Trends for advanced countermeasures against frequent urban inundation in Japan

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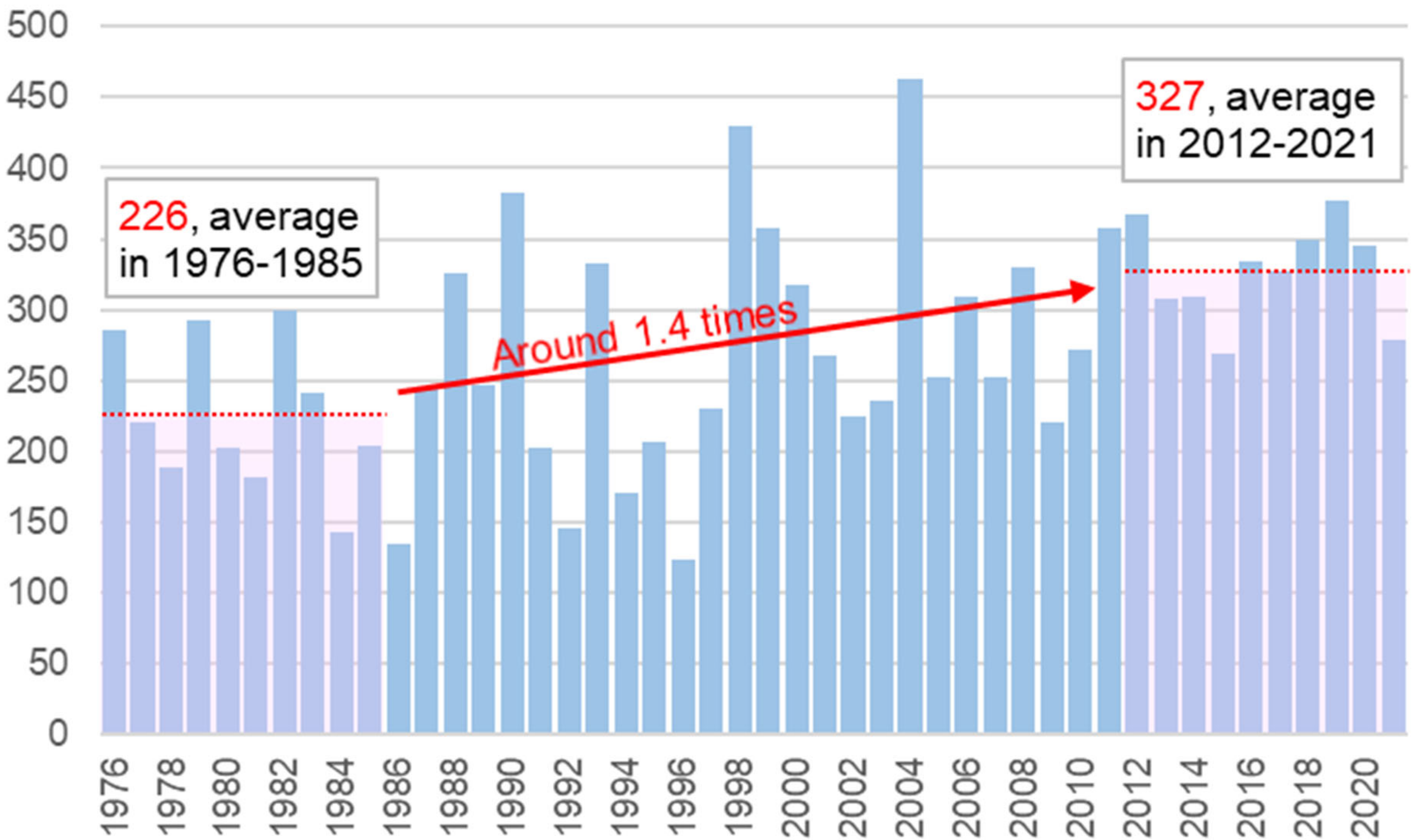


Annual occurrence of 50 mm rainfall or more in an hour (per 1300 sites)

Saga City, Saga Pref.
Aug. 2019

Omuta City, Fukuoka Pref.
Jul. 2020

In 2019, the amount of damage caused by flood disasters excluding tsunamis was the highest record, about 20 billion USD, in a single year since 1961.

Outline

Two policies in flood control

[1] Transition to “River Basin Disaster Resilience and Sustainability by All”

[2] Revision to flood control plans in consideration of climate change effects

Stormwater management master plan development/revision

[1] Design rainfall in consideration of climate change effects
--- Relevant research on nationwide rainfall data stationarity

[2] Phased action plan in consideration of climate change effects

Flood control policy [1] Transition to "River Basin Disaster Resilience and Sustainability by All"

Conventional Flood Control

■ Structural measures with clear role allocation

Mainly by administrators such as divisions of rivers, sewerage, erosion and sediment control and coasts

■ Measures implemented mainly in river areas and flood plains

"River Basin Disaster Resilience and Sustainability by All"

■ Measures to be implemented with the cooperation of all stakeholders

Including the national governments, prefectures, municipalities, private enterprises and residents

■ Measures to be implemented in any kind of place around basins

Including not only river areas and floodplains but also catchments

1) Flood Prevention **2) Exposure Reduction** **3) Disaster Resilience**

1) Flood Prevention

Catchments

- **Improve rainwater storage functions** <P / M / E / R>
  Improve rainwater storage facilities and effectively use agricultural reservoirs for flood control

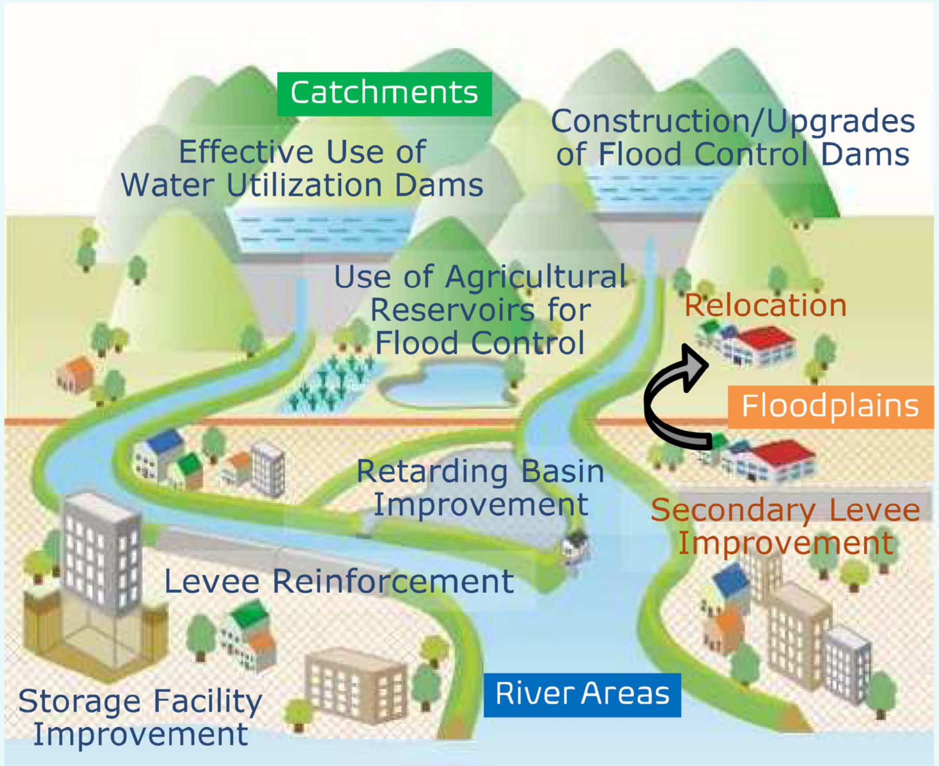
River Areas

- **Store flowing water** <N / P / M / W>
  Construction, upgrades, effective use of dams, and pre-discharge in water utilization dams for flood control
  <N / P / M>
  Upgrade retarding function integrally with land use
- **Ensure and improve the discharge capacity of river channels** <N / P / M>
  Channel excavation, setting back levees, and improvement of erosion control dams and rainwater drain facilities
- **Reduce overflow** <N / P>
  Strengthen levees to make them last a long time even when overlapping

2) Exposure Reduction

Floodplains

- **Guide residents to lower risk areas / Promote safer ways of living** <M / E/ R>
  Consider land use restrictions, encourage relocation, provide flood risk information in real estate transactions, and improve financial tools
- **Localize inundation areas** <N / P / M>
  Install banking structures and utilize existing facilities, which play the role of secondary levees



< >: Expected to be implemented by
N: National Government, P: Prefectures, M: Municipalities,
E: Private Enterprises, R: Residents, W: Water Users

3) Disaster Resilience

Floodplains

- **Improve risk information on land** <N / P>
  Promote the designation of probable inundation zones so there is sufficient area covered by risk information
- **Reinforce evacuation systems** <N / P / M>
  Develop long-term prediction technologies and acquire real-time inundation and breach detection technologies
- **Minimize economic damages** <E / R>
  Prepare anti-inundation measures in factories and buildings and develop BCPs
- **Promote safer ways of living** <E / R>
  Provide flood risk information in real estate transactions and promote anti-inundation preparedness through financial tools
- **Improve technical support systems for affected local governments** <N / E>
  Strengthen TEC-FORCE (Technical Emergency Control Force, managed by MLIT)
- **Eliminate inundation promptly** <N / P / M etc.>
  Improve sluice gates

Flood control policy [2] Revision to flood control plans in consideration of climate change effects

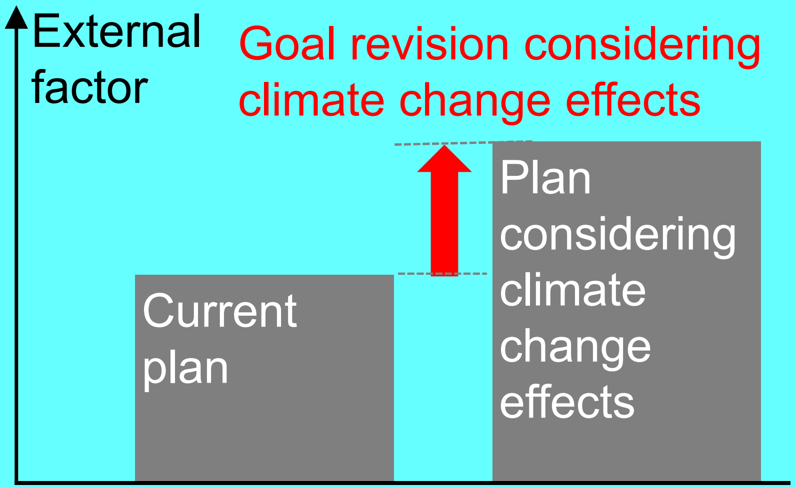
Currently

Current defense plans against floods, inland floods, landslides, storm surges and high tides were developed based on past precipitation and tide level records.

For the Future

Revise the plans considering climate change effects such as rainfall increase* and tide level rise

* In the scenario of global temperature rise below 2 degrees Celsius (target scenario of the Paris Agreement on Climate Change), precipitation is likely to increase by a factor of 1.1.



Stormwater management master plan

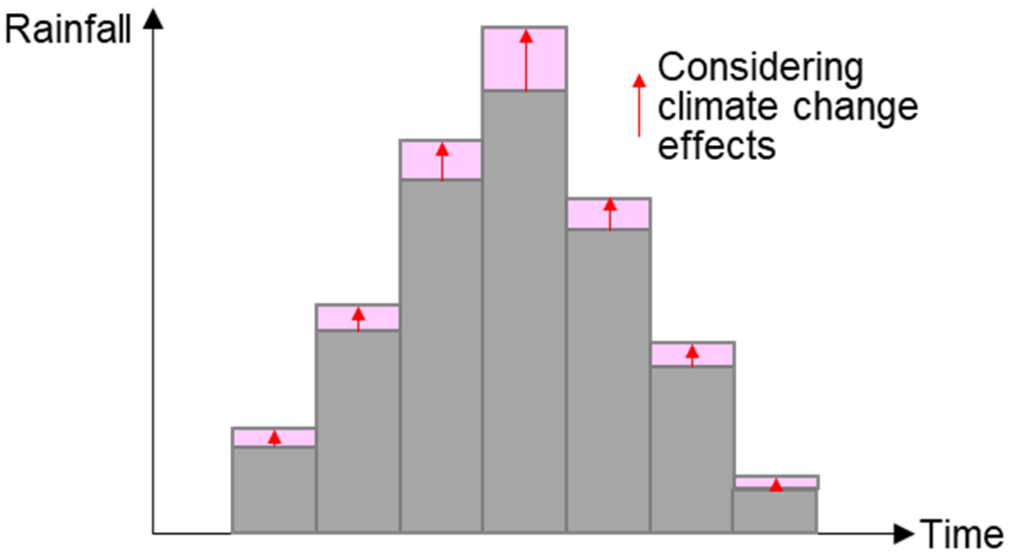
[1] Design rainfall in consideration of climate change effects

Design rainfall in consideration of climate change effects = Present design rainfall x Rainfall change factor

Formula of calculating peak stormwater flow

$$Q = 1/360 \times C \times (I \times \alpha) \times A$$

Q: Peak stormwater flow (m^3/s)
C: Runoff coefficient
I: Rainfall intensity at time of concentration (mm/h)
α: Rainfall change factor
A: Drainage are (ha)



Determined through selected climate change prediction models (present climate term: 1950-2010, mainly) for each of 16 regions

Region	Rainfall change factor
1) North Hokkaido	1.15
2) South Hokkaido	1.15
3) West Tohoku	1.10
4) East Tohoku	1.10
5) Kanto	1.10
6) Hokuriku	1.10
7) Chubu	1.10
8) Kinki	1.10
9) South Kii	1.10
10) San-in	1.10
11) Setouchi	1.10
12) West Chugoku	1.10
13) South Shikoku	1.10
14) North-west Kyushu	1.10
15) South-east Kyushu	1.10
16) Okinawa	1.10

Stormwater management master plan
--- Relevant research on nationwide rainfall data stationarity

- ✓ Validity of the present design rainfall multiplied by the rainfall change factor?
- ✓ Non-stationarities (upward trend) of nationwide rainfall data was checked.

Tested rainfall data

Annual maximum 10-minute rainfall data
Annual maximum 60-minute rainfall data
For 20 years or more

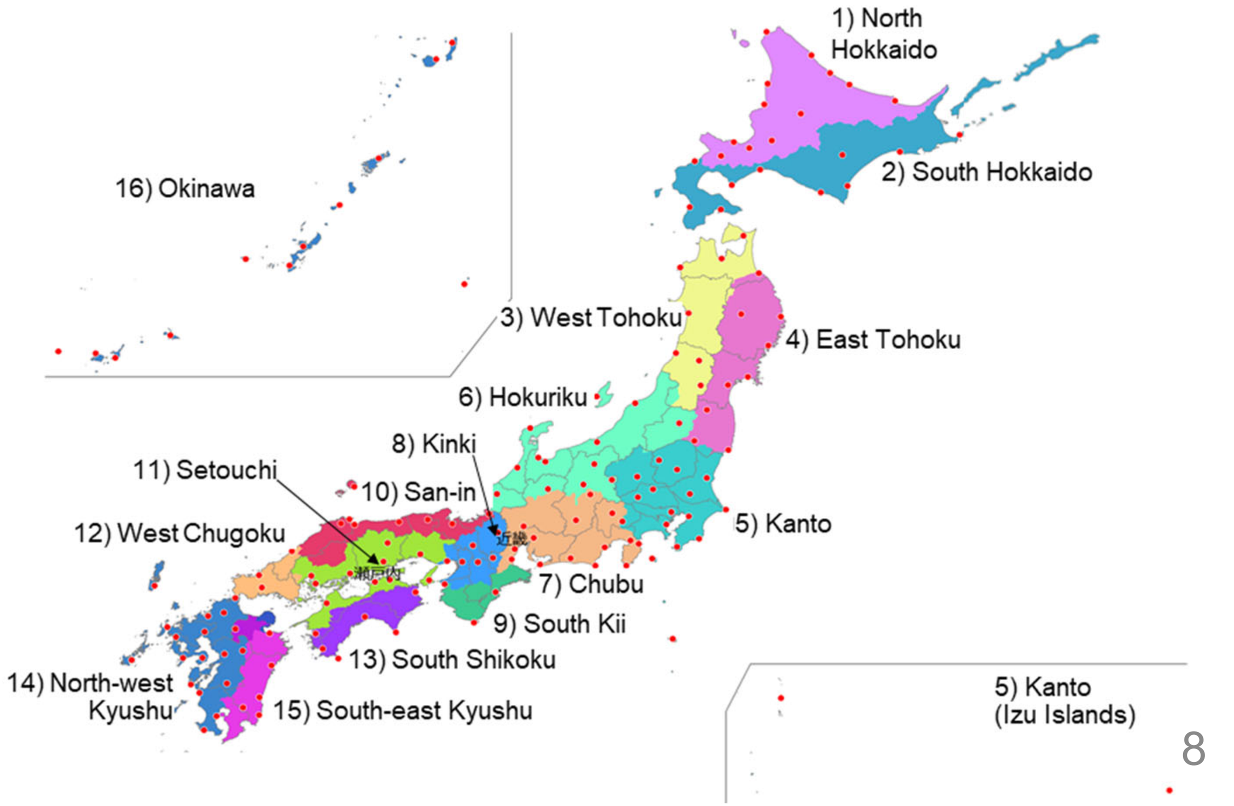
Tested rainfall data periods

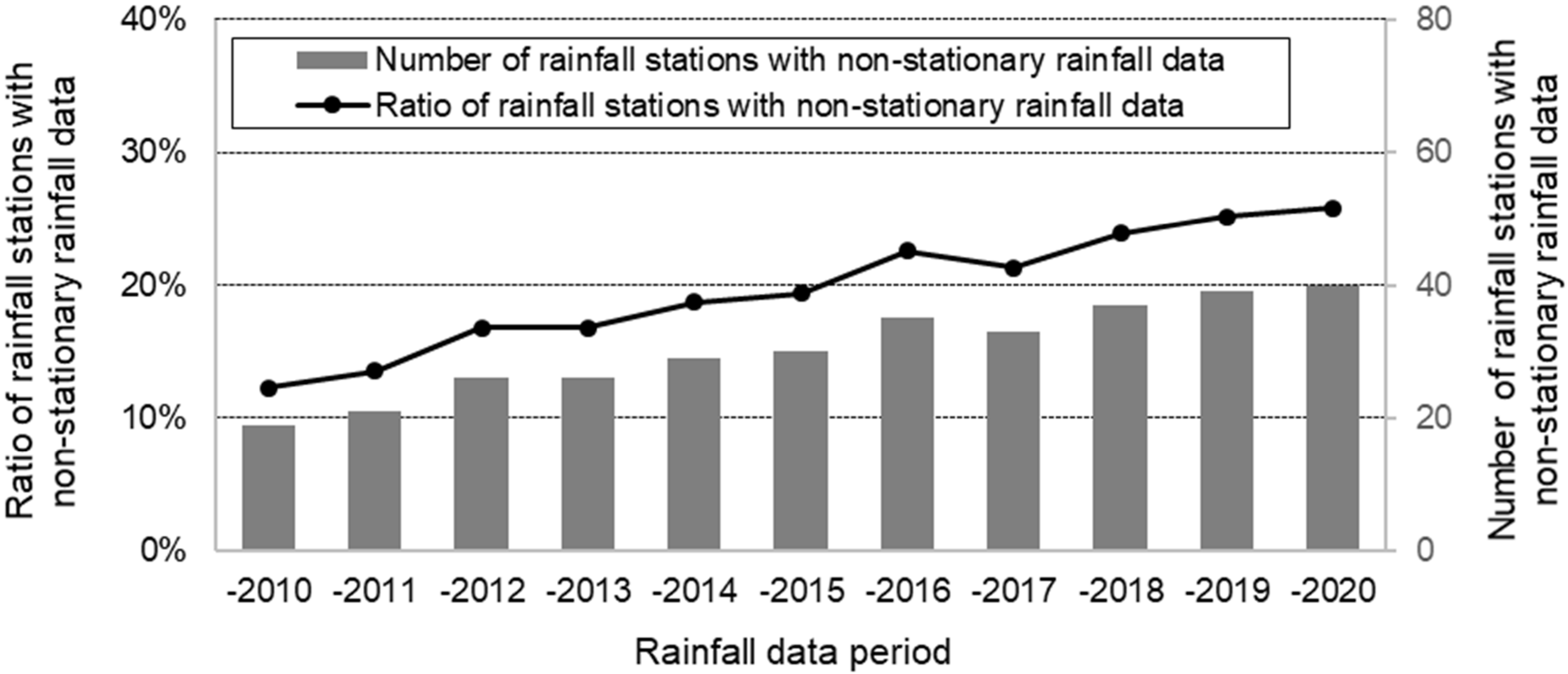
From	Until
Rainfall data acquisition start year at each rainfall station	Each year 2010-2020

Mann-Kendall test

At significant level of 5%

Rainfall stations 155 of Japan Meteorological Agency



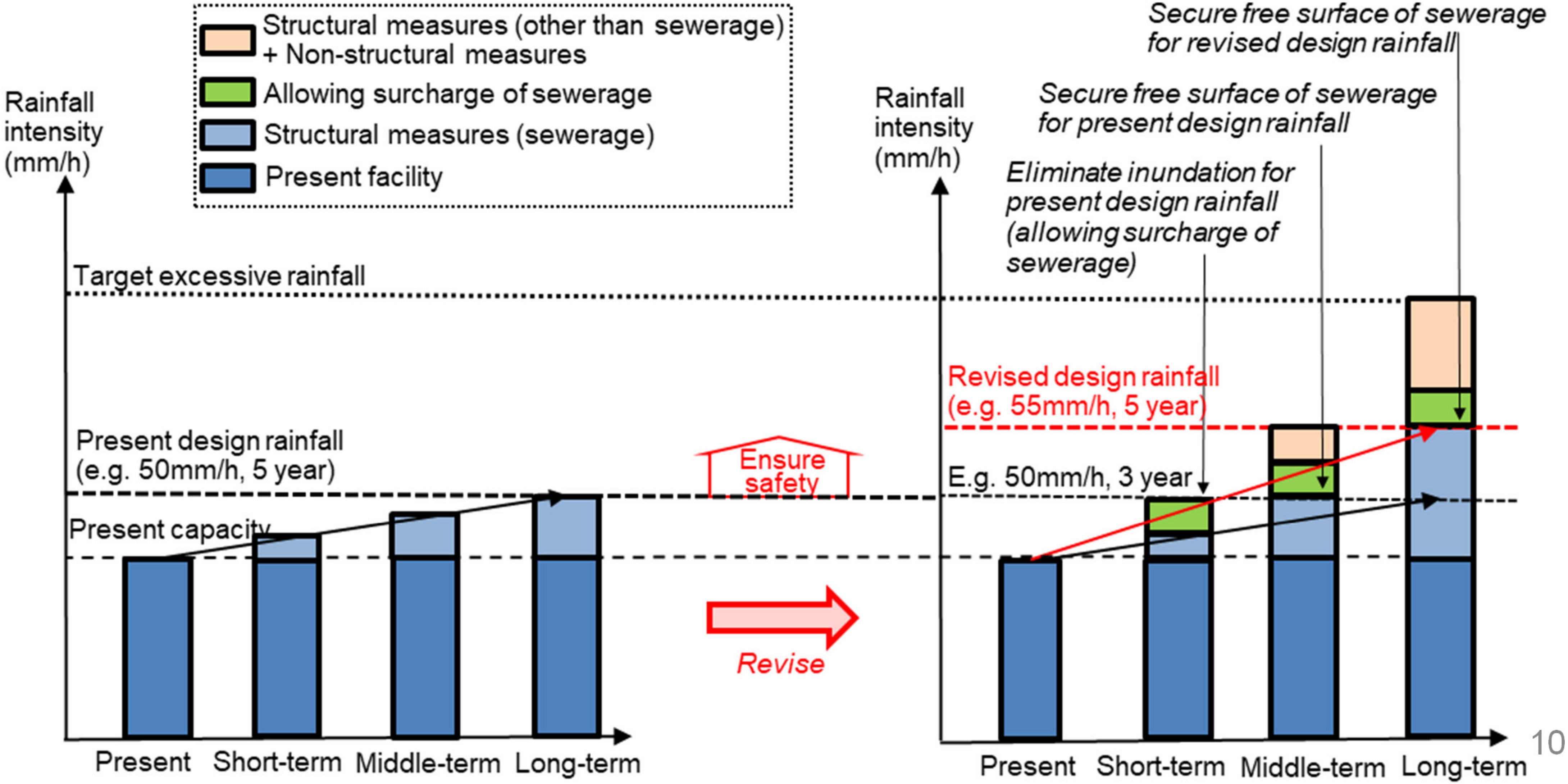


 # Non-stationary rainfall data: non-stationary annual maximum 10-minute rainfall data and/or non-stationary annual maximum 60-minute rainfall data

✓ The ratio of rainfall stations with non-stationary rainfall data is around 12% in the period until 2010, around 26% in the period until 2020, with increasing trend.

Stormwater management master plan

[2] Phased action plan in consideration of climate change effects



Summary

- Responding to increasingly severe water disasters, MLIT set out two policies in 2020:
  [1] Transition to "River Basin Disaster Resilience and Sustainability by All," and
  [2] Revision to flood control plans considering climate change effects.

- In terms of sewerage planning, development of stormwater management master plans has been promoted, in which
  [1] Design rainfall etc. are calculated in consideration of climate change effects, and
  [2] Phased action plans are considered so that the level of safety can be improved through cooperation with various stakeholders based on "River Basin Disaster Resilience and Sustainability by All."

- In developing stormwater management master plan, the validity of the present design rainfall multiplied by rainfall change factor needs to be confirmed. Research on stationarities of nationwide rainfall data was conducted. The ratio of rainfall stations with non-stationary rainfall data was around 12% in the period until 2010, around 26% in the period until 2020, with increasing trend.

References

- River Basin Disaster Resilience and Sustainability by All (https://www.mlit.go.jp/river/kokusai/pdf/pdf21.pdf) [EN]
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