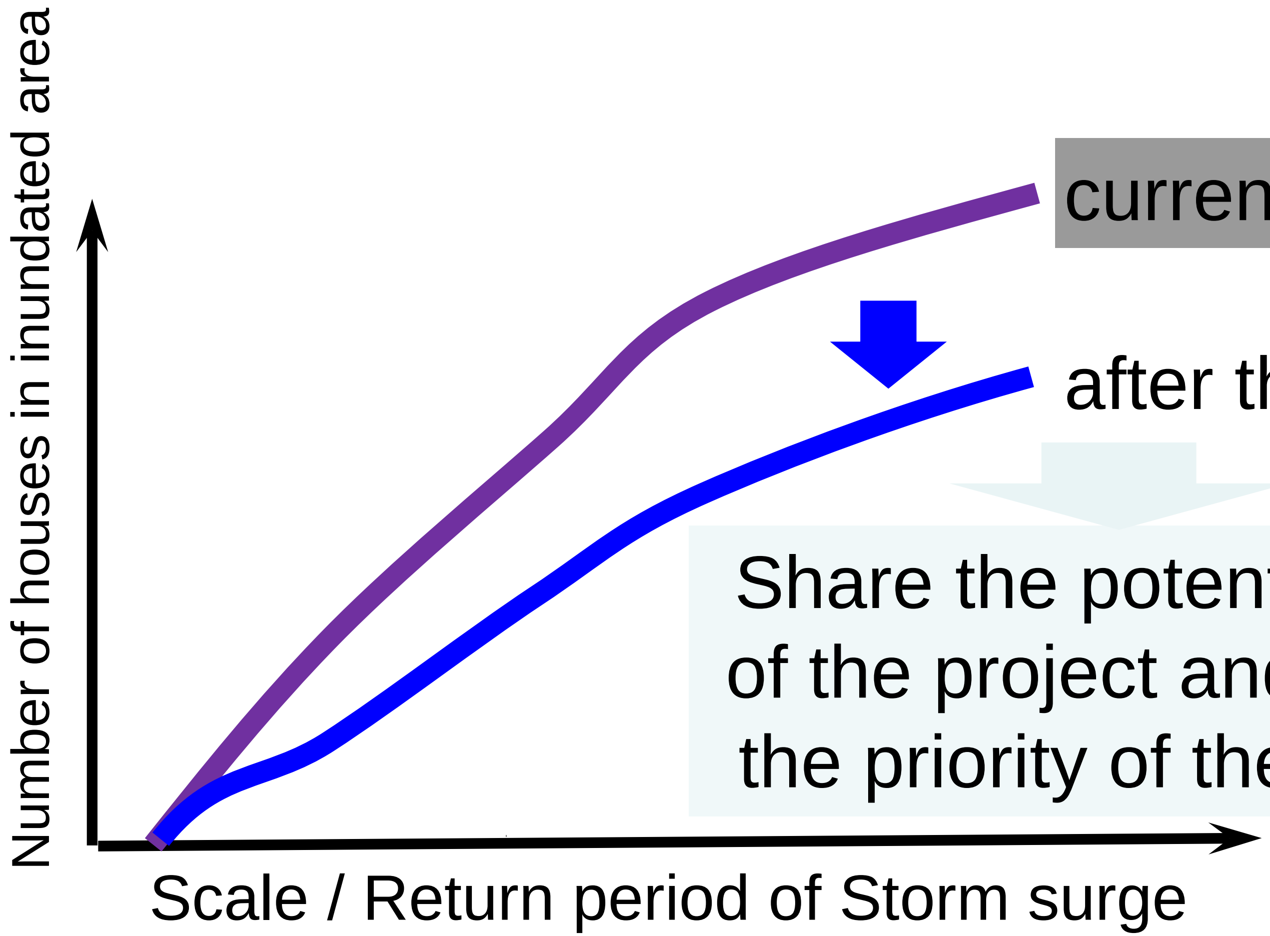
(1) To monitor the Disaster Risk in the target area.



* This graph is tentatively drawn by … depending on limited available data. ….

How to use DRG

(2) To share the effect of DRR by a proposed project.

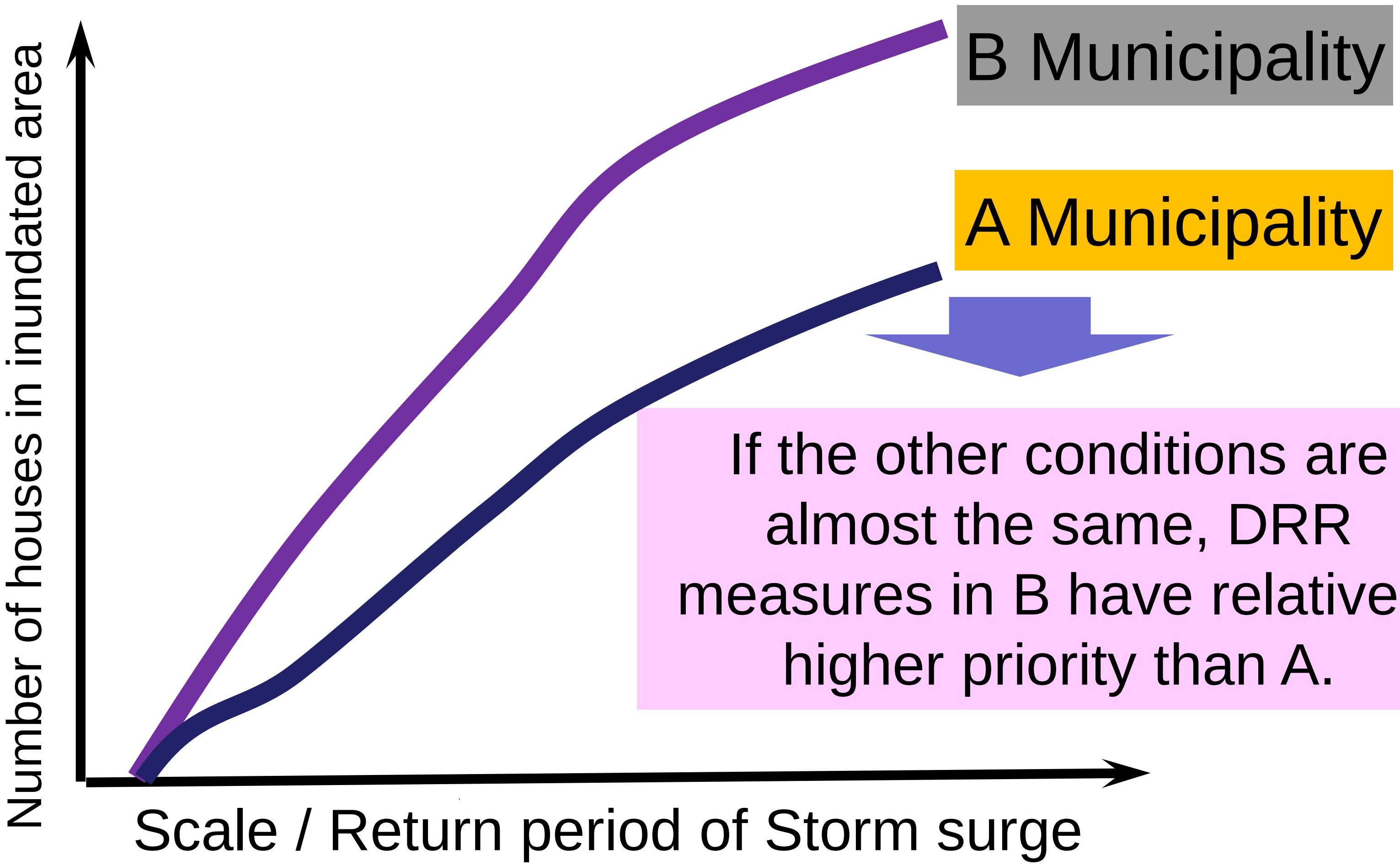


Share the potential effect of the project and discuss the priority of the project.

* This graph is tentatively drawn by … depending on limited available data. ….

国総研 国土交通省 国土技術政策総合研究所

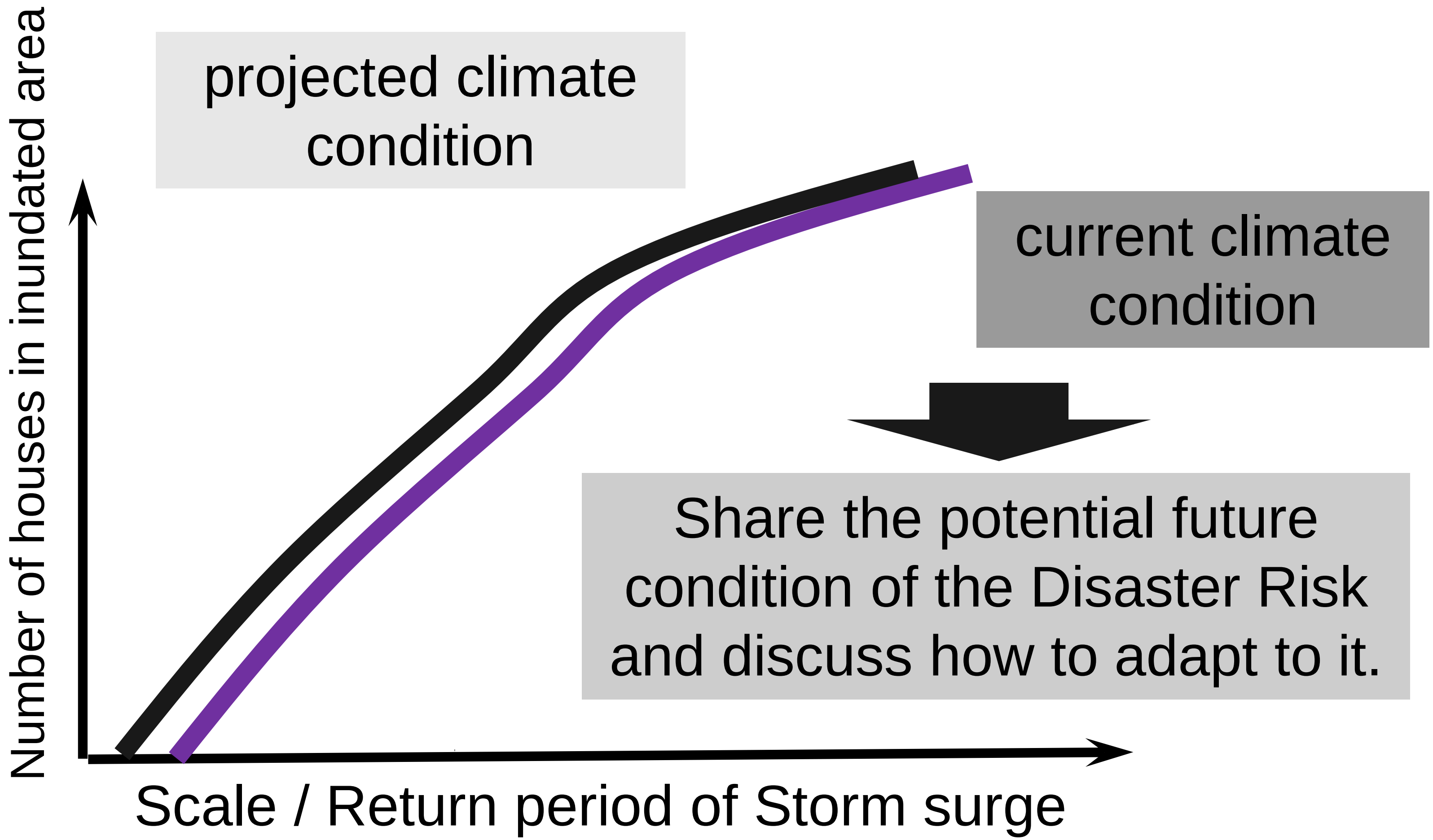
(3) To discuss the priority of the DRR measures.



If the other conditions are almost the same, DRR measures in B have relatively higher priority than A.

* This graph is tentatively drawn by … depending on limited available data. ….

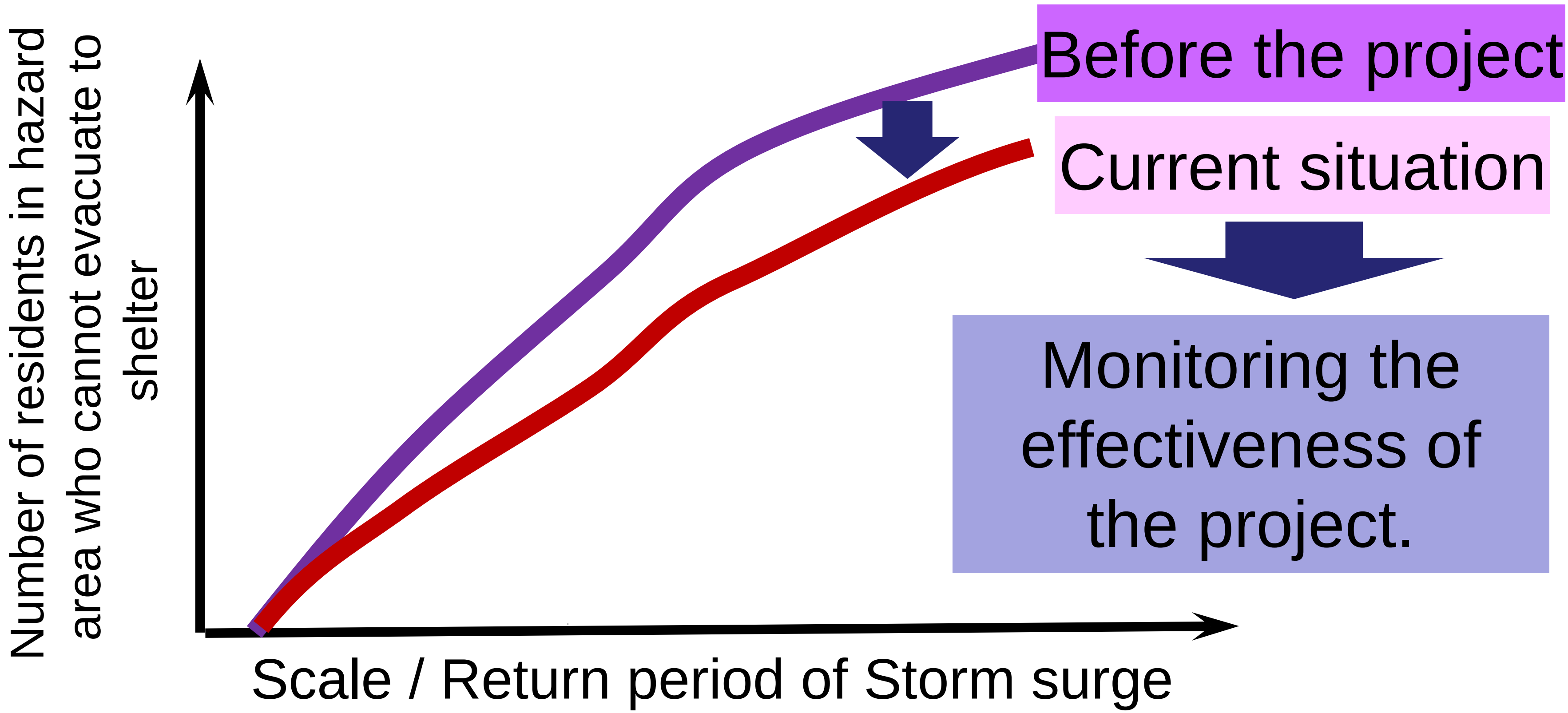
(4) To discuss the adaptation measures against GCC.



* This graph is tentatively drawn by … depending on limited available data. ….

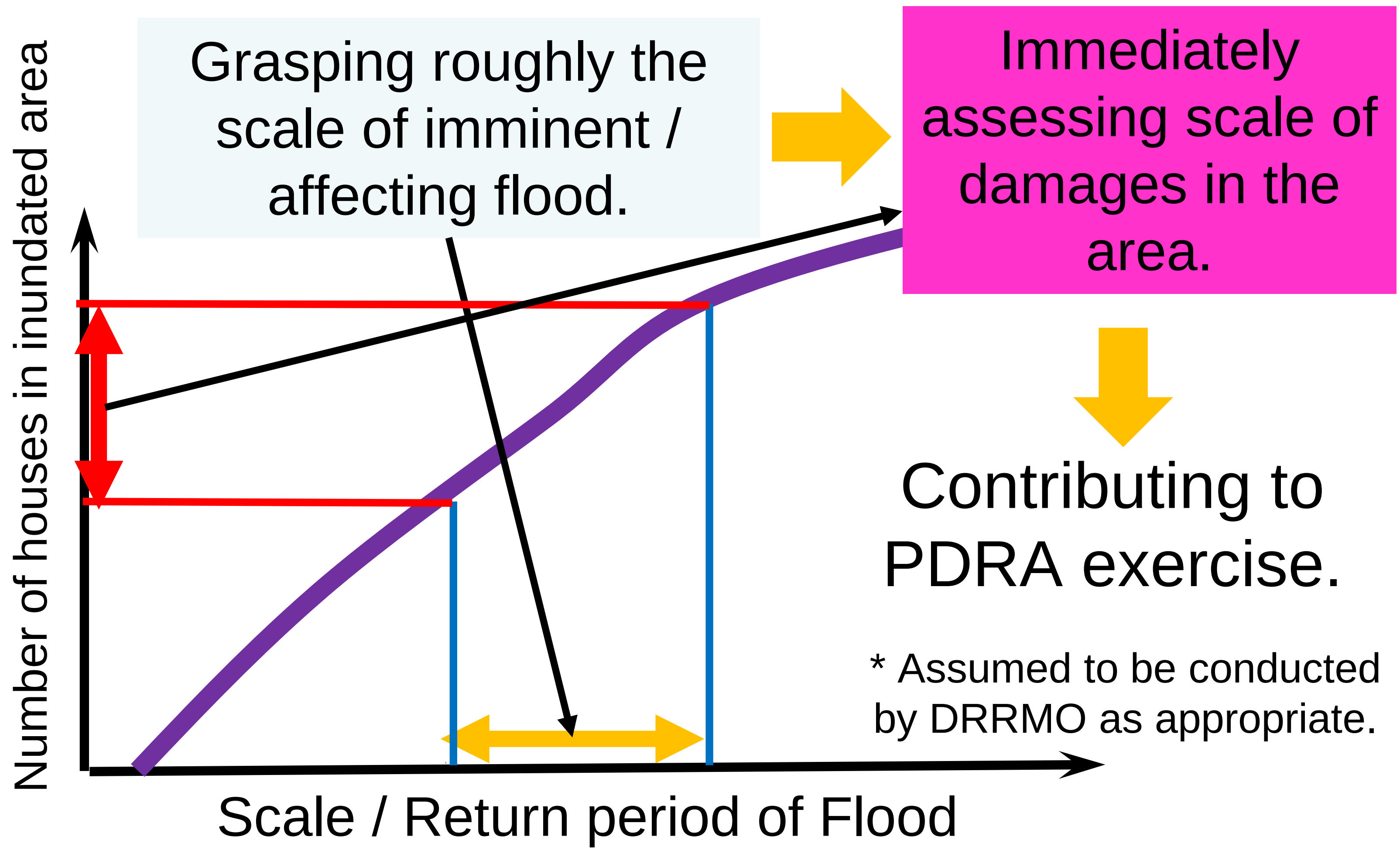
How to use DRG

(5) To monitor the effectiveness of ongoing/completed projects. e.g. monitoring the effectiveness of ongoing evacuation shelter project



* This graph is tentatively drawn by … depending on limited available data. ….

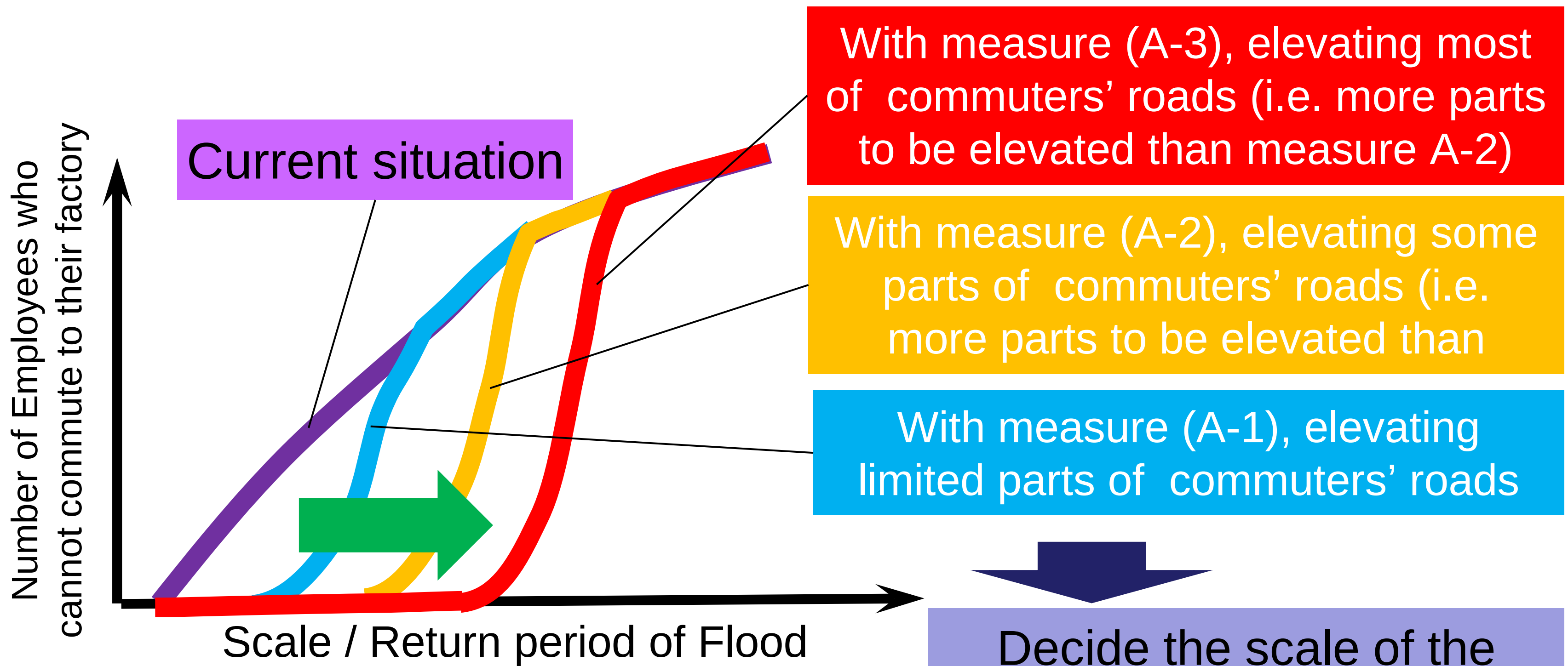
(6) To conduct immediate Pre Disaster Risk Assessment*



* This graph is tentatively drawn by … depending on limited available data. ….

(7) To Understand Risk and Impact on a factory

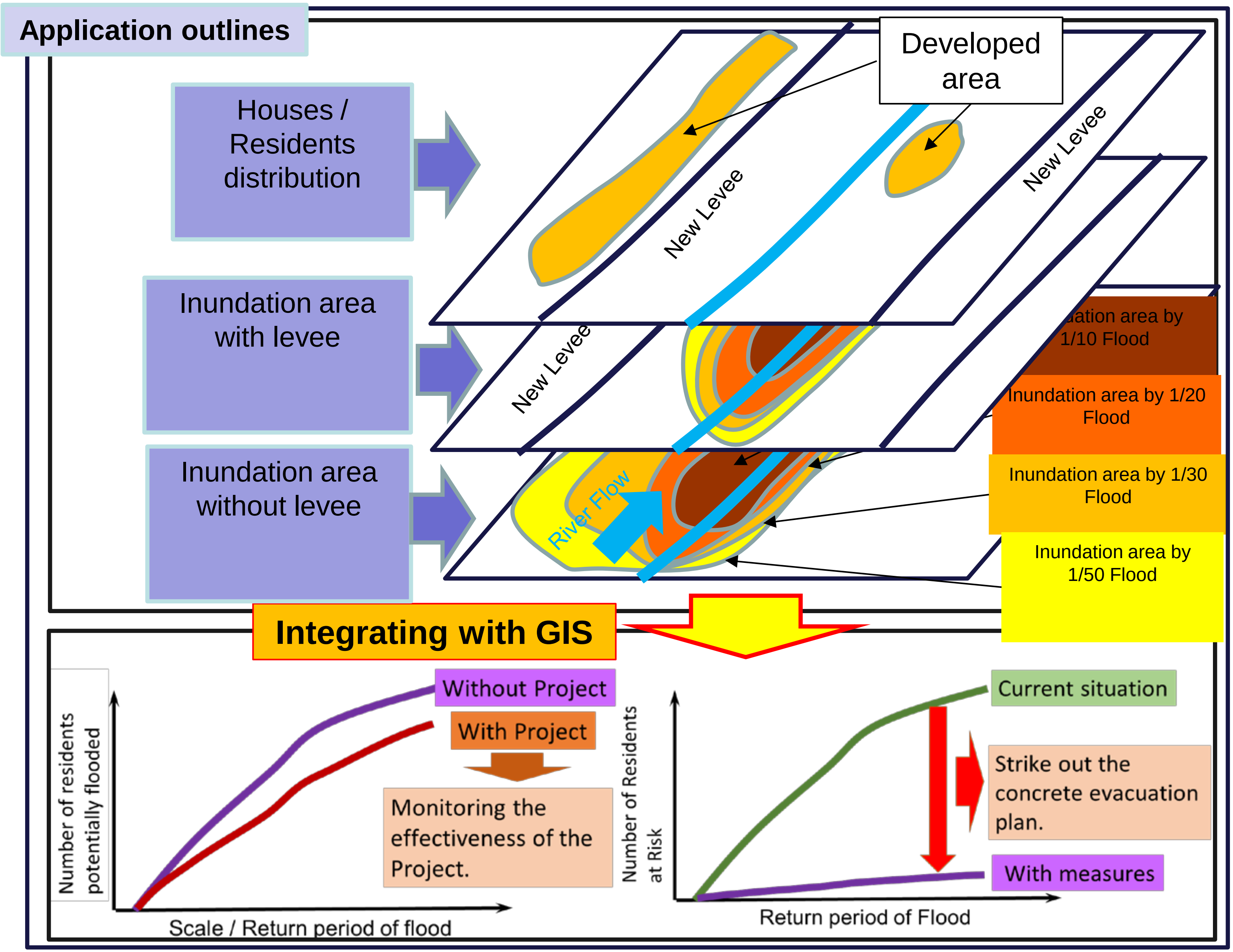
Discuss/design DRR measure



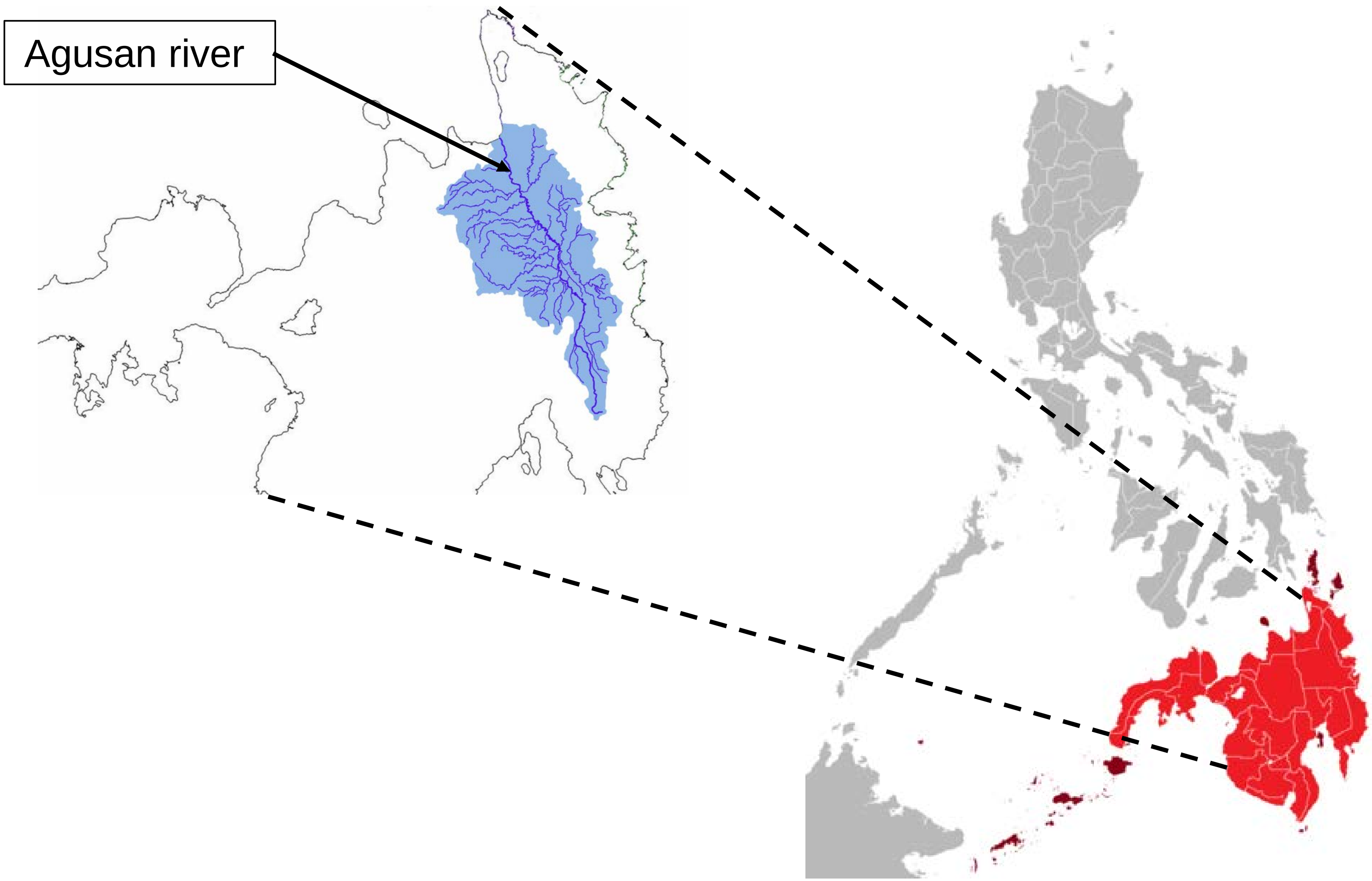
Decide the scale of the measure with Public-Private coordination.

* This graph should be drawn by integrating a set of Hazard maps, employees' house distribution, and road network and elevation by using GIS.

How to use DRG



Location of Agusan river in Mindanao



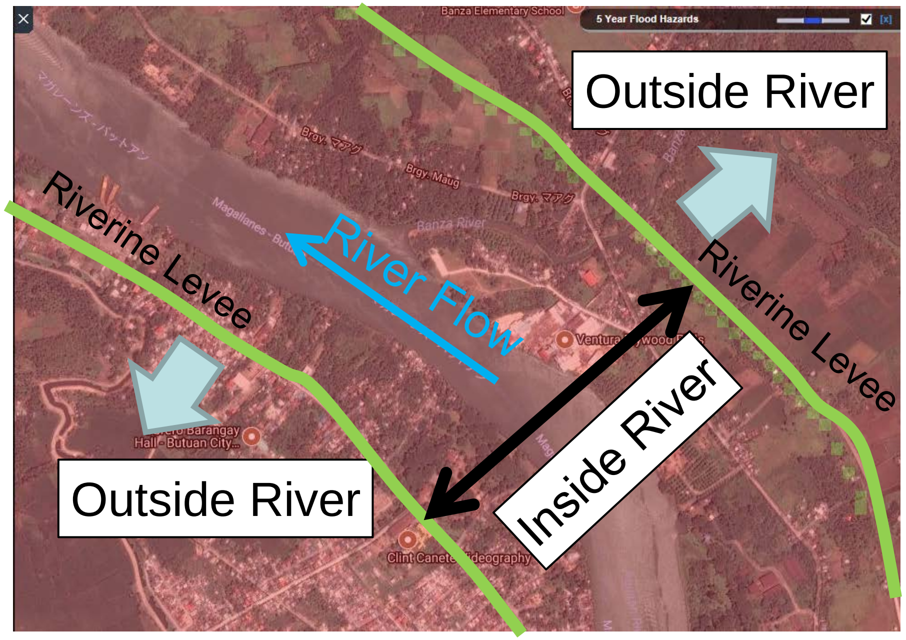
From Wikipedia (https://en.wikipedia.org/wiki/Agusan_River https://en.wikipedia.org/wiki/Mindanao)

Test application of DRG

Project NOAH's Flood Risk Map
(http://www.noah.dost.gov.ph/#/section/geoserver/flood5)

Project NOAH's Flood Risk Map was available on the web site. Based on the Map, the number of residents in the potential inundation area was each calculated by using GIS.
For "Without (river improvement) Project" case, the potential inundation area on the Map was used as it was, because the existence of the riverine levee was not considered when the Map was drawn by Project NOAH.

Test application of DRG

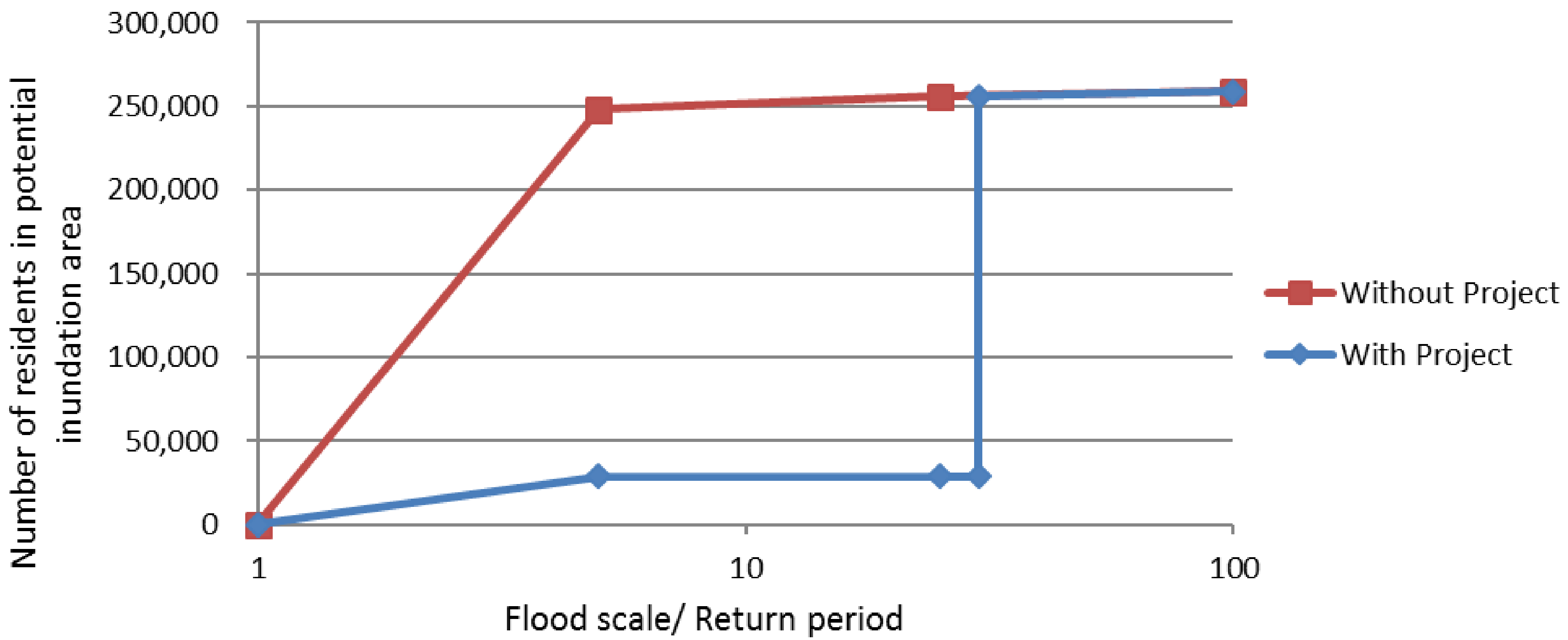


Project NOAH's Flood Risk Map (http://www.noah.dost.gov.ph/#/section/geoserver/flood5) added by the author.

For "With Project" case, the potential inundation area on the Map outside the river (Agusan River), i.e. the area farther than the riverine levee from the Agusan river channel, was taken to be not potentially inundated area for 5-year and 25-year return period scale flood, because the safety level provided by the river improvement project was 30-year return period scale.
An assumption of 1.5 m increment of inundation depth inside the river for "With Project" case compared with "Without Project" case was adopted up to the design scale of the flood of the river improvement project for considering the riverine flood water confining effect by the riverine levee constructed.

Test application of DRG

With or without Lower Agusan River improvement project



This graph is tentatively drawn by OCD-JICA Expert on DRRM Office on May 18, 2017, based on the limited available data of DPWH-RXIII, Project NOAH and PSA, and Google Map's image in the area of Butuan city and Magallanes municipality, Agusan del Norte province, Mindanao, the Philippines. This graph was drawn for the area of Butuan city and Magallanes municipality. In this graph, an assumption of 1.5 m increment of inundation depth inside the river for "With Project" case compared with "Without Project" case was adopted up to the design scale of the flood of the river improvement.

Test application of DRG

With or without Lower Agusan River improvement project

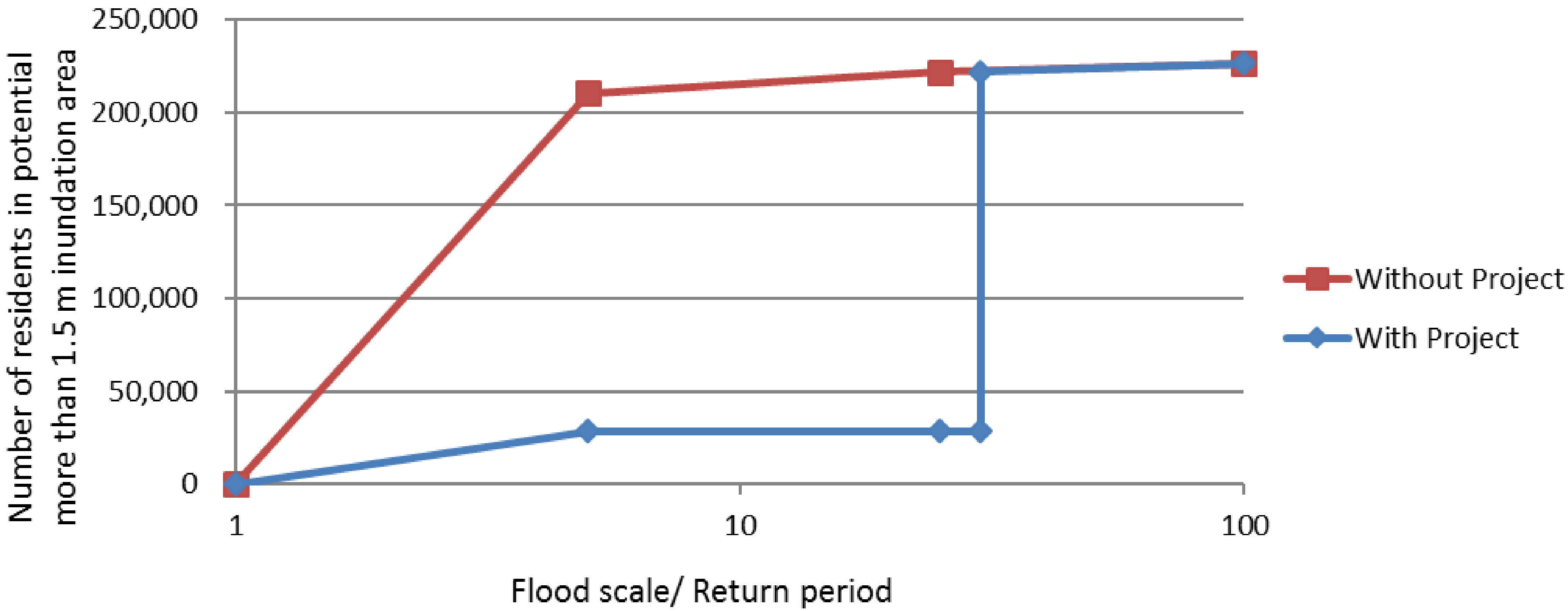


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Photo: Town in Agusan River (May 3, 2015)

Thank you for your kind attention.
I welcome your questions and comments.

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