GIROJ's Flood Loss Model

General Insurance Rating Organization of Japan

GIROJ’s Flood Loss Model

The Overview of GIROJ’s Flood Loss Model

The Overview of GIROJ’s Flood Loss Model

- GIROJ’s Flood Loss Model is consisted of four sub-models.

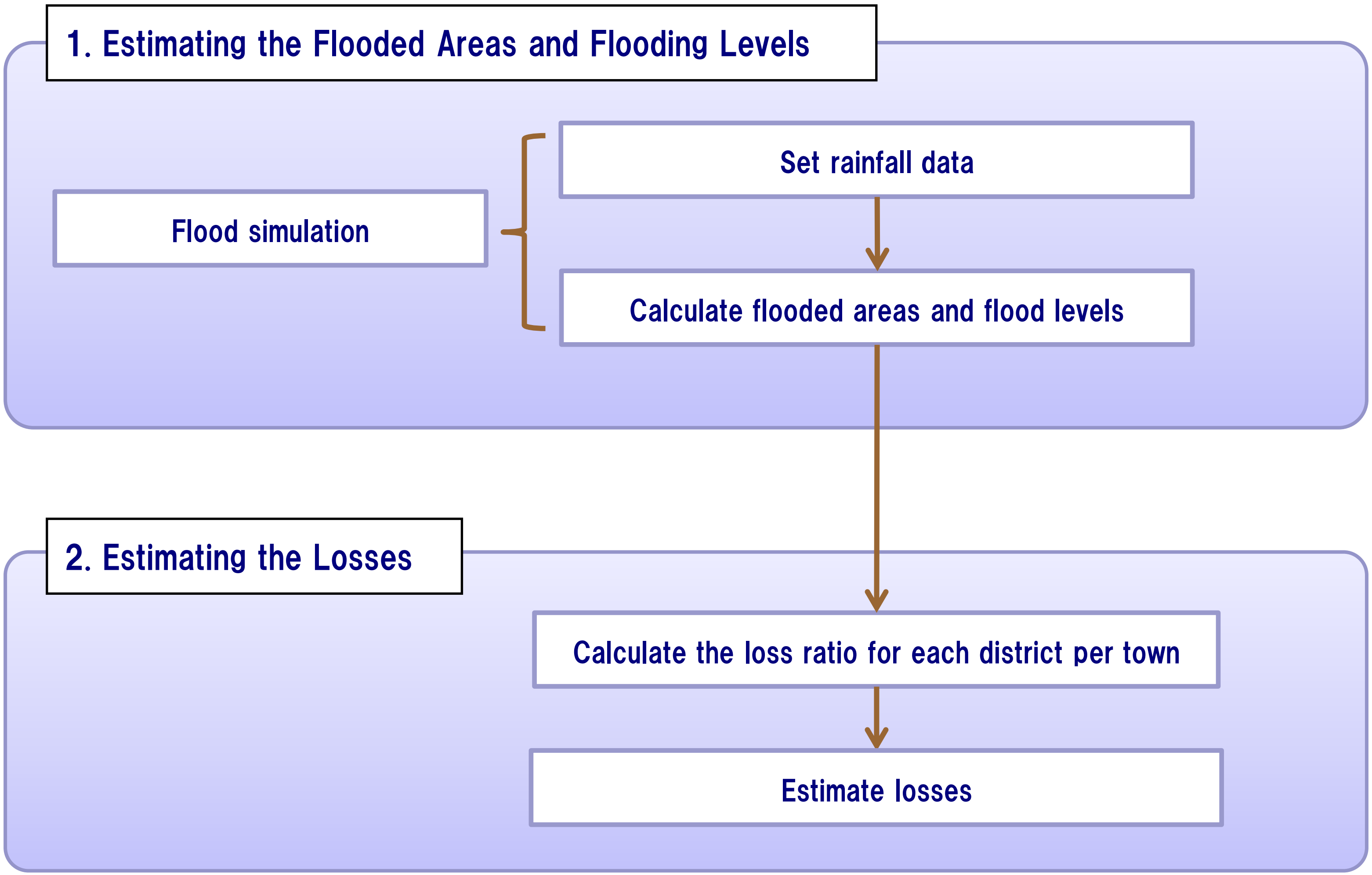
Floods

Modelling

	Floods	Sub-model
Less frequent, large-scale disasters	Riverine flooding*1	**River Flood Engineering Model** This model uses a flood simulation, calculating the flooded areas and flood levels in order to estimate the loss.
	Inland water flooding*2	**Inland Water Flood Engineering Model** This model uses an inland water flood simulation, calculating the flooded areas and flood levels in order to estimate the loss.
	Storm surge*3	**Storm Surge Flood Engineering Model** This model uses a storm surge flood simulation, calculating flooded areas and flood levels in order to estimate the loss.
Ordinarily occurring disasters	Other precipitation related events	**Statistical Flood Model** This model uses a statistical method, estimating the probability distribution of the number of damaged buildings and its loss ratio in order to estimate the loss.

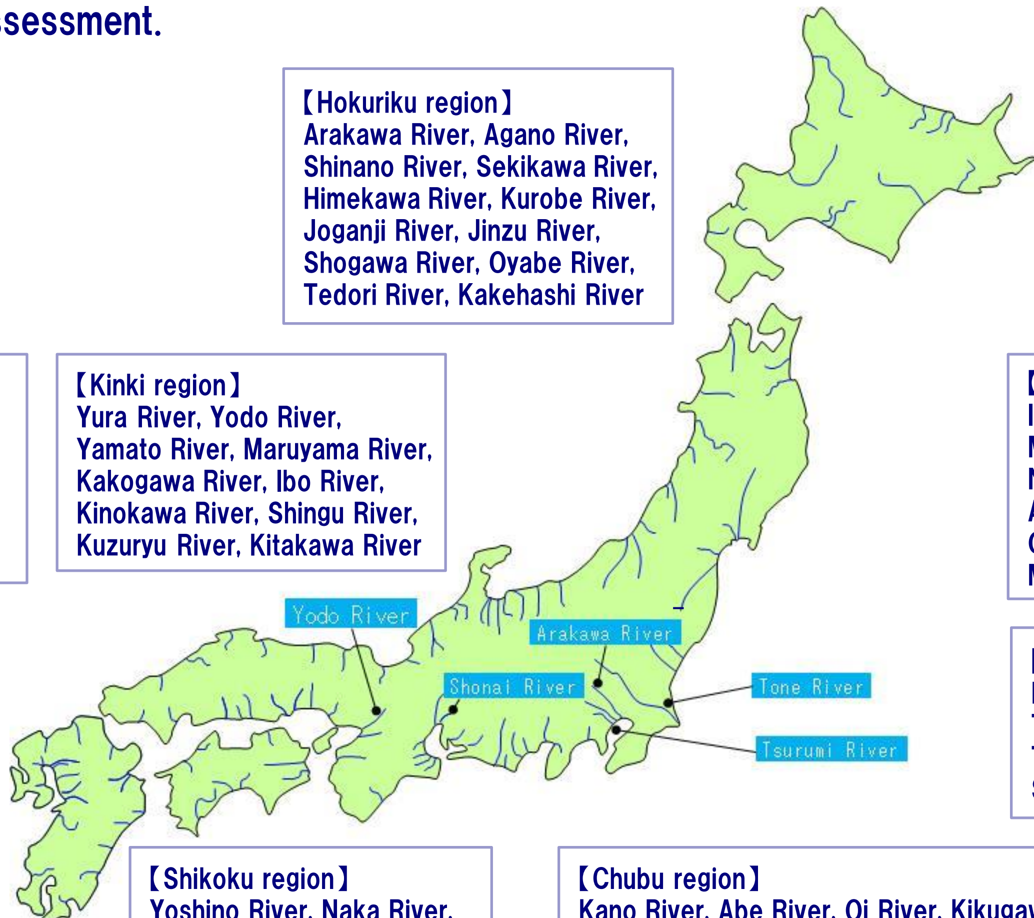
*1 Floods that occur when water overflows its riverbank or when a riverbank breaches.
*2 Floods that occur when the sewer system exceeds its capacity, causing the water to overflow.
*3 Floods that occur when water overflows its bank or when a bank breaches, due to a typhoon or large low-pressure system approaching, resulting in a sea level rise in coastal regions.

The Overview of the River Flood Engineering Model



River Flood Engineering Model: Target of Assessment

- All Class A rivers（109 rivers shown below）and some Class B rivers（about 2000 rivers）are target of the assessment.



【Hokkaido region】
Teshio River, Shokotsu River, Yubetsu River, Tokoro River, Abashiri River, Rumoi River, Ishikari River, Shiribetsu River, Shiribeshi-toshibetsu River, Mukawa River, Saru River, Kushiro River, Tokachi Rivers

【Tohoku region】
Iwaki River, Takase River, Mabechi River, Kitakami River, Naruse River, Natori River, Abukuma River, Yoneshiro River, Omono River, Koyoshi River, Mogami River, Akagawa River

【Kanto region】
Kuji River, Naka River, Tone River, Arakawa River, Tama River, Tsurumi River, Sagami River, Fuji River

【Hokuriku region】
Arakawa River, Agano River, Shinano River, Sekikawa River, Himekawa River, Kurobe River, Joganji River, Jinzu River, Shogawa River, Oyabe River, Tedori River, Kakehashi River

【Chubu region】
Kano River, Abe River, Oi River, Kikugawa River, Tenryu River, Toyogawa River, Yahagi River, Shonai River, Kiso River, Suzuka River, Kumozu River, Kushida River, Miyagawa River

【Kinki region】
Yura River, Yodo River, Yamato River, Maruyama River, Kakogawa River, Ibo River, Kinokawa River, Shingu River, Kuzuryu River, Kitakawa River

【Chugoku region】
Sendai River, Tenjin River, Hino River, Hii River, Gonokawa River, Takatsu River, Yoshii River, Asahi River, Takahashi River, Ashida River, Ota River, Oze River, Saba River

【Shikoku region】
Yoshino River, Naka River, Doki River, Shigenobu River, Hijikawa River, Monobe River, Niyodo River, Watari River

【Kyushu region】
Onga River,Yamakuni River, Chikugo River, Yabe River, Matsuura River, Rokkaku River, Kase River, Honmyo River, Kikuchi River, Shirakawa River, Midori River, Kuma River, Oita River, Ono River, Banjo River, Gokase River, Omaru River, Oyodo River, Sendai River, Kimotsuki River

* For Tone River, Arakawa River, Tsurumi River, Shonai River, and Yodo River, GIROJ’s flood simulation results are used for risk assessment. For the other rivers, flood simulation results by the Ministry of Land, Infrastructure, Transport and Tourism are used for risk assessment.

River Flood Engineering Model:
1. Assessing the Flooding Areas and Flooding Levels

- Calculating the flooding areas and flooding levels using the Flood Simulation.

Set rainfall data

(1) Rainfall occurs.
(Rainfall pattern data)

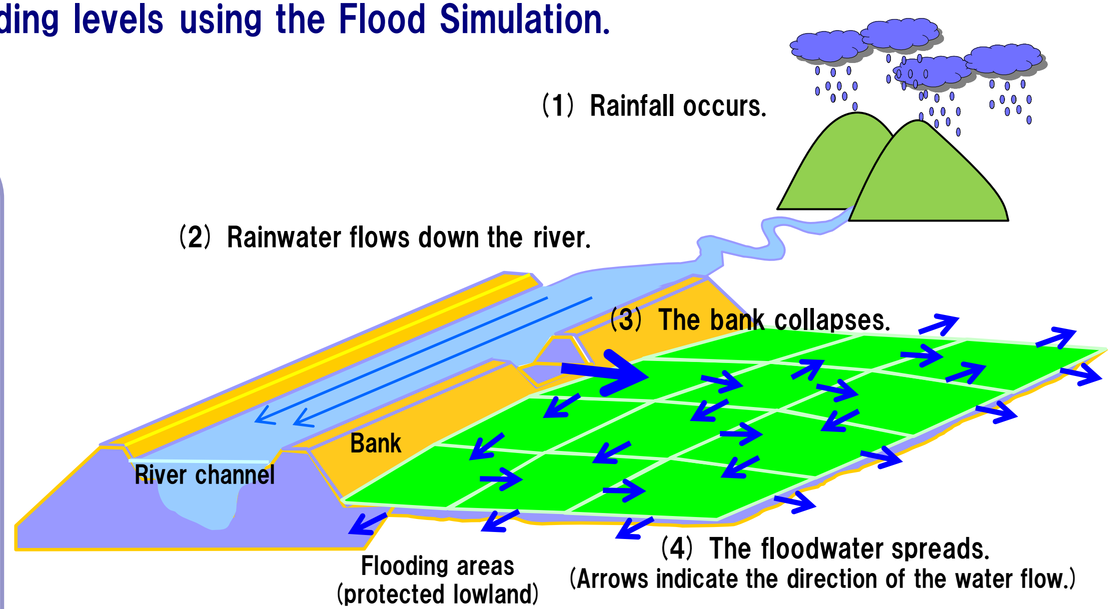
(2) Rainwater flows down the river.
(River channel data)

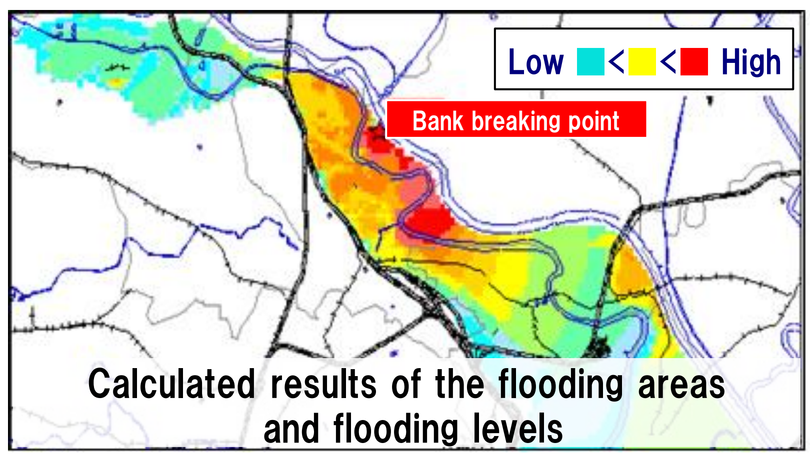
(3) The bank gives way.
(Bank data)

(4) The floodwater spreads.
(Altitude data)

Calculate the flooding areas and flooding levels.

* In step (1), heavy rainfall data, such as a 200-year return period is input.
* The data mainly used is listed in ().





Calculated results of the flooding areas and flooding levels

River Flood Engineering Model: 2. Loss Assessment

- By combining the flooded areas and flood levels calculated by the flood simulation, and the “relation formula between the flood levels and the loss ratio”, the loss ratio per town is determined, and the loss is estimated from insurance policy data.

1. Estimating Flooded Areas and Flood Levels

Calculate flooded areas and flood levels

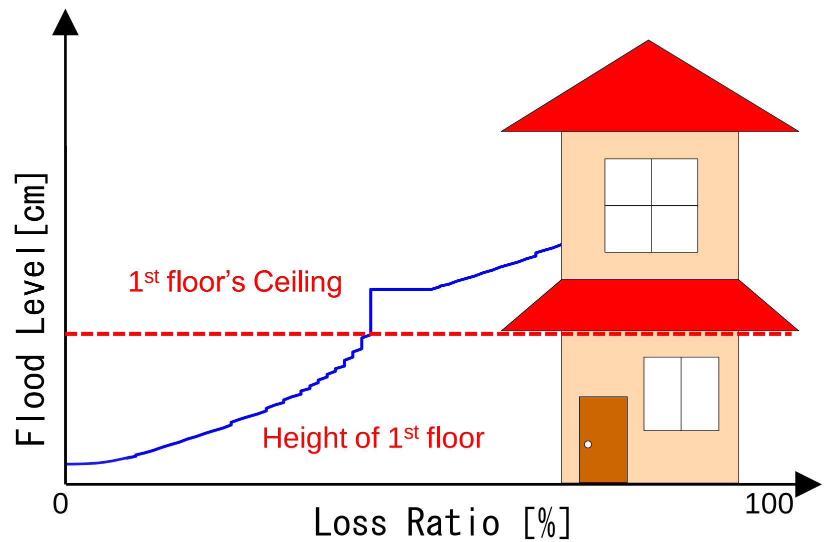
2. Estimating the Losses

Relation formula between flood levels and loss ratio

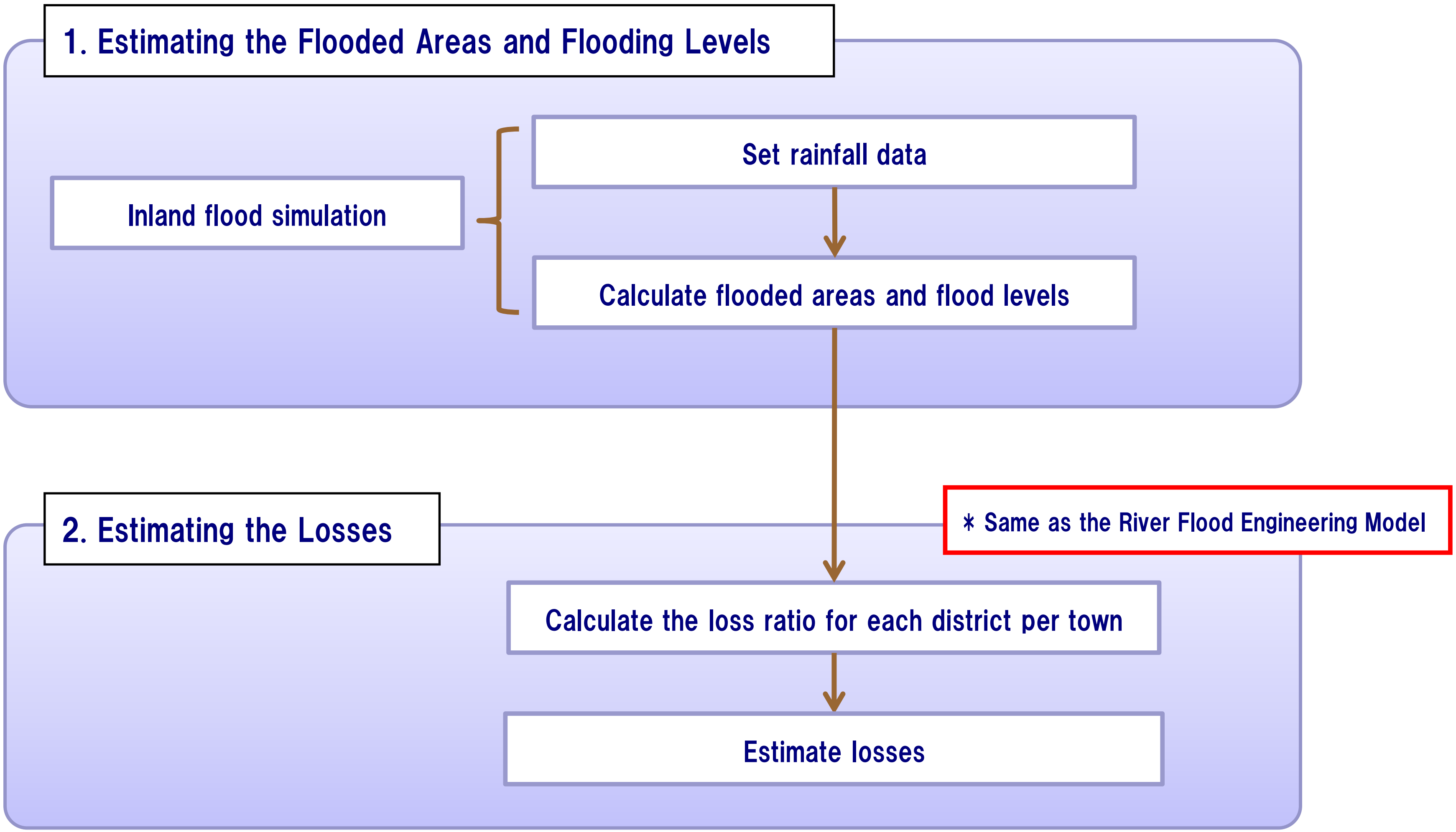
Calculate the loss ratio for each district per town

Insurance policy data

Estimate losses

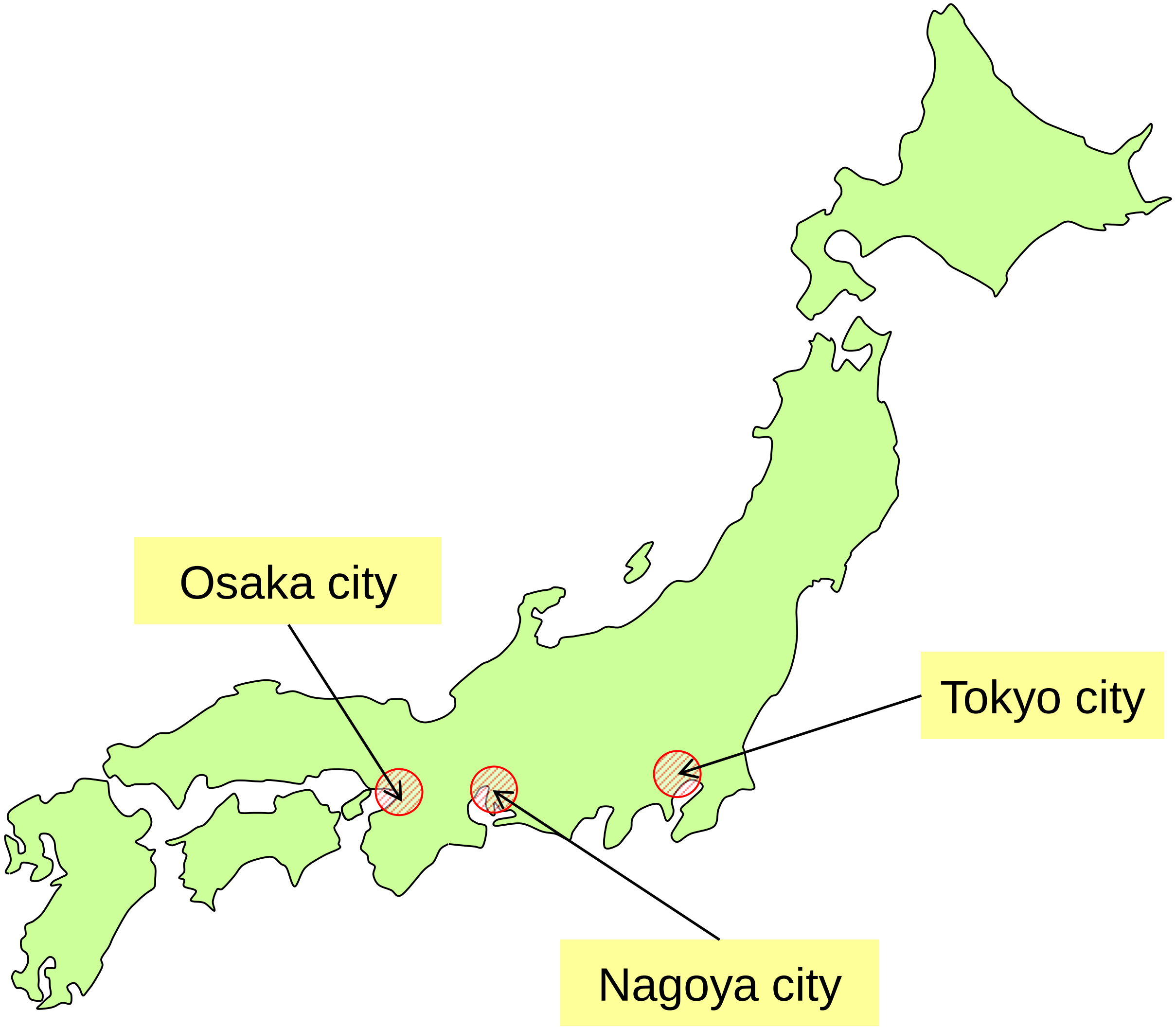


The Overview of Inland Flood Engineering Model



Inland Flood Engineering Model: Target of Assessment

- The following cities included in the three major metropolitan areas of Japan are the target of the assessment.



Inland Flood Engineering Model:
1. Assessing the Flooding Areas and Flooding Levels

- Calculating the flooding areas and flooding levels using the Inland Flood Simulation.

Setting the Rainfall

①Rainfall occurs.
（rainfall data）

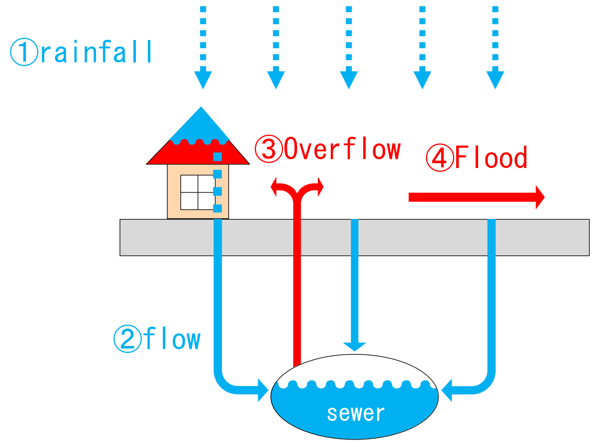
②Flow:Rain flows down the sewer.
（sewer system data）

③Overflow:Water overflows the ground.
（　　〃　　）

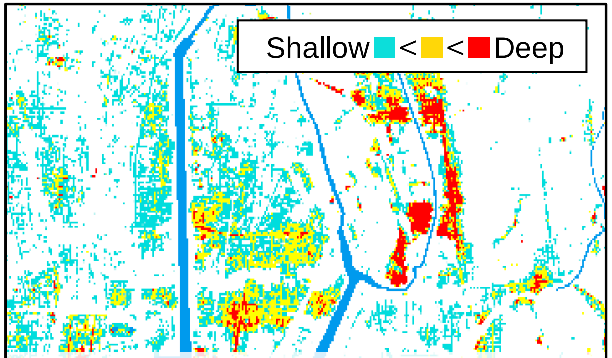
④Flood:The overflowed water spreads.
（altitude data）

Calculating the flooding areas and flooding levels.

* In step①, rainfall data such as a 200-year return period is input.
* The data mainly used is listed in ().



*The overflow occurs when the flowing amount of rainwater exceeds the drainage capacity of the sewer.



Calculated results of the flooding areas and flooding levels

Inland Flood Engineering Model: 2. Loss Assessment

- By combining the flooded areas and flood levels calculated by the Inland flood simulation, and the "relation formula between the flood levels and the loss ratio", the loss ratio per town is determined, and the loss is estimated from insurance policy data.

1. Estimating Flooded Areas and Flood Levels

Calculate flooded areas and flood levels

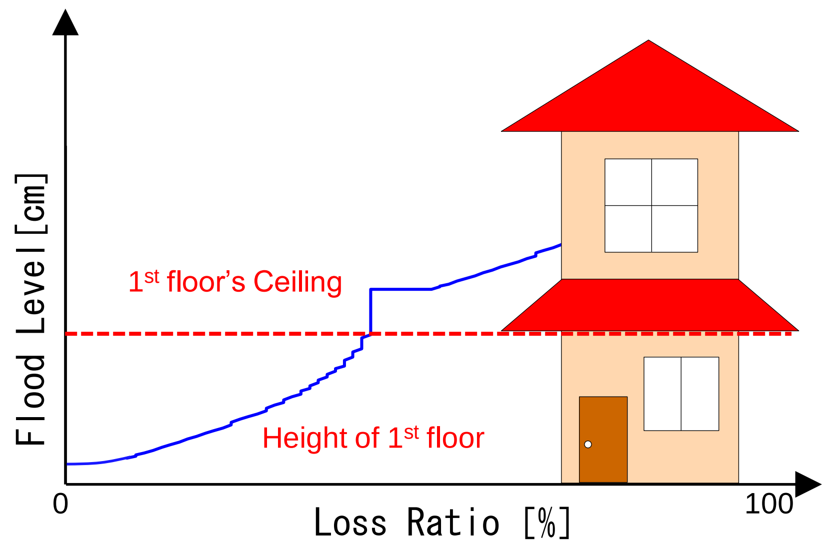
2. Estimating the Losses

Relation formula between flood levels and loss ratio

Calculate the loss ratio for each district per town

Insurance policy data

Estimate losses



The Overview of Storm Surge Flood Engineering Model

1. Estimating the Flooded Areas and Flooding Levels

Storm surge flood simulation

- Simulated typhoon*1
- ↓
- Calculate the amount of rise in tide level
- ↓
- Calculate flooded areas and flood levels

↓

2. Estimating the Losses

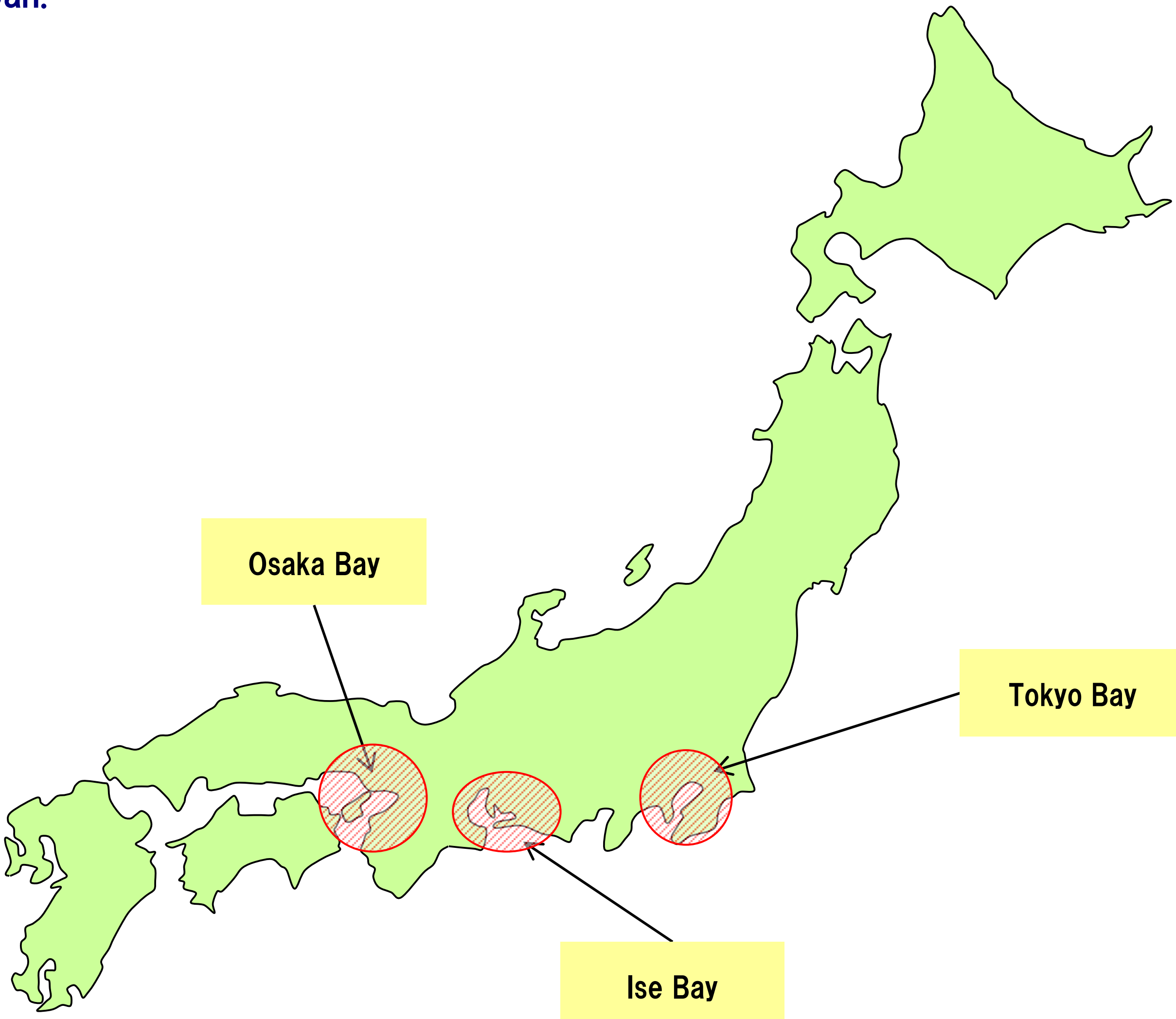
＊ Same as the River Flood Engineering Model

- Calculate the loss ratio for each district per town
- ↓
- Estimate losses

*1 A typhoon generated by a simulation that is used in GIROJ's typhoon loss model

Storm Surge Flood Engineering Model: Estimate targets

- Estimate targets are Tokyo Bay, Ise Bay, and Osaka Bay that adjoin the three major metropolitan areas in Japan.



Storm Surge Flood Engineering Model: 1. Estimating Flooded Areas and Flood Levels

- The storm surge flood simulation, calculates the risen amount of the tide level (sea level) for each typhoon (Simulated Typhoon) generated by GIROJ's Typhoon Loss Model.

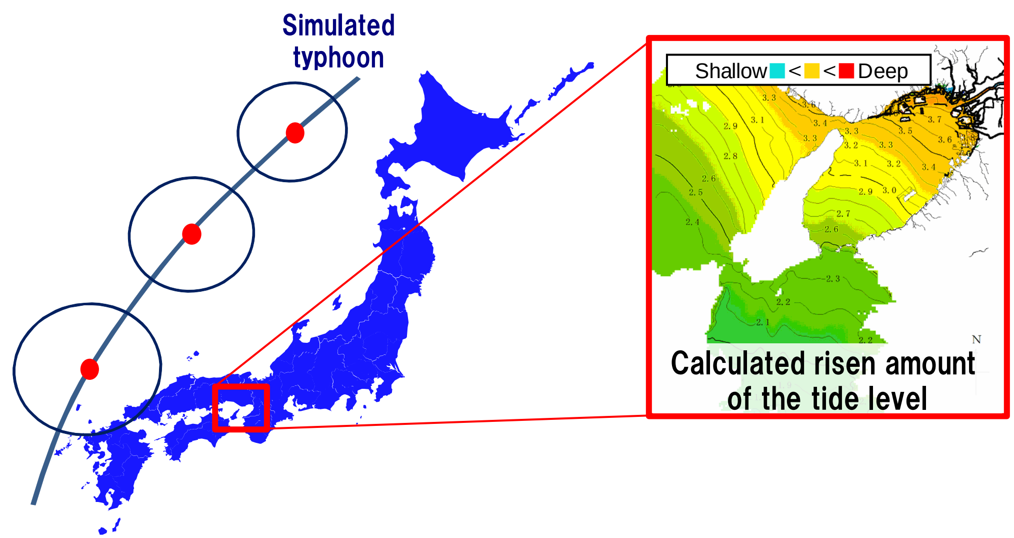
Simulated Typhoon

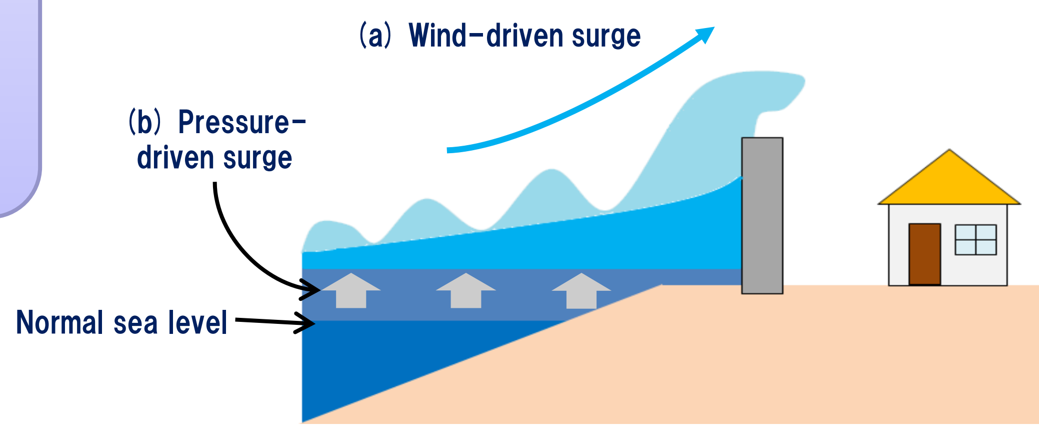
(a) Wind-Driven Surge:
The sea level increase due to strong typhoon wind.

(b) Pressure-Driven Surge:
The sea level increase due to the decline of the air pressure caused by a typhoon.

Astronomical tide level*1

Calculating the risen amount of the tide level





*1 The periodically changing amount of sea level caused by the gravitation of the moon and sun.

Storm Surge Flood Engineering Model:
1. Estimate Flooded Areas and Flood Levels

- Calculate the amount of seawater inundating land based on the rise in tide level and how the seawater spreads on land, thereby determining flooded areas and flood levels.

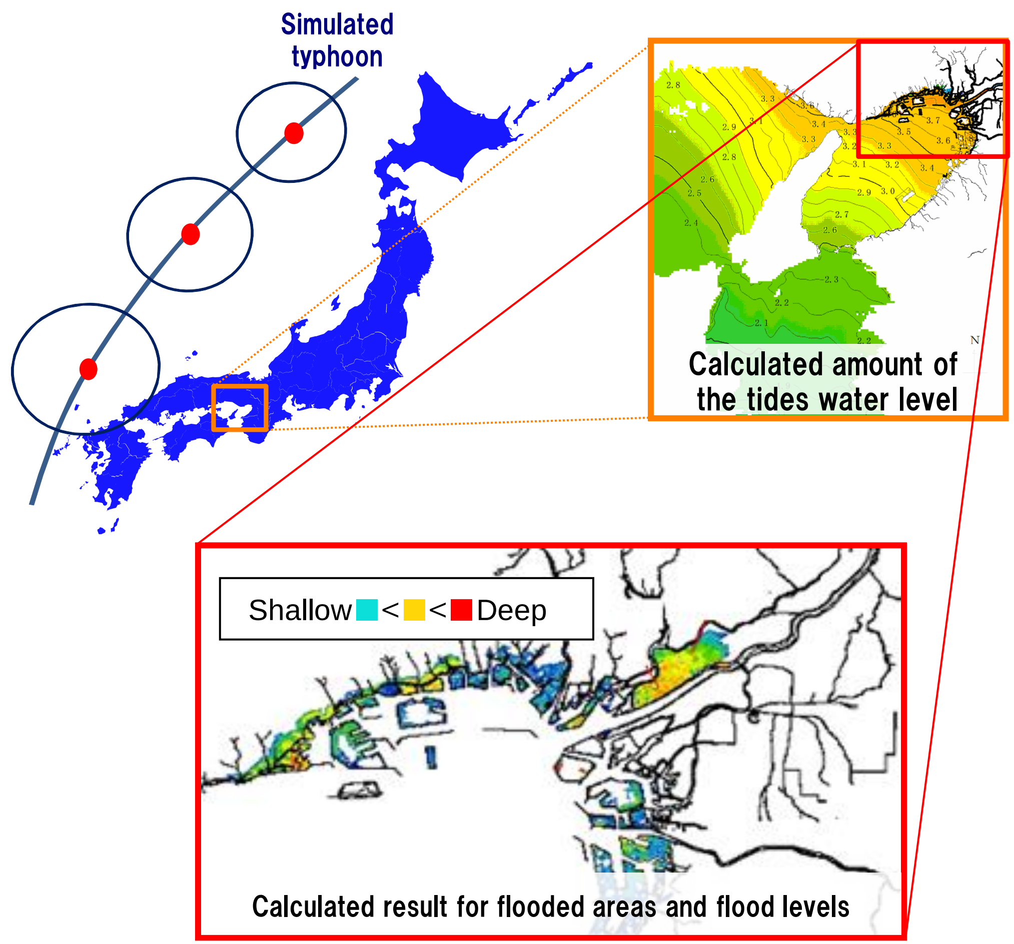
Calculate the amount of rise in tide level

(1) Seawater inundates land.
(Bank data)

(2) The floodwater spreads.
(Altitude data)

Calculate flooded areas and flood levels

* Data inside the parentheses are mainly used.



Storm Surge Flood Engineering Model: 2. Loss Assessment

- By combining the flooded areas and flood levels calculated by the Storm Surge flood simulation, and the “relation formula between the flood levels and the loss ratio”, the loss ratio per town is determined, and the loss is estimated from insurance policy data.

1. Estimating Flooded Areas and Flood Levels

Calculate flooded areas and flood levels

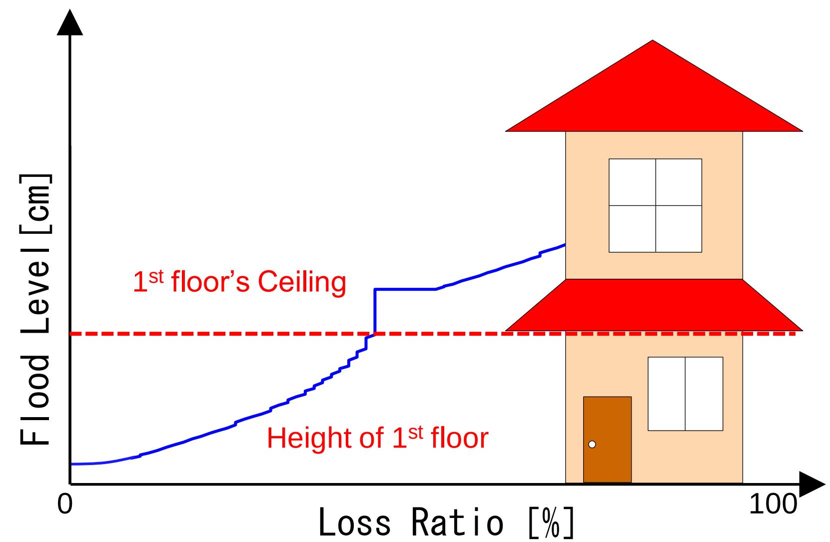
2. Estimating the Losses

Relation formula between flood levels and loss ratio

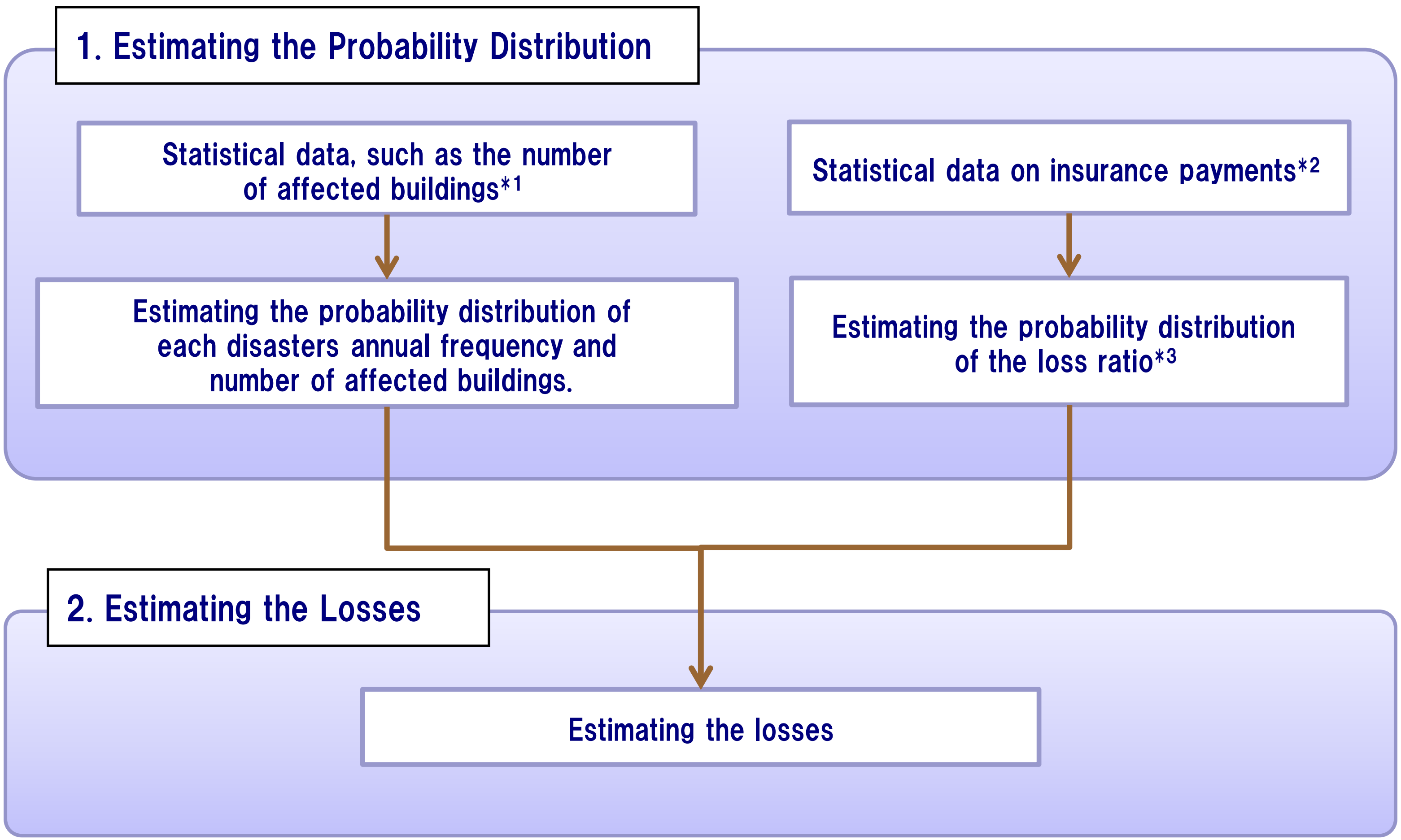
Calculate the loss ratio for each district per town

Insurance policy data

Estimating the losses



The Overview of Statistical Flood Model



*1 Flood Damage Statistics Survey (Ministry of Land, Infrastructure, Transport and Tourism) etc. is used.
*2 Fire insurance statistics (General Insurance Rating Organization of Japan) is used.
*3 Loss ratio = amount of loss / insured value

Statistical Flood Model: 1. Estimating the Probability Distribution

(about the distribution of the disasters annual frequency and number of affected buildings)

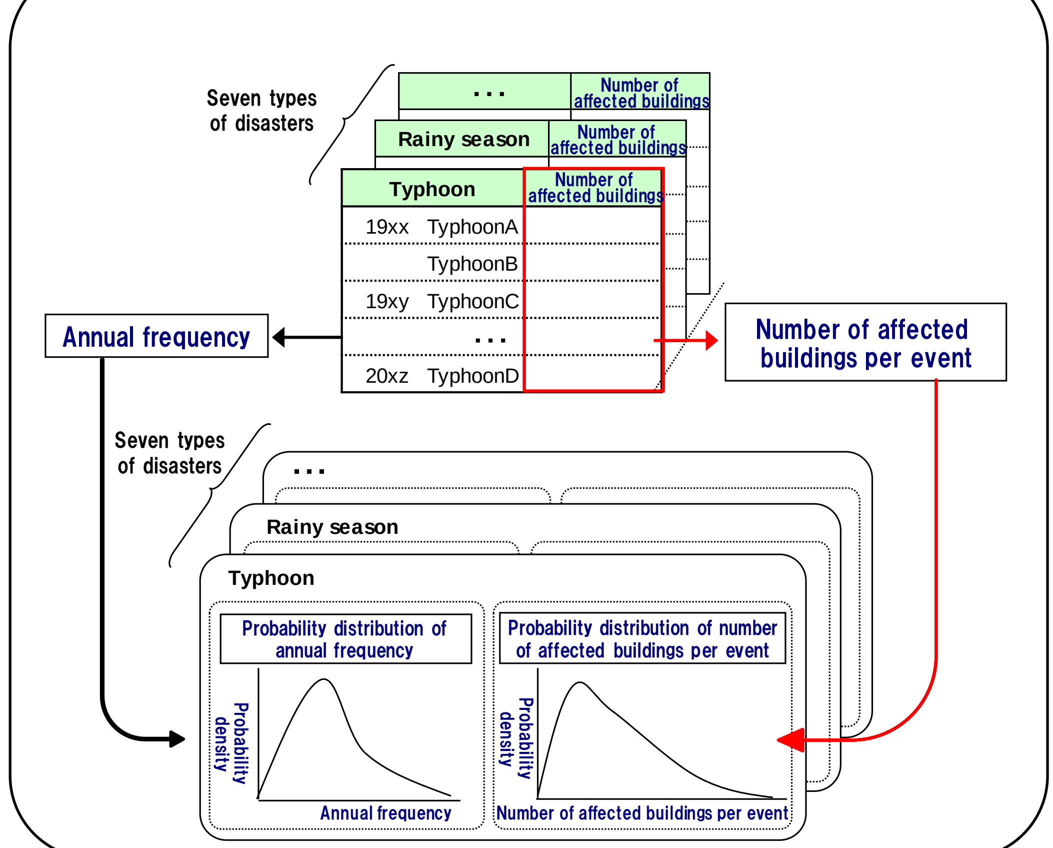
- **Based on statistical data of the number of affected buildings etc, the probability distribution of the annual frequency and the number of affected buildings are estimated according to each seven types of disasters** (1.typhoon, 2.rainy season, 3.heavy rain, 4.wind and waves, 5.snow melting, 6.landslides, and 7.other extraordinary disasters).

Statistical data, such as the number of affected buildings

↓ Classify into seven disaster types based on disaster names

Estimate the probability distribution of the annual frequency and number of affected buildings for each disaster

Schematic diagram for estimation of distribution of the annual frequency and number of affected buildings for disasters



Statistical Flood Model: 1. Estimating the Probability Distribution

(about the distribution of the loss ratio)

- Estimating the probability distribution of the loss ratio common to all disaster types based on statistical data on insurance payments.

Statistical data on insurance payments

↓

Estimating the probability distribution of the loss ratio

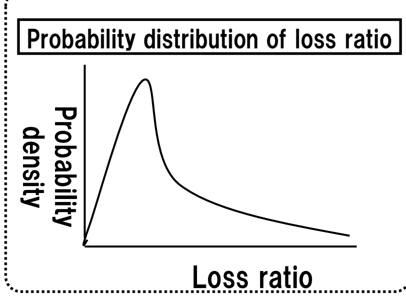
Schematic diagram for estimation of probability distribution of loss ratio

Statistical data on insurance payments

(1) Insured value	(2) Amount of loss
100	10
200	40
…	

(3) Loss ratio = ((2) / (1))
0.1
0.2
…

(Common to all disaster types)



Statistical Flood Model: 2. Estimate Losses

- Calculating the disasters annual frequency, number of affected buildings, and the loss ratio based on the estimated probability distribution. Then, after determining the number of insurance payments and the average amount of insurance payments using the insurance policy data, the loss is estimated per type of disaster, per prefecture.

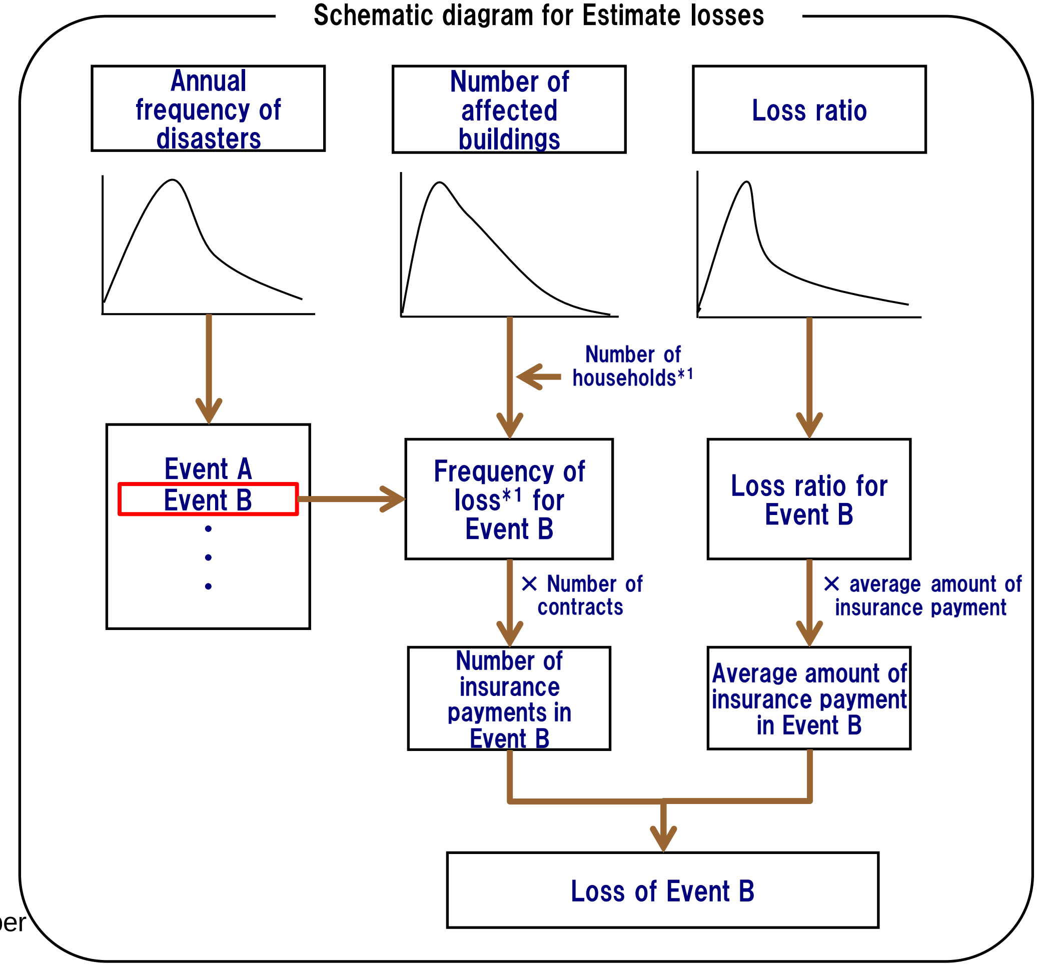
1. Estimating the Probability Distribution

Estimating the probability distribution of the disasters annual frequency, number of affected buildings, and loss ratio.

2. Estimating the Losses

Insurance policy data

Estimating the losses



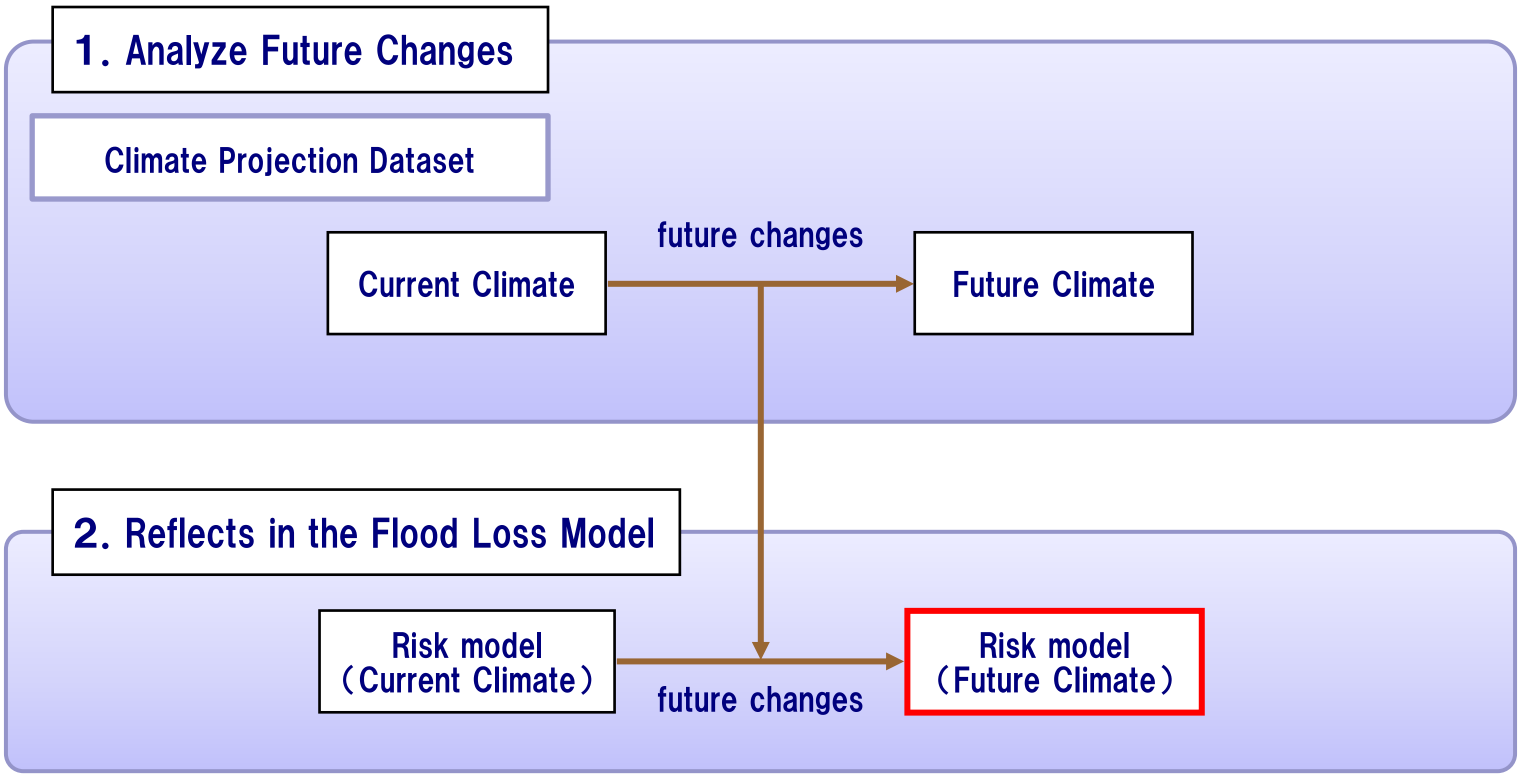
*1 The calculated number of affected buildings is allocated across prefectures based on past disaster cases. Then, the allocated number is divided by the number of households for each prefecture to determine the frequency of loss for each prefecture.

Reflecting the Impacts of Climate Change

The Overview of Reflecting the Impacts of Climate Change

- To evaluate future water disaster risks that change due to climate change, we reflect the impacts of climate change in our risk model.
- Utilizing Climate Projection Dataset*1

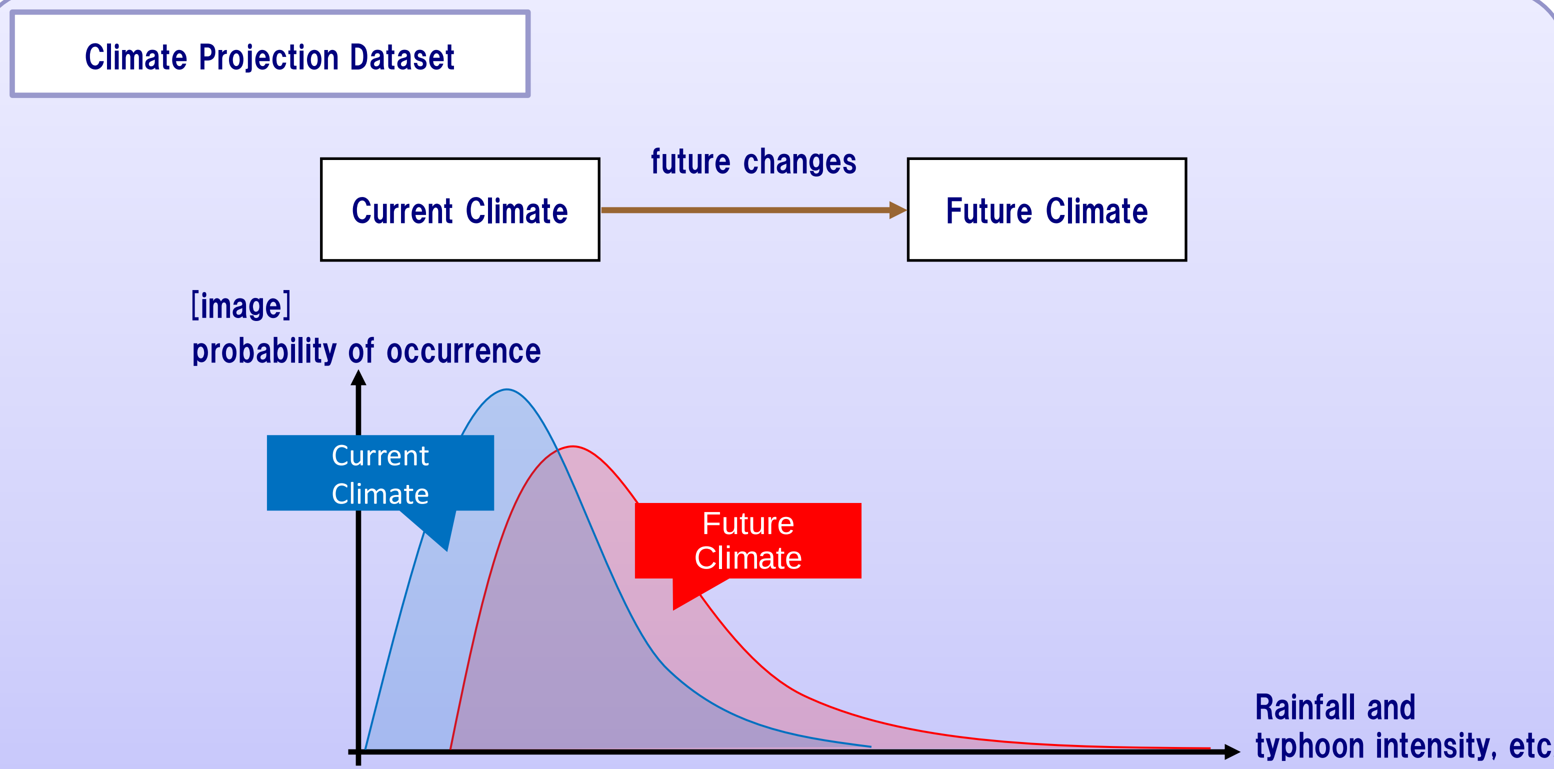
  Analyzing future changes in rain and typhoons due to climate change, and reflecting these changes in the risk model.



*1 Utilizing Climate Projection Dataset created under the Ministry of Education, Culture, Sports, Science and Technology's Program for Risk Information on Climate Change and the Japan Agency for Marine-Earth Science and Technology's Earth Simulator Strategic Project with Special Support. Conducting an analysis of the experimental results using six representative climate models utilized in IPCC(Intergovernmental Panel on Climate Change) 's report.

Reflecting the Impacts of Climate Change:
1. Analyze Future Changes (Climate Projection Dataset)

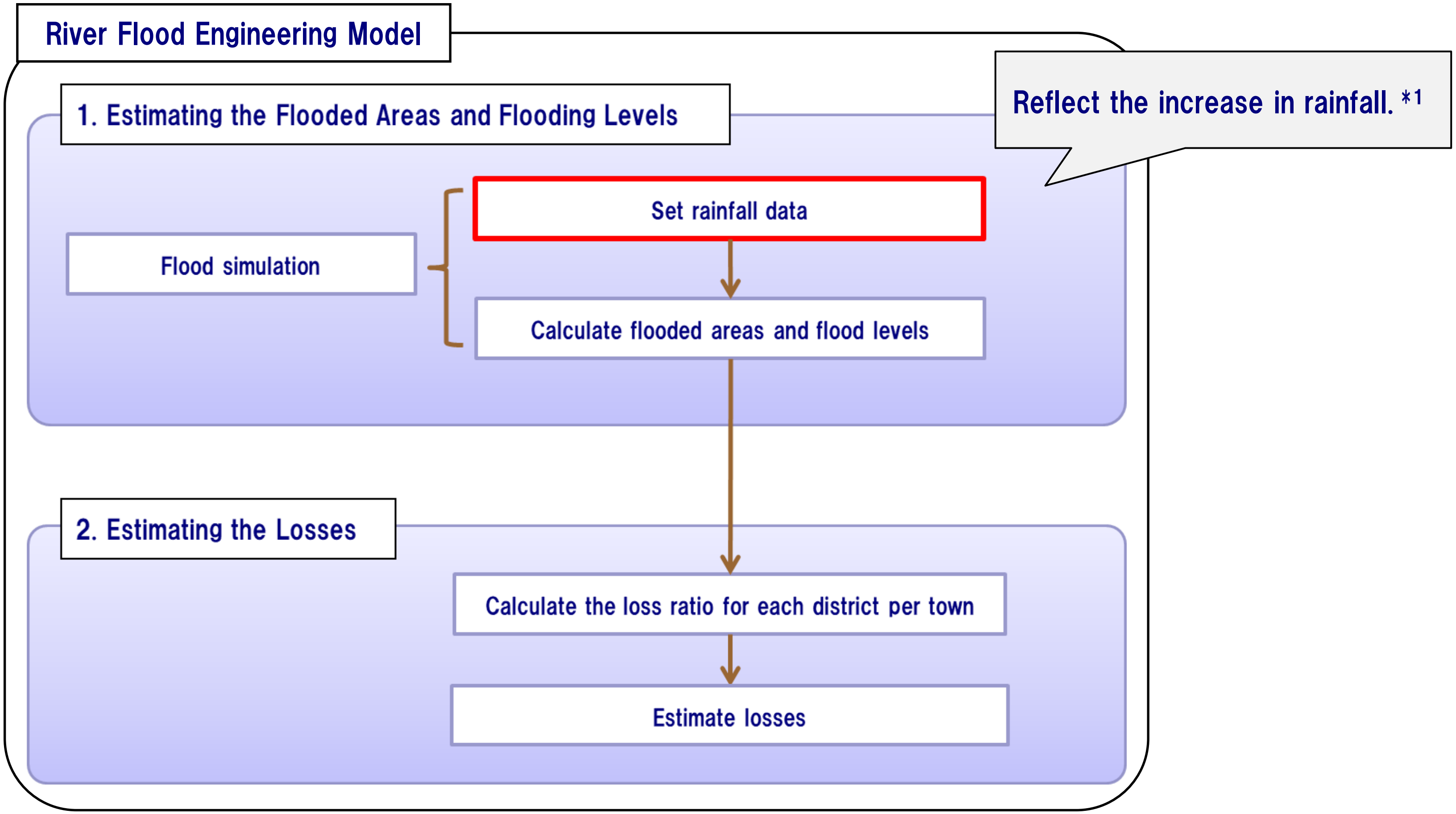
- Analyzing the results of climate simulations from the climate projection dataset, which include both historical climate conditions and climates that are 1.5℃, 2℃, and 4℃ warmer than the pre-industrial period. The analysis focuses on future changes in rainfall and typhoon intensity, etc. under both current and warmer climate conditions.



Comprehend changes in rainfall and typhoon intensity, etc. due to climate change.

Reflecting the Impacts of Climate Change: 2. Reflects in the Flood Loss Model

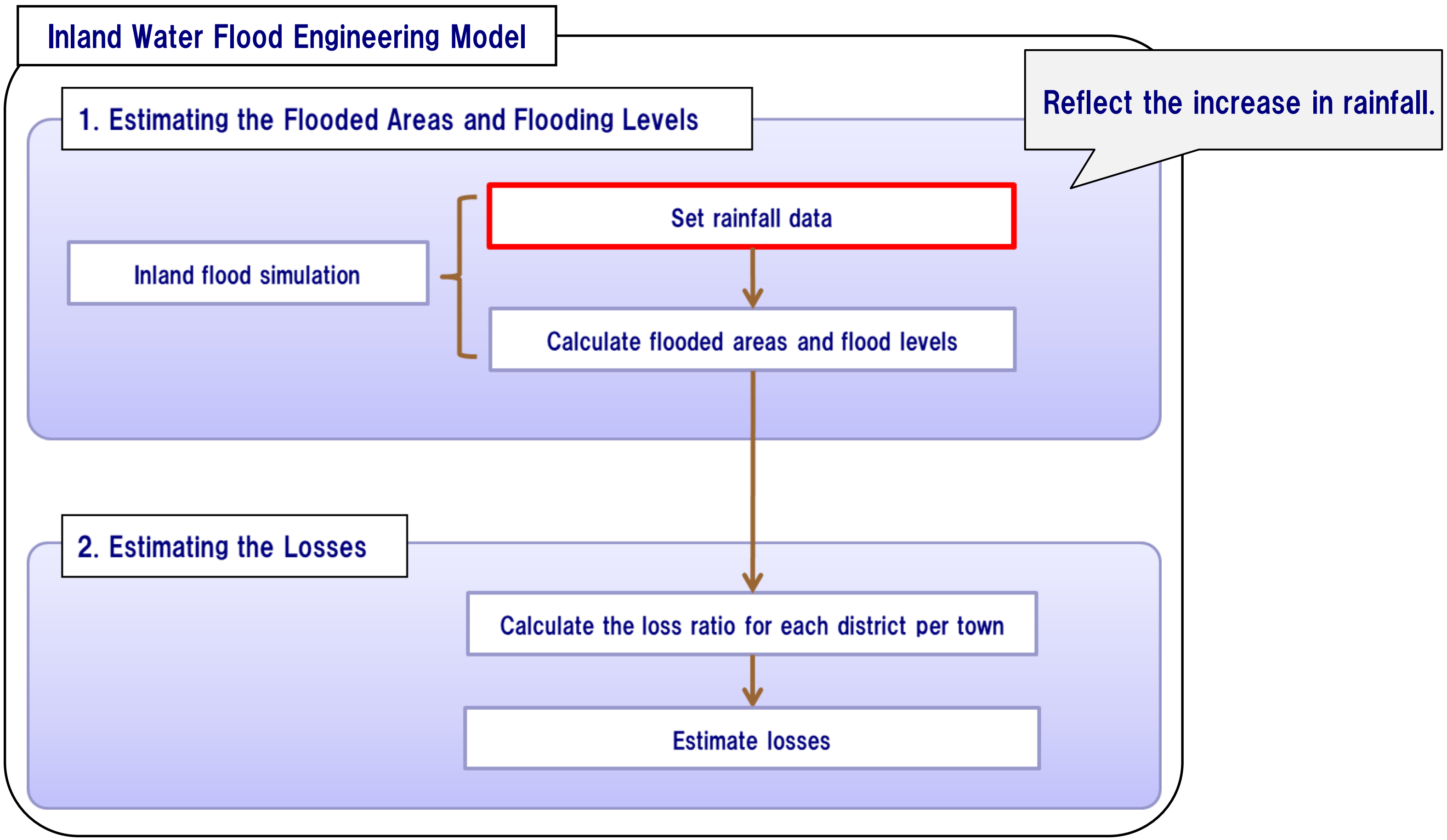
- Reflecting future changes obtained from the analysis of climate projection dataset in the flood loss model (River Flood Engineering Model)



*1 Reflect changes in occurrence probability of each rainfall amount for rivers using flood inundation simulation results from the Ministry of Land, Infrastructure, Transport and Tourism, excluding the Tone River, Arakawa River, Tsurumi River, Shonai River, and Yodo River.

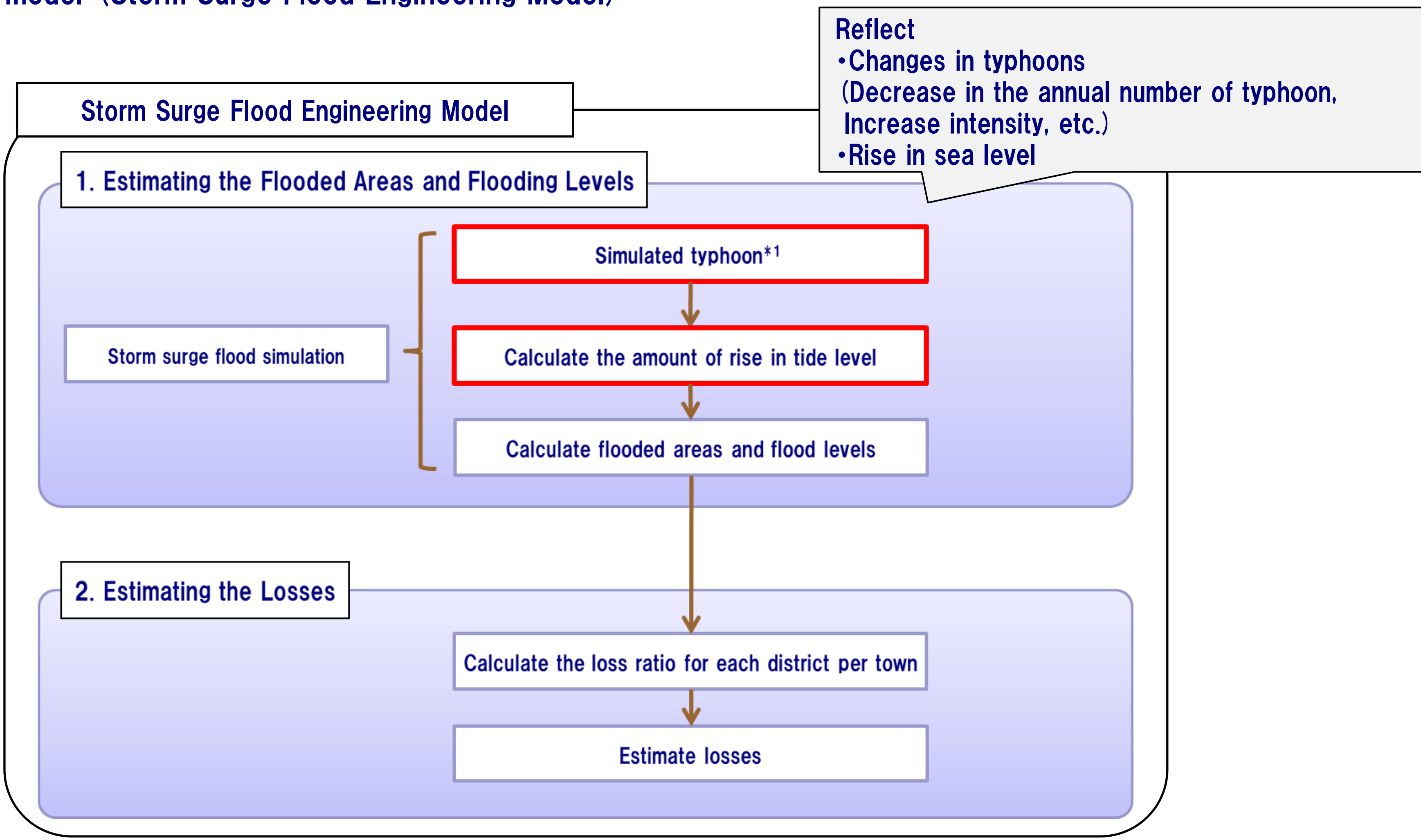
Reflecting the Impacts of Climate Change: 2. Reflects in the Flood Loss Model

- Reflecting future changes obtained from the analysis of climate projection dataset in the flood loss model (Inland Water Flood Engineering Model)



Reflecting the Impacts of Climate Change:
2. Reflects in the Flood Loss Model

- Reflecting future changes obtained from the analysis of climate projection dataset in the flood loss model（Storm Surge Flood Engineering Model）



Reflecting the Impacts of Climate Change: 2. Reflects in the Flood Loss Model

- Reflecting future changes obtained from the analysis of climate projection dataset in the flood loss model (Statistical Flood Model)

Considering the increase in rainfall and changes in typhoons regarding the three event types (typhoons, rainy season, and heavy rain). Then reflect in the probability distribution of each disasters annual frequency and number of affected buildings.