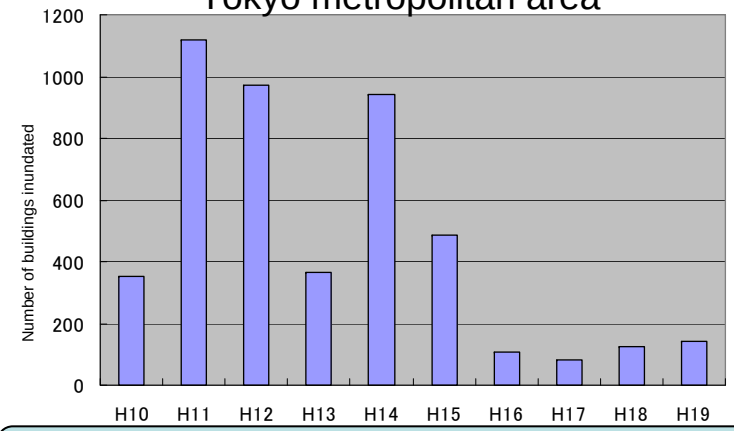
Enhancement of heavy rain countermeasures through early detection of local heavy rain

Inundation damage due to local heavy rain

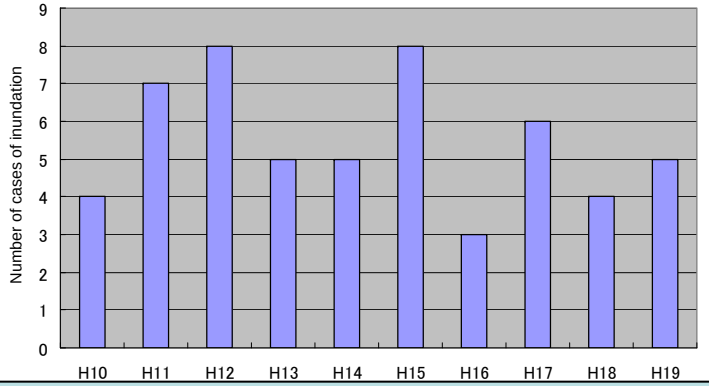
Number of buildings inundated per year in the Tokyo metropolitan area



An average of 468 buildings are inundated (above or below the floor level) per year

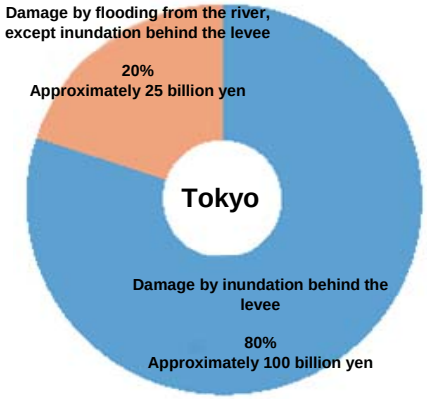
In an event of inundation, 85 buildings suffer inundation damage on the average

Number of cases of inundation per year in the Tokyo metropolitan area



Heavy rain causes inundation 5.5 times per year on the average.

(*Number of buildings inundated (behind the levee) and the number of cases of inundation due to local heavy rain)
Prepared by the National Institute for Land and Infrastructure Management (NILIM) based on the “past flood disaster data” available at the website of the Tokyo metropolitan government.



Percentages of cost of damage by inundation behind the levee, and by flooding from the river
Total during a ten-year period between 1993 and 2002
Source: “Consideration of flood control measures” at the website of the Ministry of Land, Infrastructure, Transport and Tourism

Urban inundation damage

Fatal accidents due to inundation of basement room
・One person was trapped in a basement room and killed in Fukuoka City, Fukuoka Prefecture in June 1999
・One person was trapped in a basement room and killed in Shinjuku Ward, Tokyo in July 1999.

Freezing of urban functions due to inundation
・Subway and underground mall were inundated in Fukuoka City, Fukuoka Prefecture in July 2003.
・ Underground mall was inundated in Shibuya Ward, Tokyo in September 2004.
・Subway platform was inundated in water in Azabu (Minato Ward), Tokyo in October 2004.

Inundation of underground mall in Fukuoka City, Fukuoka Prefecture in June 1999
Source: “Consideration of flood control measures” at the website of the Ministry of Land, Infrastructure, Transport and Tourism

Frequent occurrence of inundation damage

Damage reduction by countermeasures against local heavy rain

Accurate detection of the heavy rain, quick initial actions, facilities improvement and appropriate operation

Rapid increase of river water due to local heavy rain

Rapid increase of river water causes numerous water accidents.

- Toga River in Kobe City, Hyogo Prefecture (July 28, 2008)
  Five persons in the river were washed away and killed.

  →Water level rose by 1.3 m in ten minutes.
  (Water level rose by approximately 1 m in two minutes:
  Report of a Japan Society of Civil Engineers investigation team)

- Sewerage system in Toshima-ward, Tokyo (August 5, 2008)
  Five workers in a sewer pipe were washed away and killed.

  →Evacuation efforts after confirming water increase were too late.

- Nomi River in Ota-ward, Tokyo (July 8, 2008)
  Two workers were washed away and killed.

  →Rainfall in the upper reaches increased river water despite no precipitation at the work site.

Rapid increase of river water near the Kabuto Bridge on the Toga River
(Source: River monitoring system of Kobe municipal government)

Rapid increase of river water causes water accidents

- Heavy rain induces flooding and causes river water to increase rapidly before people are evacuated.
- Heavy rain not only at a spot but also in surrounding areas causes flooding.

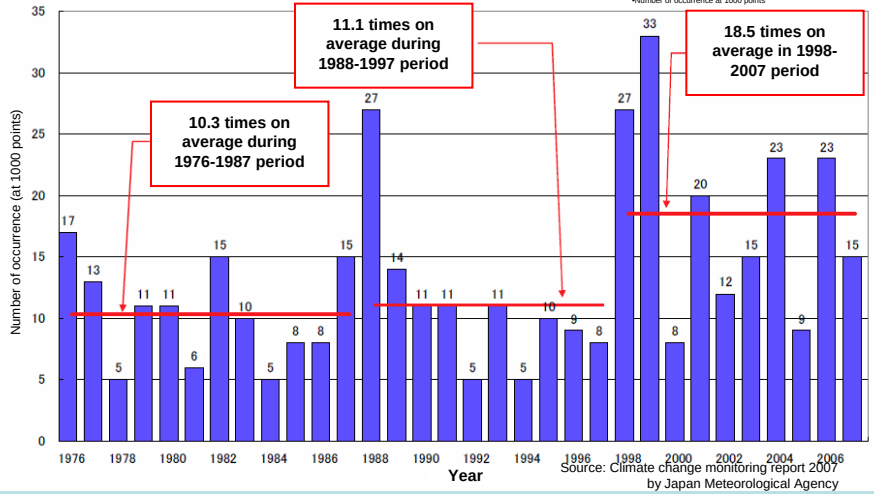
Water accidents prevention measures

Detecting heavy rain early and disseminating information to support evacuation

Heavy rain in recent years and in the future

Events of heavy rain have been increasing.

Number of occurrence of hourly precipitation of 80 mm or more in a year (at 1000 points)



Source: Climate change monitoring report 2007 by Japan Meteorological Agency

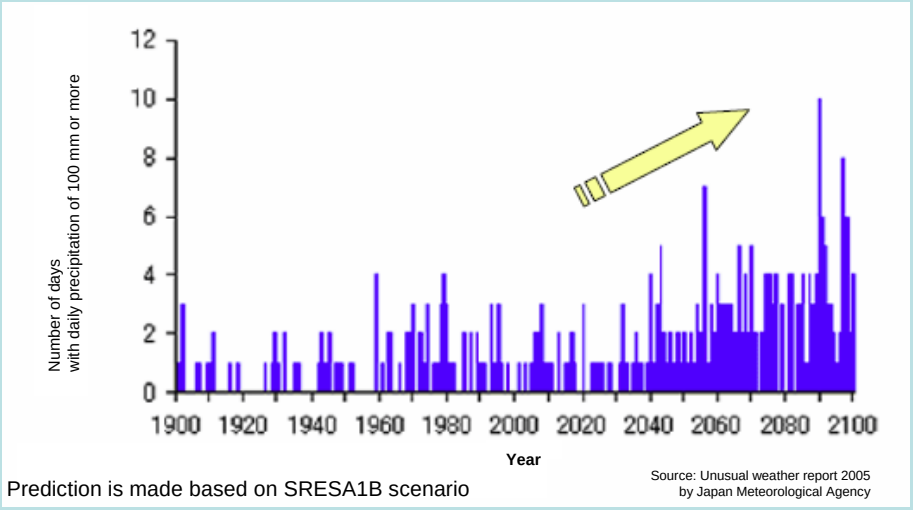
National average of precipitation of 80 mm or more (at 1000 points)

10.3 times during the 1976-1987 period

18.5 times during the 1998-2006 period

⇒**Frequency of heavy rain nearly doubled in 20 years**

Increase of occurrence of heavy rain due to climate change



Prediction is made based on SRESA1B scenario

Source: Unusual weather report 2005 by Japan Meteorological Agency

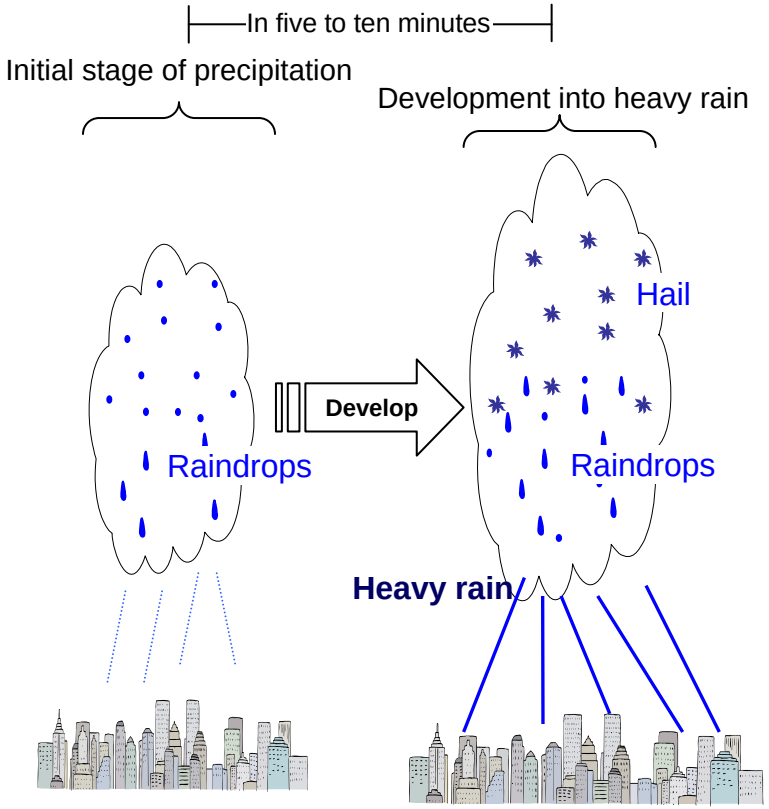
The frequency of heavy rain is **expected to increase with the progress of global warming**.

・Heavy rain is expected to occur more frequently.

⇒Frequent water accidents due to increasing heavy rain are of concern.

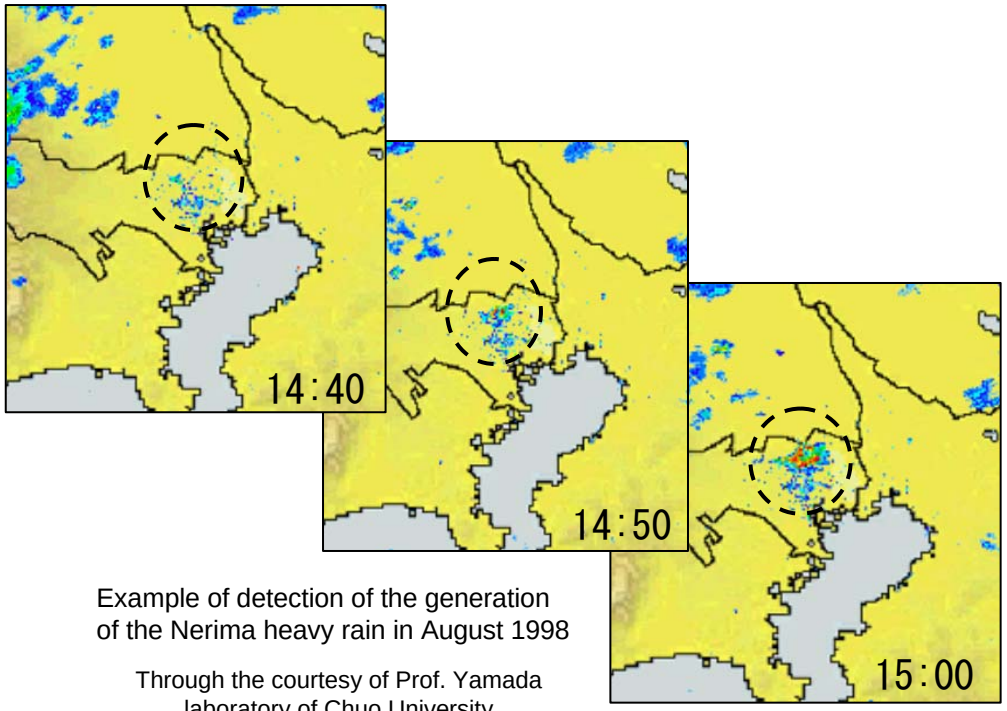
How to detect local heavy rain

Characteristics of heavy rain (i)
Heavy rain intensifies quickly



Observation for detecting heavy rain in the initial stage of generation

Characteristics of heavy rain (ii)
Heavy rain in a range of several to dozens of kilometers



Example of detection of the generation of the Nerima heavy rain in August 1998

Through the courtesy of Prof. Yamada laboratory of Chuo University (observation resolution: 500 m mesh)

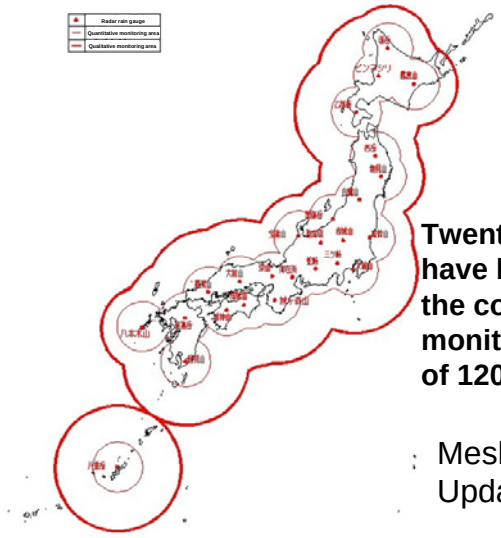
Detailed precipitation observation with 250 through 500 m mesh

•Monitoring system is required for heavy rain that quickly intensifies and induces large amounts of rain locally.

Previous local heavy rain monitoring system

C-band radar monitoring network

(Ministry of Land, Infrastructure, Transport and Tourism)



Twenty-six radar rain gauges have been installed all over the country. Quantitative monitoring areas with a radius of 120 km cover the country.

Mesh size: 1 km
Update interval: 10 minutes

Local heavy rain monitoring by C-band radar

Defects:

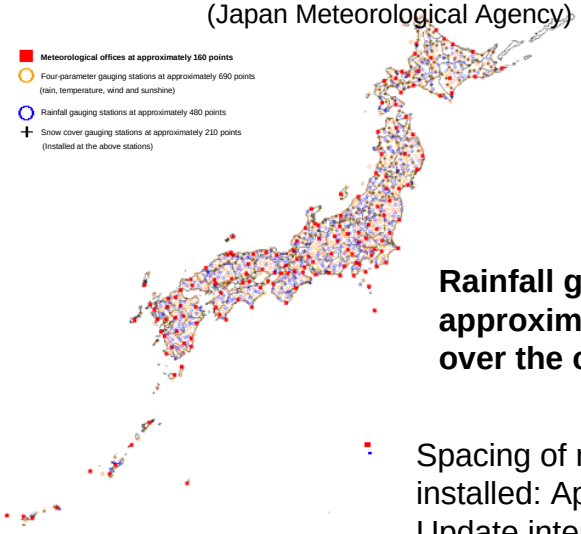
The update interval is long. The monitoring system is inadequate for detecting local heavy rain early that induces large amounts of rain in a few to dozens minutes. Accurate estimation of rainfall requires the correction by rainfall gauges and the correction takes some time.

Benefit:

Instantaneous monitoring over a wide area is possible.

Rainfall monitoring network with AMeDAS rainfall gauging stations

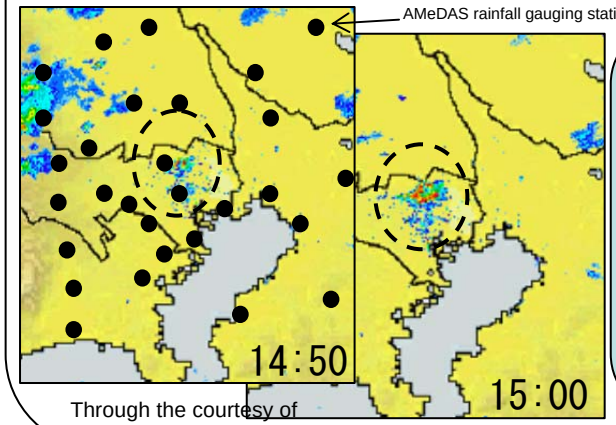
(Japan Meteorological Agency)



Rainfall gauges installed at approximately 1300 points over the country.

Spacing of rainfall gauges installed: Approximately 17 km
Update interval: 10 minutes

State at the time of the Nerima heavy rain in August 1998



Through the courtesy of
Prof. Yamada laboratory of Chuo University

Rainfall monitoring by AMeDAS

Defects:

Stations have been installed at long spacings, inadequate for accurately detecting the occurrence of local heavy rain and identifying the local rain area.

Benefit:

Rainfall can be monitored accurately.

No adequate monitoring system had been developed to detect local heavy rain.

Reinforcement of heavy rain monitoring system using multi-parameter (MP) radar

Characteristics of MP radar

1.Radar observation using X-band

→Detailed rainfall observation with 250- to 500-m mesh

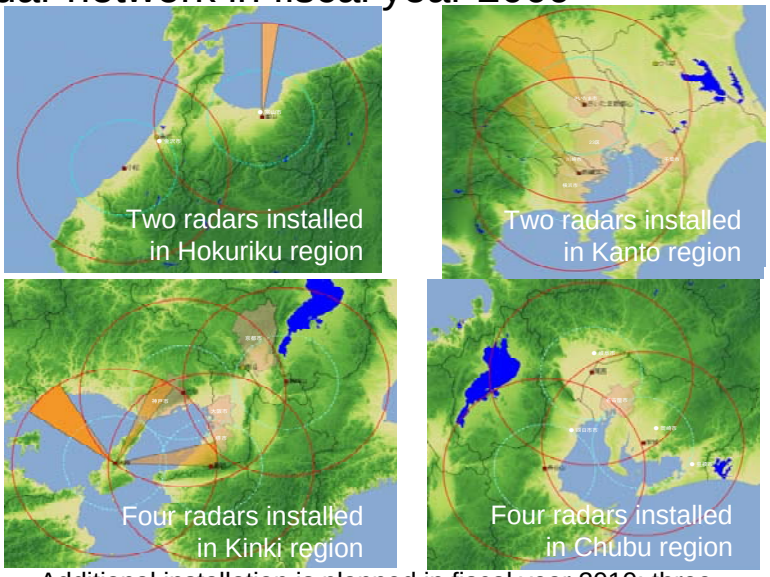
2.Accurate estimation of rainfall with no requirement of correction

→Rainfall observation with frequent update at intervals of approximately one minute

Rainfall over a wide area can be detected in detail instantaneously and accurately.

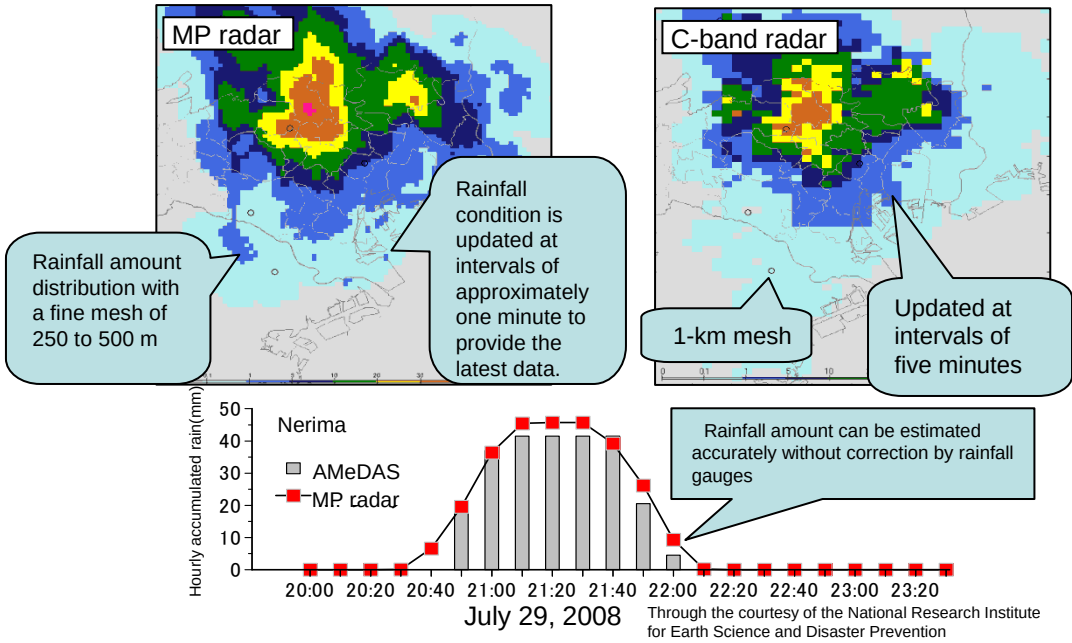
Rainfall observation to detect local heavy rain is possible.

Introduction of multi-parameter radar network in fiscal year 2009



Additional installation is planned in fiscal year 2010: three in Chugoku region, four in northern Kyushu, one in southern Kyushu, three in Chubu region (Shizuoka) and one in Hokuriku region.

Heavy rain observation using MP radars



*X-band multi-parameter radar ⇒ MP radar

Problems with observation using MP radars

Deterioration of rainfall estimation accuracy due to interruption by rainfall

- Estimating rainfall based on the field intensity as conventionally practiced using X-band waves results in considerable decaying due to rainfall. In the event of heavy rain in particular, rainfall amount estimation accuracy is deteriorated.

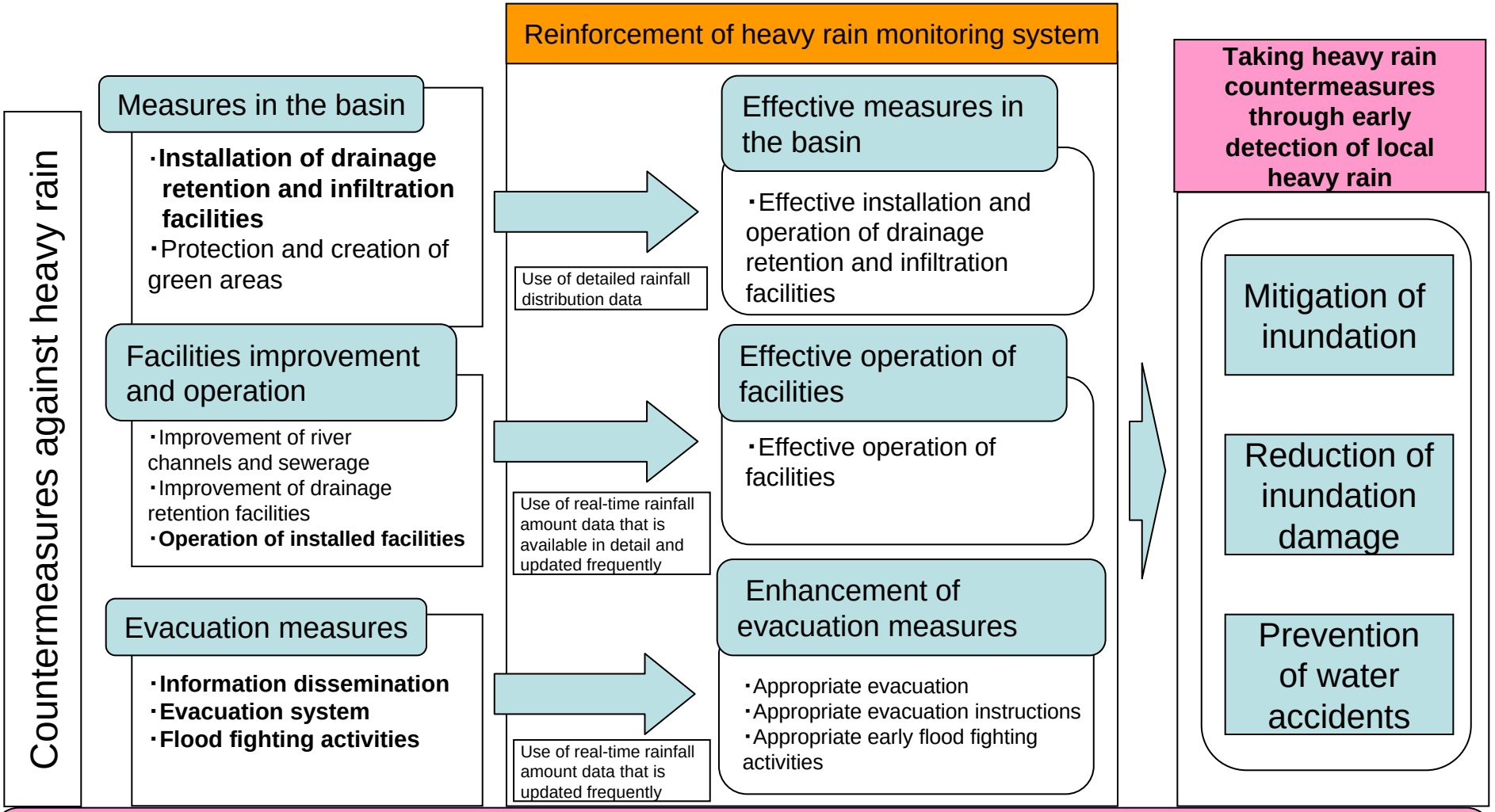
We have overcome the deterioration of rainfall estimation accuracy through

- Rainfall estimation using phase data that is unlikely to be affected by rainfall
- Rainfall estimation in cooperation with C-band radar data that is unlikely to be affected by rainfall
- Rainfall observation in different directions using multiple radars

Narrow observation range

- Observation using X-band waves covers a narrower range than observation using C-band waves because of the characteristics of radioactive waves.
  - Observation range is enlarged by developing a network of MP radars.

Reinforcement of heavy rain monitoring system

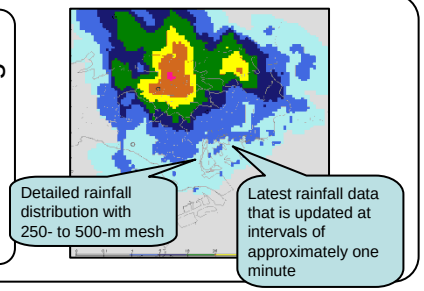


・Heavy rain monitoring system is reinforced and heavy rain countermeasures through early detection of local heavy rain are implemented.
・Inundation is mitigated, inundation damage is reduced and water accidents are prevented by taking effective measures in the basin and enhancing evacuation measures.

Enhancement of evacuation measures

Application of heavy rain monitoring data

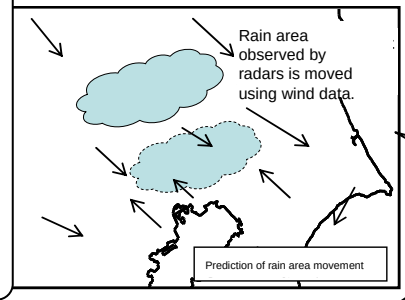
Heavy rain monitoring



Heavy rain monitoring data that is available in detail and updated frequently

Distribution of information to general public, river administrators, disaster prevention staff, etc.

Prediction of rain area movement

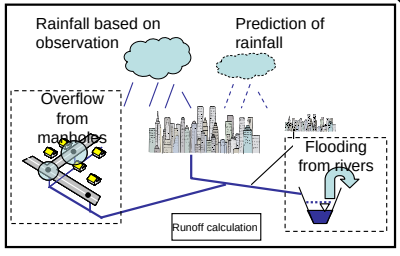


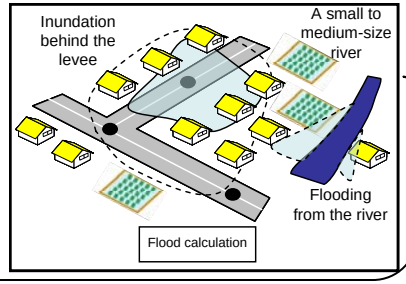
Distribution of information on the prediction of rain area movement in approximately one hour

Distribution of information to general public, river administrators, disaster prevention staff, etc.

The movement of rain area is predicted by moving the rain area observed by radars using wind data or by using the history of movement of rain area. Prediction accuracy is expected to increase by using detailed rainfall data collected with multi-parameter radars.

Prediction of inundation





Distribution of information on the prediction of inundation in approximately one hour

Distribution of information to river administrators, disaster prevention staff, etc.

Flow in the river channel and sewer pipe is analyzed, and calculations are made based on the flooding from the river and inundation behind the levee. The inundation prediction model is also used as a tool for evaluating inundation mitigation effects.

Enhancement of evacuation measures

Appropriate evacuation

・Heavy rain monitoring data and rain area movement prediction data
→Support in decision-making for evacuation
→Support for appropriate evacuation such as evacuation to the higher floor of the building or to a specified shelter

Appropriate evacuation instructions

・Heavy rain monitoring data and inundation prediction data
→Support for appropriate evacuation instructions
・Increase of accuracy of hazard map using precise rainfall distribution data
→Dissemination of precise information in advance

Appropriate early flood fighting activities

・Heavy rain monitoring data and inundation prediction data
→Support for appropriate installation of cutoff plates or piling up sandbags
→Support for early rescue of people requiring help during a disaster

Evacuation measures are enhanced not only by using heavy rain monitoring data but also through the prediction of rain area movement and inundation by applying heavy rain monitoring data.

Effective measures in the basin and effective facilities operation

- Measures in the basin

  Effective installation and operation of drainage retention and infiltration facilities

  - Methods are to be established for evaluating the runoff control effects of drainage retention and infiltration facilities based on the heavy rain monitoring data (precipitation data) and rainwater discharge data that are precise in terms of time and space, and methods are to be proposed for effectively installing and using drainage retention and infiltration facilities.

- Operation of facilities

  Effective operation of facilities

  - Methods are to be proposed for effective operation of facilities based on the heavy rain monitoring data that is precise in terms of time and space.

- Proposal of best combination of measures

  - Structural and non-structural alternatives are to be proposed as measures in the basin, sewerage and rivers; the effectiveness of inundation mitigation measures is to be evaluated using an inundation prediction model; and the best combination of measures is to be proposed.

Research schedule

	Enhancement of evacuation measures			Effective measures in the basin and effective operation of facilities
	Distribution of heavy rain monitoring information	Distribution of rain area movement prediction information	Distribution of inundation prediction information	
FY 2009	Development of rainfall monitoring system	Development of rain area movement prediction system	Development of inundation prediction system	Rainwater discharge observation
FY 2010	Commencement of pilot operation, verification of accuracy and expansion to additional areas	Commencement of pilot operation, verification of accuracy and expansion to additional areas	Pilot operation and model enhancement	Establishment of methods for evaluating the effectiveness of runoff control facilities
FY 2011	Enhancement of algorithm	Model enhancement	Expansion to additional areas	Proposal of methods for effective installation and use of runoff control facilities
FY 2012	Verification of accuracy	Verification of accuracy	Verification of accuracy	Proposal of methods for effective operation of facilities
FY 2013	Commencement of full-scale operation	Commencement of full-scale operation	Commencement of full-scale operation	Proposal of the best combination of structural and non-structural measures