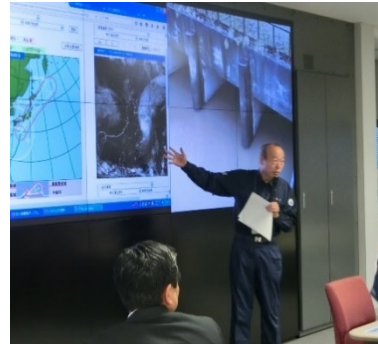


Dissemination of Disaster Prevention Information from Japan Meteorological Agency



January 26, 2022

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Mitigation, Japan Meteorological Agency

Today's topics

1 Introduction

- Increase of localized, concentrated, and intensified weather
- Japan at the end of the 21st century under global warming
- Role of the Japan Meteorological Agency (JMA)

2 Issues of disaster prevention weather information and evacuation

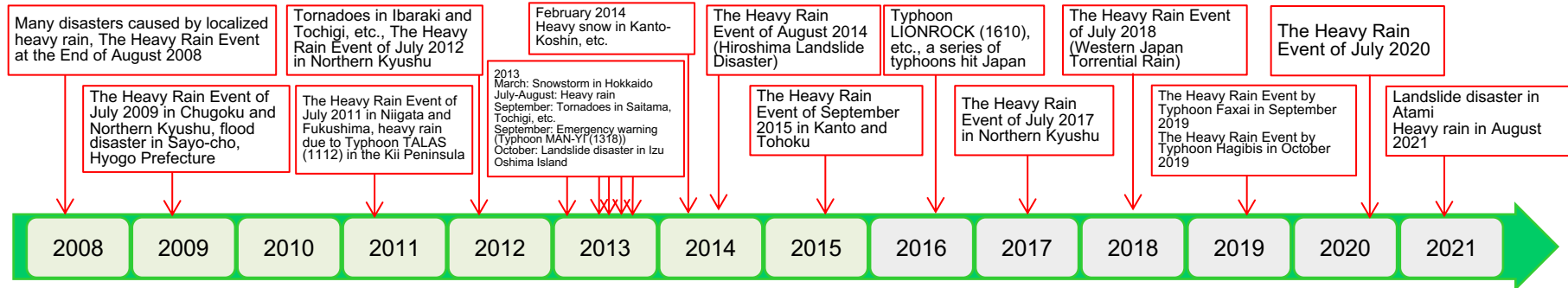
- Using disaster prevention weather information to prompt evacuation
- Toward enhancing regional disaster prevention ability
- Taking on the challenge of improving the prediction accuracy of stationary linear mesoscale convective systems

3 Conclusion

- Permanent mindset of JMA
—as the provide of disaster prevention weather information—

Increase of localized, concentrated, and intensified weather

A series of weather disasters in recent years



New weather conditions: localized, concentrated, and intensified



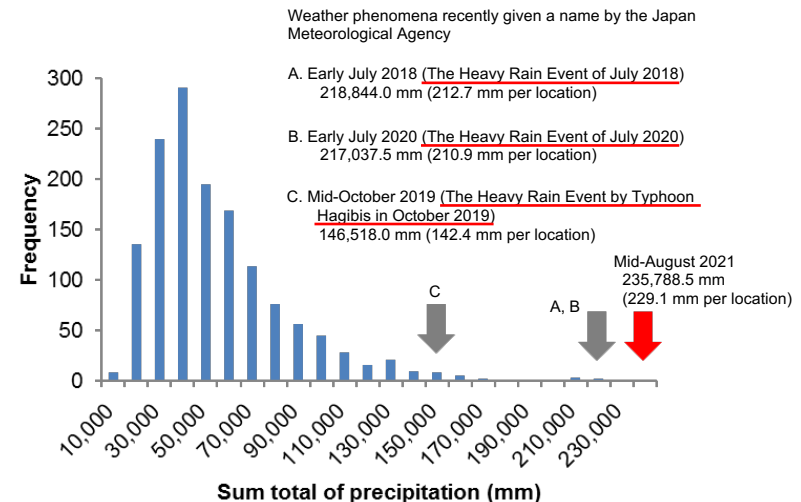
The Heavy Rain Event of July 2018
Landslide disaster in Uwajima, Ehime Prefecture
(Photo taken on July 7, provided by Uwajima City)



The Heavy Rain Event of July 2020
The Kuma River flooding damage in Yatsushiro, Kumamoto Prefecture
(Photo taken by meteorological office staff on July 4)

Heavy rain in August 2021

The overall total precipitation observed by 1029 selected AMeDAS stations throughout Japan for each season was 235,788.5 mm in mid-August 2021, the highest since 1982.



Japan at the end of the 21st century predicted in the 2°C/4°C rise scenario

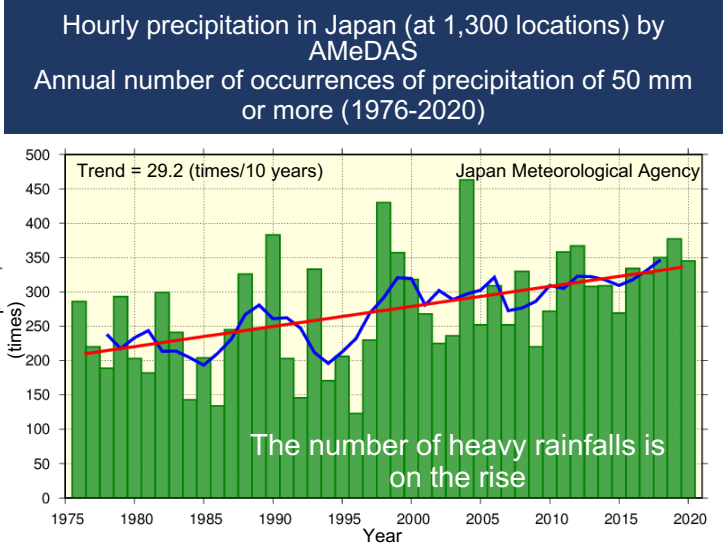
(Excerpt from “Japan’s Climate Change 2020—Assessment Report on Observation and Prediction of Atmosphere, Land, and Ocean”)

Precipitation

Prediction

	Prediction based on the 2°C rise scenario World in which the 2°C target of the Paris Agreement is achieved	Prediction based on the 4°C rise scenario World in which no additional mitigation measures of a greater degree than that at the present are taken
Number of days per year with daily precipitation of 200 mm or more	Increase by about 1.5 times	Increase by about 2.3 times
Frequency of hourly precipitation of 50 mm ^{Note)} or more	Increase by about 1.6 times	Increase by about 2.3 times
Annual maximum daily precipitation	Increase by about 12% (about 15 mm)	Increase by about 27% (about 33 mm)
Number of days per year with daily precipitation of less than 1.0 mm	(No advantageous change is predicted)	Increase by about 8.2 days

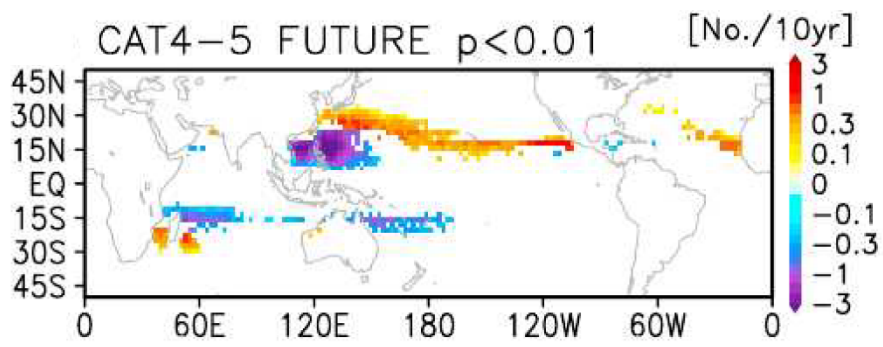
Note) Hourly precipitation of 50 mm or more is also described as “very heavy rain (falling like a waterfall).” Rain is so heavy that umbrellas are completely useless and the splash of rainwater turn all around whitish, deteriorating visibility.



Typhoon (tropical cyclone)

Prediction

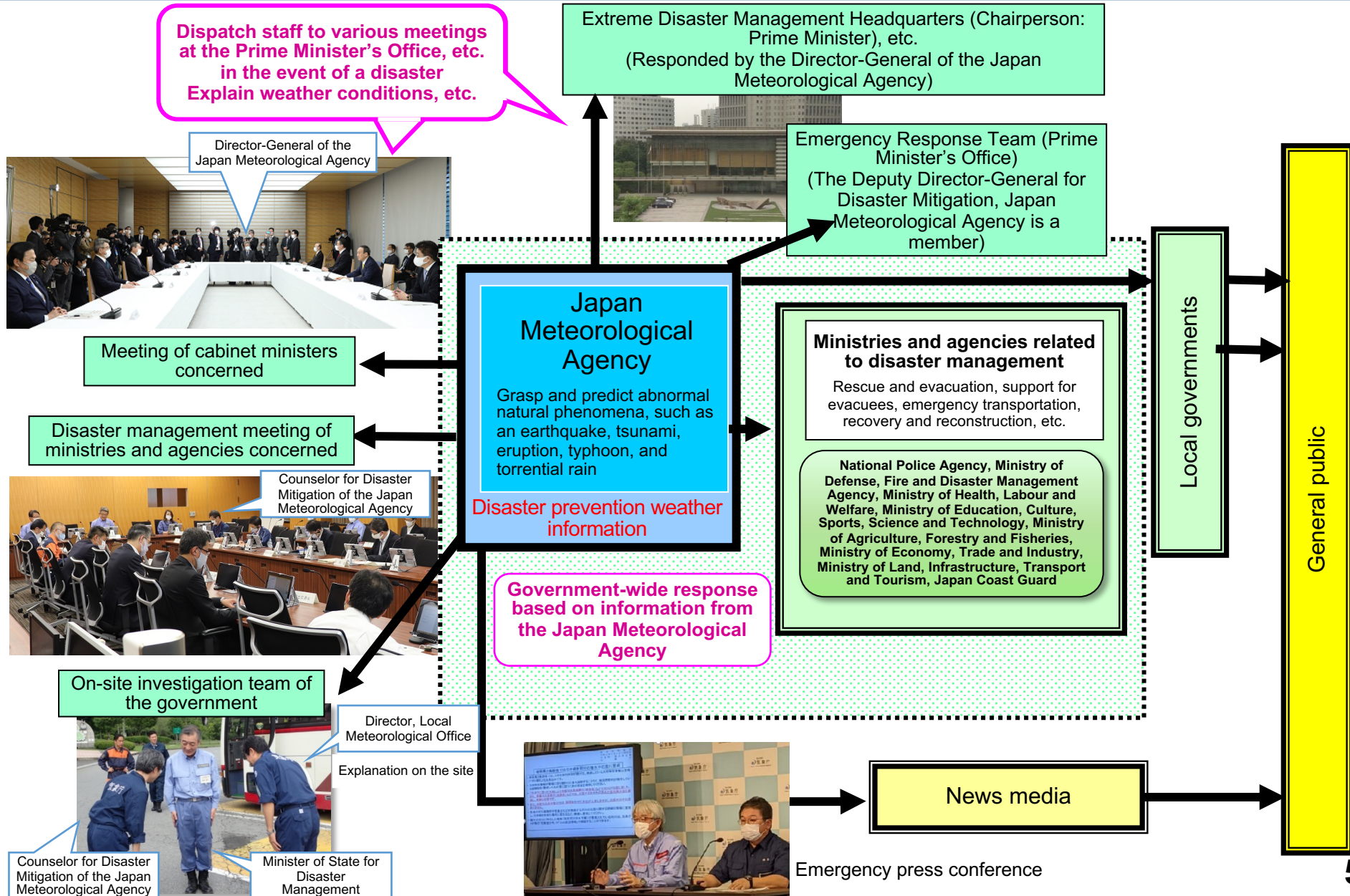
- Many studies predict that the intensity of typhoons near Japan will increase (due to the increase in the amount of water vapor in the atmosphere, which is the energy source of typhoons).
 - The results of the 4°C rise experiment (simulation) and other studies indicate that the frequency* of very strong tropical cyclones (equivalent to “fierce” typhoons) is likely to increase above the sea on the southern side of Japan.
- * The number of units that exist in the location per certain period of time



Changes in the frequency of very strong tropical cyclones

Changes from present (1979-2010) in the frequency of very strong tropical cyclones with a 4°C increase in global average temperature (from Yoshida et al. (2017))

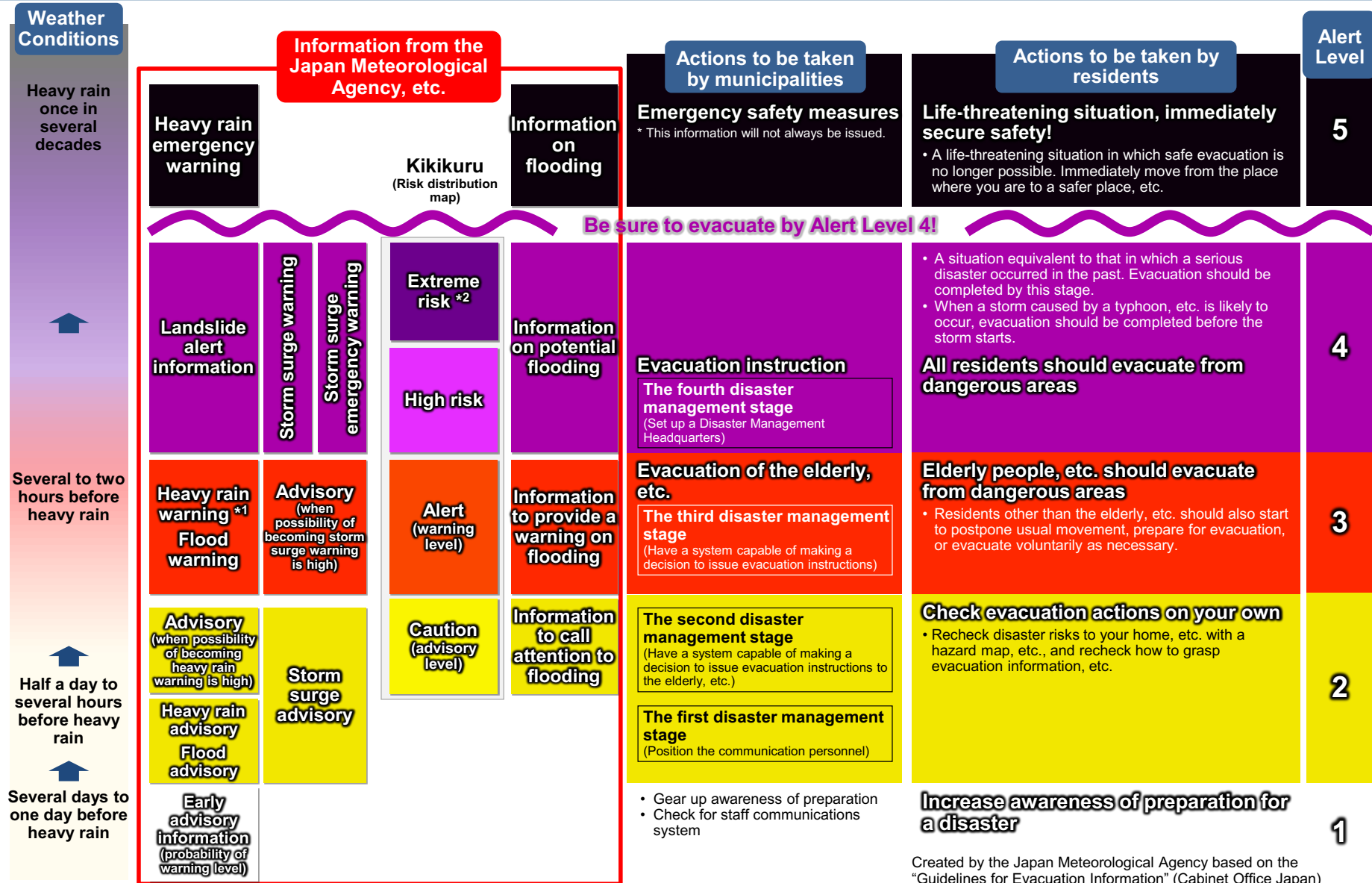
Role of the Japan Meteorological Agency in national governmental and regional disaster management



Disaster prevention weather information should be understandable to people, to prompt them to evacuate to save their lives.

- ✓ Information should convey a sense of imminent danger of a disaster in a “simple” and “easy to understand” manner, and be “easy to use.”
 - ✓ Information should be sent at an early stage to lead to early disaster management response and evacuation.
 - ✓ Information should be highly accurate and trusted.
- * Enhance regional disaster prevention ability using disaster prevention weather information

Disaster prevention weather information to be used for disaster management response of municipalities and evacuation actions of residents



*1 An advisory with a high possibility of becoming a heavy rain warning (landslide) between nighttime and early next morning is equivalent to Alert Level 3 (evacuation of the elderly, etc.).

*2 It is important that evacuation is completed before the emergence of "extreme risk" (dark purple). The "dark purple" is possibly used to narrow down the areas affected by the issuance of Alert Level 5 of emergency safety measures when a heavy rain emergency warning is issued.

Equivalent alert level and its meaning

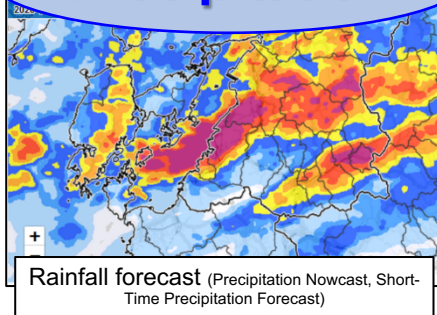
Equivalent alert level (example of information)	What the alert level means and what action to take
Equivalent to Alert Level 5 (heavy rain emergency warning)	<p>This information is used by local governments to make a decision to issue an Alert Level 5 of emergency safety measures. This is equivalent to Alert Level 5, which indicates that a disaster has occurred or is imminent.</p> <p>There is <u>a situation where it is extremely likely that some kind of disaster has already occurred. Secure the safety of yourself immediately as your life is in danger.</u></p>
Equivalent to Alert Level 4 (landslide alert information)	<p>This information is used by local governments to make a decision to issue an Alert Level 4 of evacuation instruction. This is equivalent to Alert Level 4, which requires evacuation from dangerous areas.</p> <p>In areas where a disaster is expected, etc., <u>pay attention to evacuation instructions issued by local governments, and even if evacuation instructions have not been issued, make your own evacuation decisions using information, such as Kikikuru (risk distribution map) and river water level information.</u></p>
Equivalent to Alert Level 3 (heavy rain warning (landslide))	<p>This information is used by local governments to make a decision to issue an Alert Level 3 of evacuation of the elderly, etc. This is equivalent to Alert Level 3, which requires evacuation from dangerous areas for the elderly, etc.</p> <p>In areas where a disaster is expected, etc., <u>pay attention to evacuation instructions of the elderly, etc. issued by local governments, and for people other than the elderly, etc. also, prepare for evacuation and make your own evacuation decisions using information, such as Kikikuru (risk distribution map) and river water level information.</u></p>
Alert Level 2 (heavy rain advisory)	<p>This is Alert Level 2, which requires confirmation of evacuation actions.</p> <p><u>Use a hazard map and other information to check areas where disasters are expected, evacuation shelters, and evacuation routes.</u></p>
Alert Level 1 (early advisory information (probability of warning level))	<p>This is Alert Level 1, which indicates the need to increase awareness of preparation for a disaster.</p> <p><u>Pay attention to the latest disaster prevention weather information, etc., to increase awareness of preparation for a disaster.</u></p>

—Translating rainfall amount forecasts into disaster risk forecasts—

“Risk distribution map” of disaster occurrence #Kikikuru

Calculate the risk level by considering slope, geology, urbanization rate, etc.

Precipitation

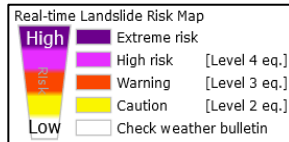
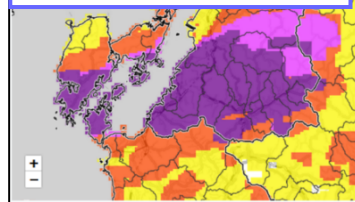


- From precipitation data, indicators (indices) of the risk of disaster occurrence were developed.
- The level of risk is indicated on the map in different colors (yellow → red → light purple → dark purple).
- In the dark purple areas, the level for conditions equivalent to that of past major disasters has already been exceeded.
- Immediately evacuate in areas of light purple that are likely to exceed this level soon.

Landslide disasters

Landslide Kikikuru
(Risk distribution map of heavy rain warning (landslide))

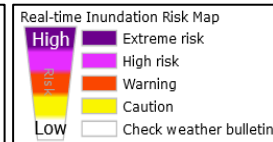
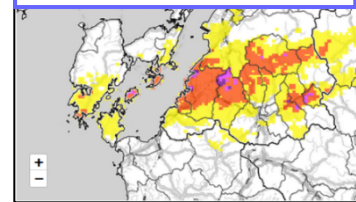
Forecast up to 2 hours ahead



Inundation

Inundation Kikikuru
(Risk distribution map of heavy rain warning (inundation))

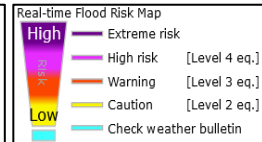
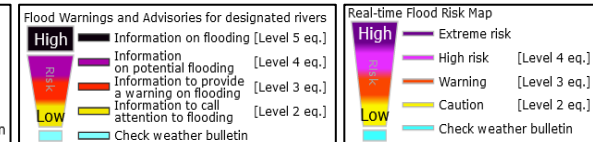
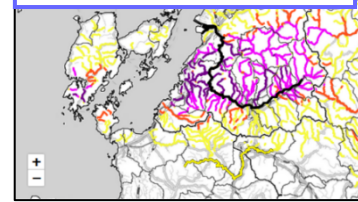
Forecast up to 1 hour ahead



River flood

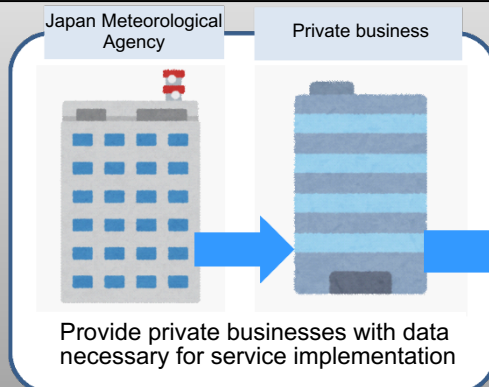
Flood Kikikuru
(Risk distribution map of flood warning)

Forecast up to 3 hours ahead

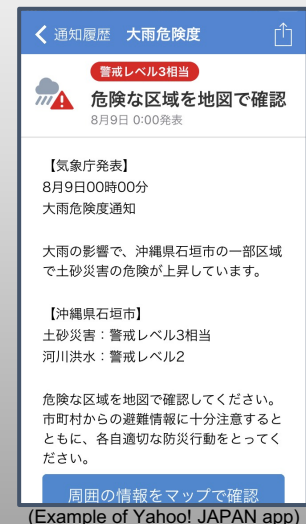
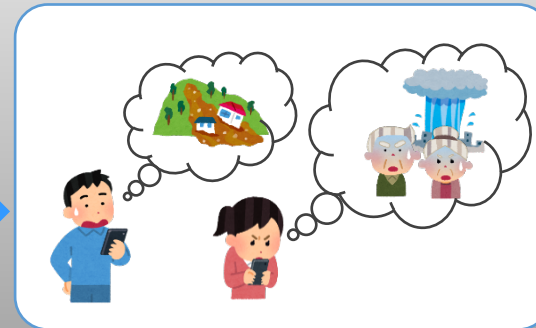


Kikikuru (risk distribution map) notification service for those who are interested

In cooperation with private companies, we started a service that notifies people of changes in risk levels via e-mail or mobile apps, etc.



In City A, the risk has increased to a level equivalent to Alert Level ○.



Communicating disaster prevention information in an easy-to-understand and simple manner

(Five Alert Levels and disaster prevention weather information)

Without waiting for Alert Level 5, it is very important to make a decision to evacuate early and promptly at the stage of Alert Level 3 or 4.					
Alert Level	Actions to be taken by residents	Information of municipalities	Warnings, etc.	Information from the Japan Meteorological Agency, etc. corresponding to Alert Levels	Flood warnings and advisories for designated rivers
5	Life-threatening situation, immediately secure safety!	Emergency safety measures <small>* This information will not always be issued.</small>	Heavy rain emergency warning	Kikikuru (Risk distribution map)	Information on flooding
Be sure to evacuate by Alert Level 4!					
4	<ul style="list-style-type: none"> A situation equivalent to that in which a serious disaster occurred in the past. Evacuation should be completed by this stage. When a storm caused by a typhoon, etc. is likely to occur, evacuation should be completed before the storm starts. 		Landslide alert information	Extreme risk^{*2}	Information on potential flooding
	All residents should evacuate from dangerous areas	Evacuation instruction		High risk	
3	Elderly people, etc. should evacuate from dangerous areas <ul style="list-style-type: none"> Residents other than the elderly, etc. should also start to postpone usual movement, prepare for evacuation, or evacuate voluntarily as necessary. 	Evacuation of the elderly, etc.	Heavy rain warning^{*1} Flood warning	Alert (warning level)	Information to provide a warning on flooding
2	Check evacuation actions on your own <ul style="list-style-type: none"> Recheck disaster risks to your home, etc., with a hazard map, etc., and recheck how to grasp evacuation information, etc. 		Heavy rain advisory Flood advisory	Caution (advisory level)	Information to call attention to flooding
1	Increase awareness of preparation for a disaster		Early advisory information (probability of warning level)		

Expressions used for disaster prevention weather information are to be changed

Light purple indicated in Kikikuru
(risk distribution map) is equivalent to Alert Level 4!
Make a decision on evacuation on your own!



*1 An advisory with a high possibility of becoming a heavy rain warning (landslide) between nighttime and early next morning is equivalent to evacuation of the elderly, etc. (Alert Level 3).

*2 It is important that evacuation is completed before the emergence of "extreme risk" (dark purple). The dark purple information is possibly used to narrow down the areas affected by the issuance of Alert Level 5 of emergency safety measures when a heavy rain emergency warning is issued.

Alert call from early stage

(The Heavy Rain Event by Typhoon Hagibis in October 2019)

Alert call several days in advance

■ Oct. 8 (Tue), 16:52 [General weather information]

- The typhoon is likely to approach between western and northern Japan from the 12th to 13th.
- There is a possibility of storms, heavy rain at a warning level, and turbulence over a wide area nationwide.

■ Oct. 9 (Wed), 14:00 [Press conference] Three days before landfall

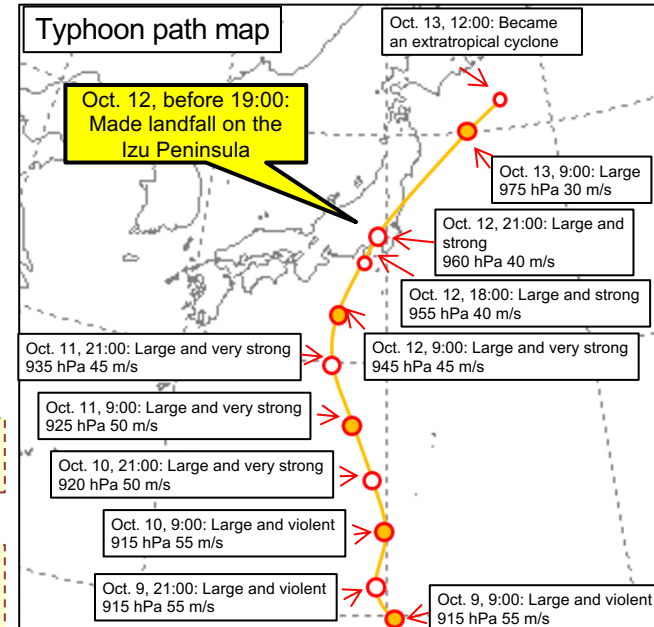
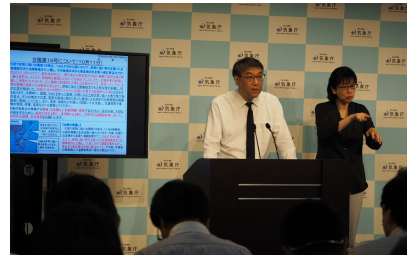
- The typhoon is likely to approach or make landfall between western and eastern Japan from the 12th to 13th.
- The forecast for the typhoon still indicates a wide margin. However, since the typhoon is large, a wide area can be largely affected.
- By the 11th, be prepared for storms, etc. Take early action to protect your life and the lives of your loved ones.

■ Oct. 10 (Thu), 14:00 [Press release]

- The typhoon is likely to approach and make landfall between western and eastern Japan from the 12th to 13th.
- Heavy rain is expected over western, eastern, and northern Japan from the 12th to 13th. Total precipitation is likely to be heavy mainly in eastern Japan.

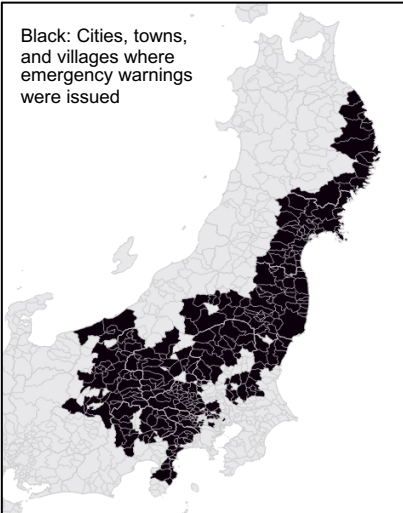
■ Oct. 11 (Fri), 11:00 [Press conference] One day before landfall

- The typhoon is expected to make landfall in the Tokai or Kanto region from the evening to the night of the 12th. Record winds and heavy rain are expected over a wide area from western Japan to the Tohoku region. Depending on the situation, there is a possibility of issuing a heavy rain emergency warning.
- In addition to Izu, the Kanto region is also likely to have a record heavy rain equivalent to that of the Kano River Typhoon in 1958, which caused many landslides and river floods.

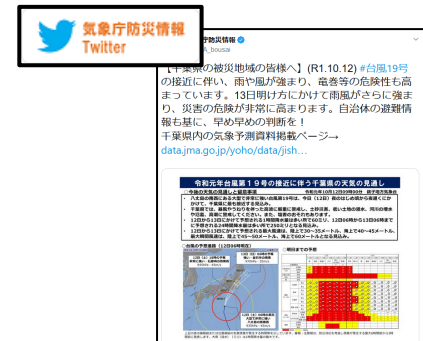


<Time of announcement and cancellation of heavy rain emergency warning>

Prefecture	Announcement time	Cancellation time	Number of cities, towns, and villages affected
Shizuoka	Oct. 12, 15:30	Oct. 12, 22:20	6 cities and towns
Kanagawa	Oct. 12, 15:30	Oct. 13, 00:20	13 cities, towns, and villages
Tokyo	Oct. 12, 15:30	Oct. 12, 23:55	25 cities, towns, and villages
Saitama	Oct. 12, 15:30	Oct. 13, 00:40	40 cities, towns, and villages
Gunma	Oct. 12, 15:30	Oct. 13, 00:10	26 cities, towns, and villages
Yamanashi	Oct. 12, 15:30	Oct. 12, 23:01	20 cities, towns, and villages
Nagano	Oct. 12, 15:30	Oct. 13, 03:20	43 cities, towns, and villages
Ibaraki	Oct. 12, 19:50	Oct. 13, 02:20	20 cities and towns
Tochigi	Oct. 12, 19:50	Oct. 13, 02:20	14 cities and towns
Niigata	Oct. 12, 19:50	Oct. 13, 03:20	3 cities
Fukushima	Oct. 12, 19:50	Oct. 13, 04:00	50 cities, towns, and villages
Miyagi	Oct. 12, 19:50	Oct. 13, 05:45	35 cities, towns, and villages
Iwate	Oct. 13, 00:40	Oct. 13, 08:40	14 cities, towns, and villages

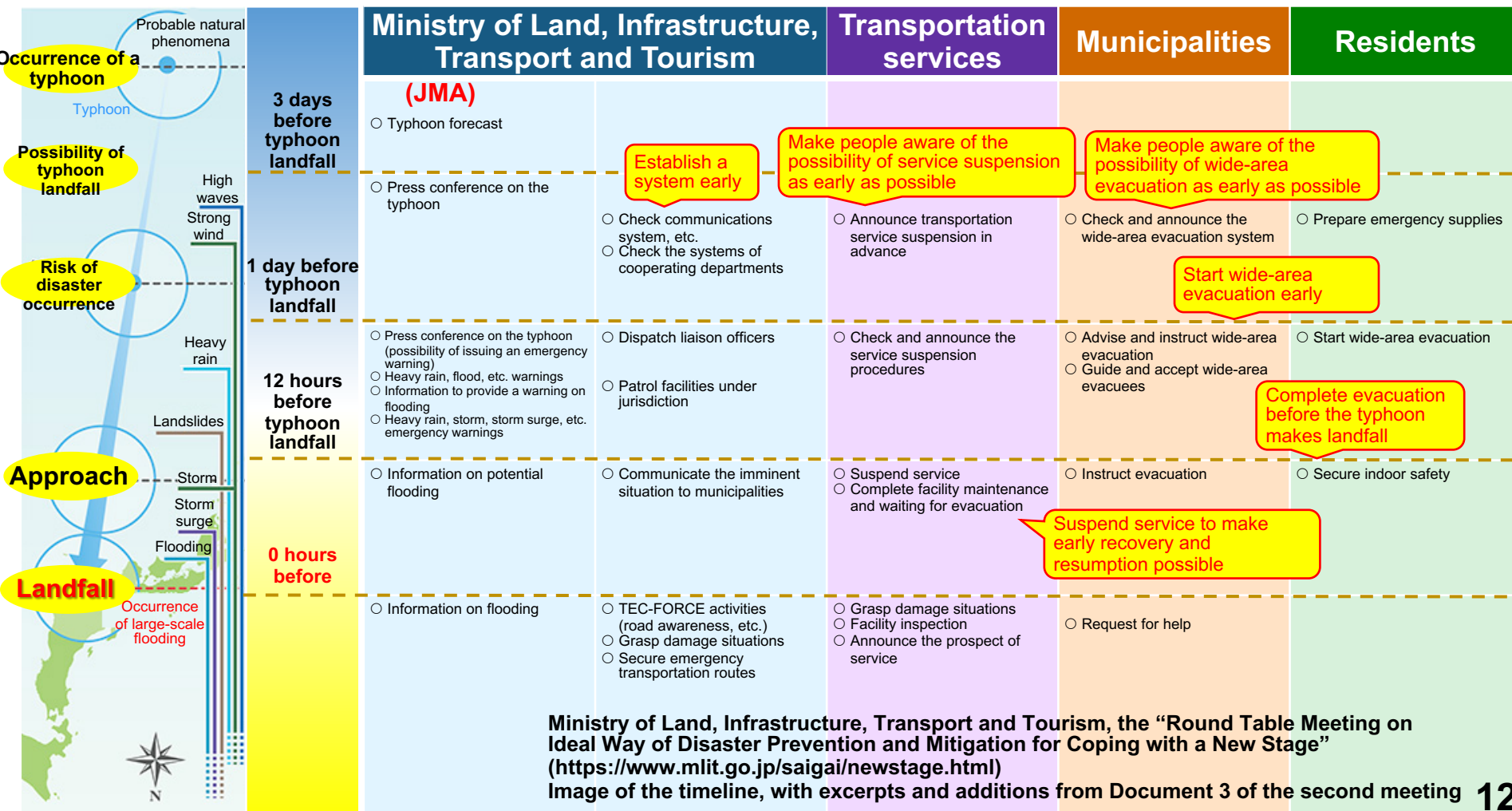


- Announce warnings and weather information, etc. at meteorological offices in each region
- Hold press conferences, and call for alert via hotlines to municipalities, etc.



Timeline (chronological disaster management action plan)

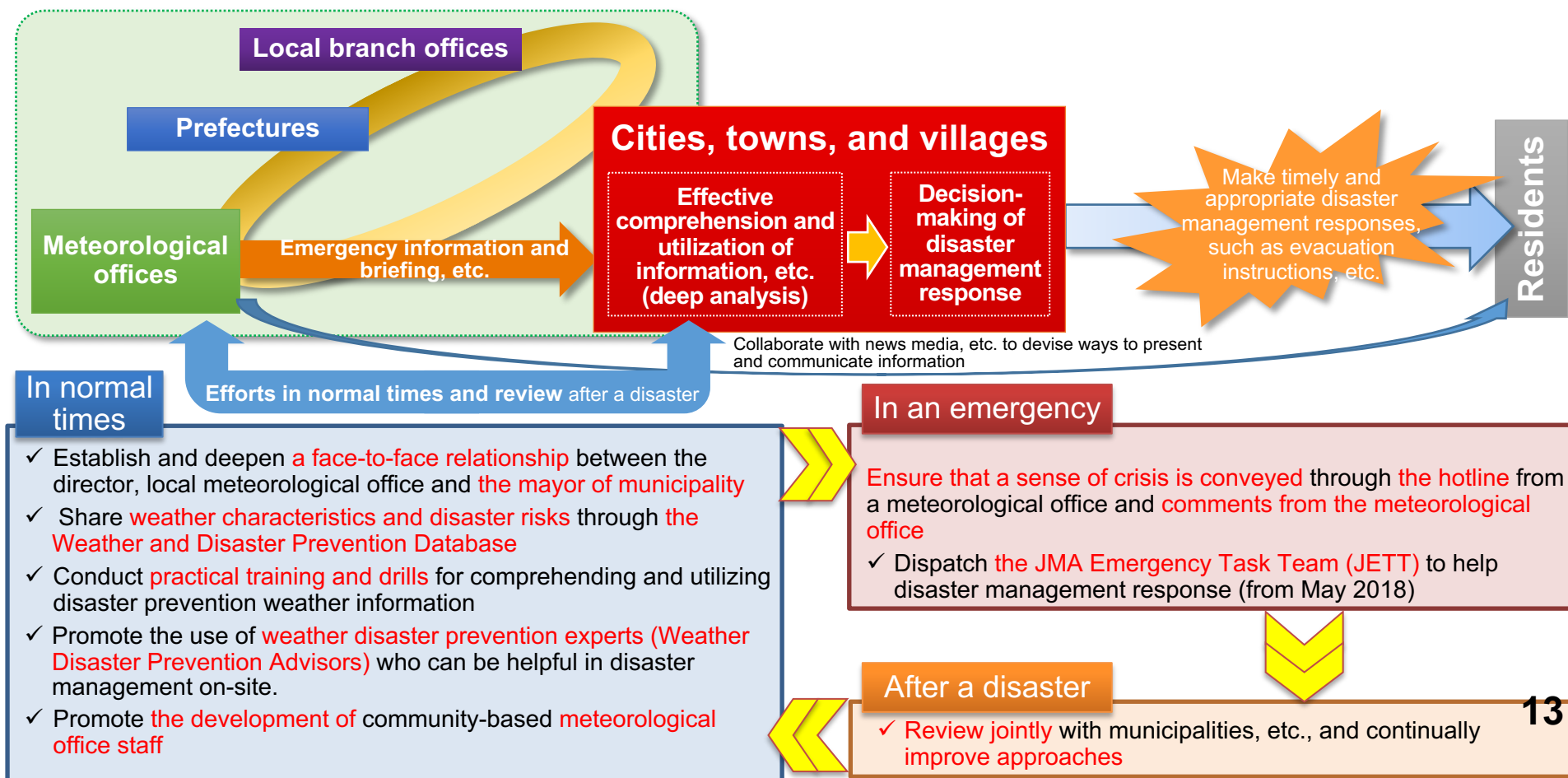
Timeline is a plan that specifies disaster management actions and their implementers in chronological order, focusing on “when,” “who,” and “what,” based on the premise that a disaster occurs and organizations involved in disaster management work together to assume and share the situation in which the disaster occurs in advance. This is also called a disaster management action plan. Mutual cooperation of the national government, local governments, businesses, residents, and other organizations in formulating a timeline will allow them to make a coordinated response in the event of a disaster.



Toward enhancing regional disaster prevention ability

Ideal way of weather disaster prevention services in regions

- With a strong sense of responsibility as a member of the “disaster prevention awareness society,” we will **work together with cities, towns, villages, prefectures, and local branch offices of related ministries and agencies to further contribute to regional weather disaster prevention** to prompt residents to take concrete disaster prevention actions.
- For municipalities at the forefront of disaster management, **more efforts will be made in normal times** to ensure that existing disaster prevention weather information and new information, such as “risk distribution map,” are further **“comprehended and utilized” (analyzed deeply)** in making decisions on disaster management measures in emergencies.



Deploying efforts to help municipalities at meteorological offices across Japan

Strengthening regional disaster management support through “Forecasters of Your Town”

Organize a team in charge based on the disaster characteristics of each region. Stay close to a municipality and build a close relationship between the persons in charge. (Starting with the Kanto-Koshin region in FY2019, gradually expand this approach nationwide)

(Efforts in emergencies) Proactively dispatching the JETT, strengthening the municipal head's hotline and information dissemination, etc.

- Proactively dispatch the JETT to provide weather or earthquake explanations, etc.
- Hotline to advise the heads of municipalities
- Promote explanations relating to evacuation actions
- Hold a press conference from an early stage
- Hold a press conference as a joint effort of local meteorological office and regional development bureau (Not only the weather outlook, but also the conditions of rivers, etc. are explained in detail)



The JETT was dispatched to Hitoyoshi, Kumamoto Prefecture. The weather outlook was explained at the Disaster Management Headquarters meeting (The Heavy Rain Event of July 2020)



Joint press conference by the Fukuoka Regional Headquarters and the Kyushu Regional Development Bureau (The Heavy Rain Event of July 2020)

Teams in charge (Tokyo's example)

Teams in charge of each region (23 wards, Tama, islands)



A case study of approaches to build collaborative relationships with municipalities

Visit Katsushika Ward to discuss the implementation of a wide-area evacuation drill in the event of a flood

Visit Nijijima-mura to discuss disaster management responses in case of heavy rain and volcanic eruption

(Efforts in normal times) Promoting weather disaster prevention workshops

- Proactively hold workshops at local meteorological offices to allow municipalities nationwide to participate
- Hold weather disaster prevention workshops, offering the latest information, such as the relationship between the five Alert Levels and disaster prevention weather information



(Efforts in normal times) Promoting the utilization of disaster prevention weather information

- Visit municipalities individually to provide detailed explanations on how to utilize disaster prevention weather information
- Share the perception of the relationship between municipal heavy rain warning standards, etc. and the standards for issuing evacuation instructions, etc.
- Review and advise on disaster management response of municipalities



Meteorological office staff giving explanations to municipal officials

Status of support from meteorological offices across Japan for heavy rain due to the rain front in August 2021

(As of Aug. 27, 09:00)

- Meteorological offices in each region provide detailed explanations of the future weather outlook and other information for local governments and other organizations through briefings, dispatch of the JETT (JMA Emergency Task Team), hotlines, etc. Joint press conferences are held with regional development bureaus to call for alert.
- The main office of the Japan Meteorological Agency also holds joint press conferences with the Water and Disaster Management Bureau to call for alert widely through the media.

Briefings and joint press conferences



(Photo) The Osaka Regional Headquarters and the Kinki Regional Development Bureau held a joint press conference to call for alert. [Aug. 14]

- Twenty meteorological offices across Japan held briefings for local governments and other organizations on the future weather outlook.
- The Fukuoka Regional Headquarters and the Kyushu Regional Development Bureau, the Osaka Regional Headquarters and the Kinki Regional Development Bureau, the Takamatsu Regional Headquarters and the Shikoku Regional Development Bureau, and the Hiroshima Regional Headquarters and the Chugoku Regional Development Bureau held a joint press conference to call for alert.

Hotline to local governments

Meteorological offices across Japan provide a hotline to 578 municipalities in 39 prefectures.

- Share a sense of crisis regarding a situation requiring to issue a high alert and evacuation information.

Dispatch of JETT



(Photo) JETT delegates (Nagasaki Local Meteorological Office) explained the outlook for future rainfall at the Nagasaki Prefecture Disaster Management Headquarters. [Aug. 15]

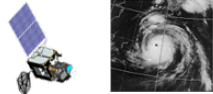
- A total of 185 persons were dispatched from meteorological offices nationwide to five cities and towns in 18 prefectures.
Akita Prefecture, Shizuoka Prefecture, Aichi Prefecture, Niigata Prefecture, Nagano Prefecture, Toyama Prefecture, Ishikawa Prefecture, Kyoto Prefecture, Tottori Prefecture, Tottori City, Shimane Prefecture, Hiroshima Prefecture, Hiroshima City, Ehime Prefecture, Fukuoka Prefecture, Saga Prefecture, Takeo City, Omachi-cho, Kumamoto Prefecture, Oita Prefecture, Nagasaki Prefecture, Unzen City, Kagoshima Prefecture
- In addition, we continued to dispatch staff to Mutsu City in Aomori Prefecture and Atami City in Shizuoka Prefecture.

The latest technology to support disaster management and meteorological services

Watching now

Observation data (Japan and overseas)

Meteorological satellite observation network



Upper atmospheric meteorological observation network
Radiosondes
Wind Profiler
Aircraft



Radar meteorological observation network



Surface meteorological observation network
Meteorological offices
AMeDAS observation



Ocean meteorological observation network
Research vessels
Merchant ships



Foreign meteorological institutions



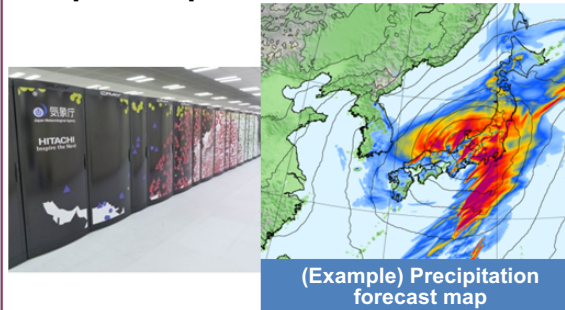
Observation data collection

Predicting the future

Analysis, prediction, and information formulation

Numerical prediction

Numerical simulation using supercomputers



(Example) Precipitation forecast map

Forecasters



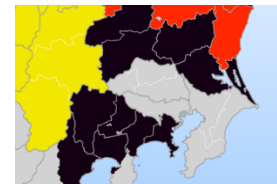
Monitor, analyze, and predict weather in the area in charge around the clock to announce weather forecasts and disaster prevention weather information, including weather warnings

Information release

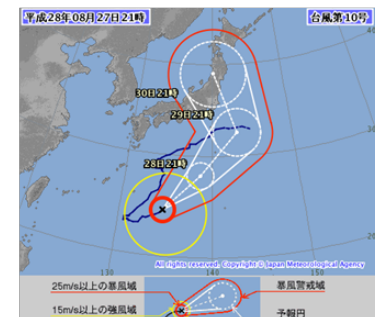
Weather forecasts Disaster prevention weather information

Weather forecasts, weekly weather forecasts, emergency warnings, warnings, advisories, typhoon information, etc.

Emergency warnings Warnings Advisories No warnings or advisories



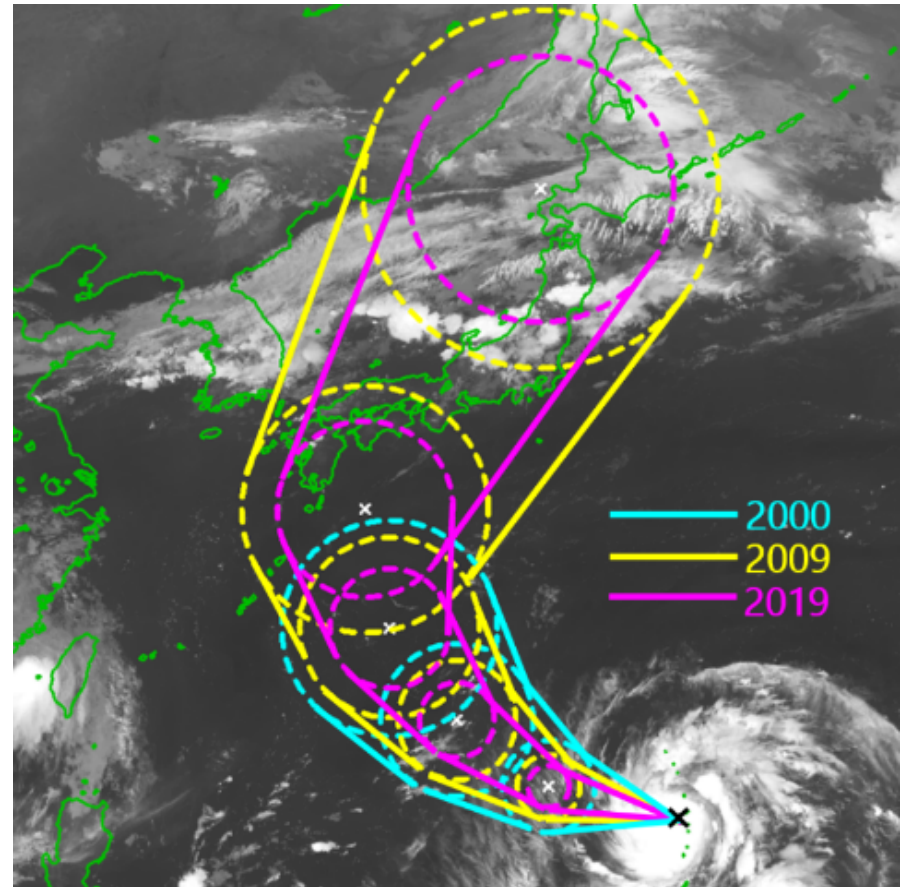
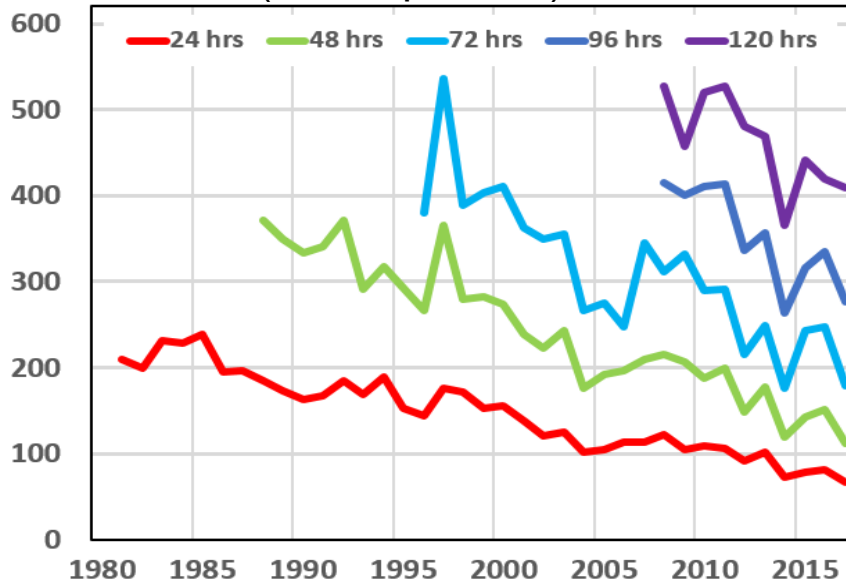
(Japan Meteorological Agency's website)
Emergency warnings, warnings, advisories



(Japan Meteorological Agency's website)
Typhoon information

Advances in typhoon forecasting

Annual average errors in typhoon path forecasts (center position)



* Image of improved prediction accuracy of center position

In the last 30 years or so,

- annual average errors in typhoon path forecasts halved
- the radius of forecast circles was also improved to less than half

Taking on the challenge of improving the prediction accuracy of stationary linear mesoscale convective systems

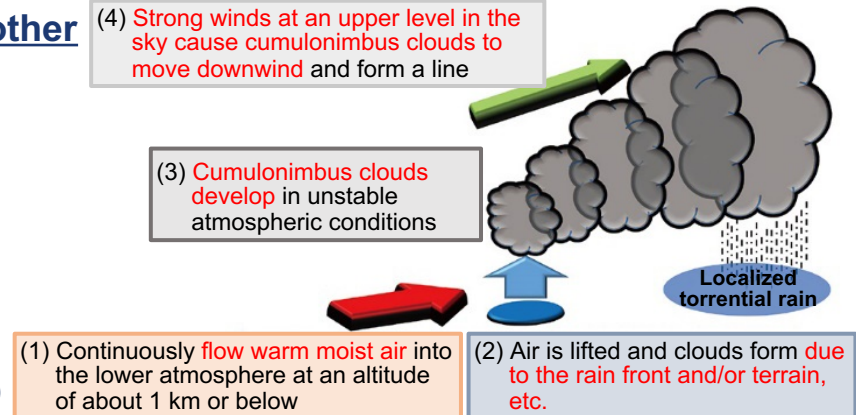
[What is a stationary linear mesoscale convective system?]

A stationary linear mesoscale convective system is generated by cumulonimbus clouds formed one after another that cause linear precipitation areas to stay in almost the same place for several hours, bringing about heavy rain. When a stationary linear mesoscale convective system develops, disaster risks increase.

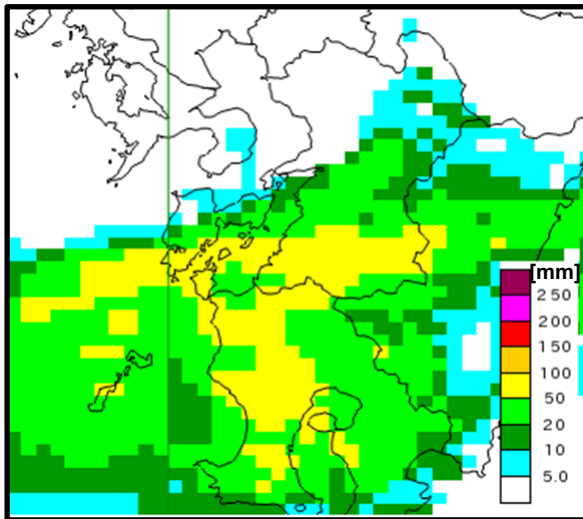
(Recent disaster cases)

- The Heavy Rain Event of August 2014 (Hiroshima)
- The Heavy Rain Event of September 2015 in Kanto and Tohoku
- The Heavy Rain Event of July 2017 in Northern Kyushu
- The Heavy Rain Event of July 2018 (Western Japan Torrential Rain)
- The Heavy Rain Event of July 2020

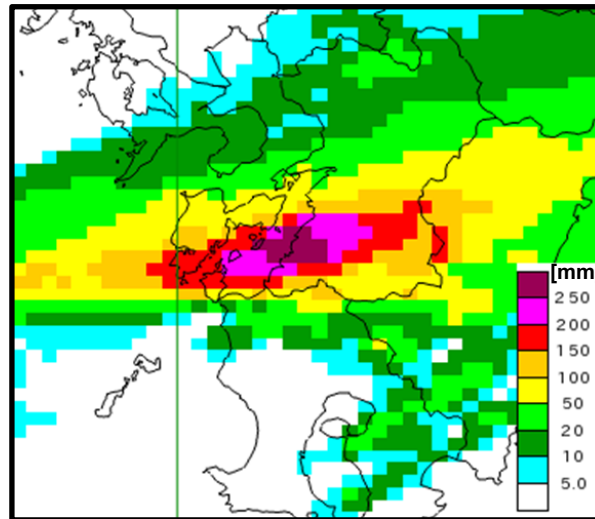
Schematic diagram of generation mechanism of a stationary linear mesoscale convective system



3-hour precipitation at 6:00 on July 4, 2020,
predicted 15 hours before



Live cast at 6:00 on July 4, 2020,
3-hour precipitation



The Kuma River flooding damage in Yatsushiro, Kumamoto Prefecture
(The Heavy Rain Event of July 2020)

Improvement of information provision for torrential rain caused by stationary linear mesoscale convective systems

Information
provision started
from June 17, 2021

Calling for attention to significant and continuous heavy rain
brought by stationary linear mesoscale convective systems

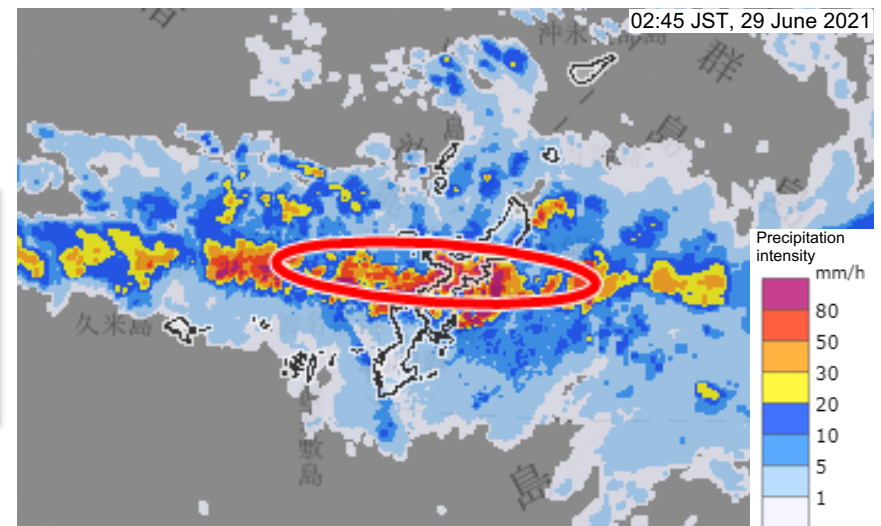
- Even though it is difficult to predict stationary linear mesoscale convective systems in advance, its information will be released when linear torrential rain area caused by a band of cumulonimbus clouds is detected through observations including weather radar.
- While the risk of disasters due to heavy rain is rapidly increasing, the situation where extremely heavy rain continues to fall in the same place caused by a stationary linear mesoscale convective system is explained using a keyword “stationary linear mesoscale convective system.”

Example of information on significant heavy rain

〇〇 Prefecture weather information on significant heavy rain

In the 〇〇 and 〇〇 regions, extremely heavy rain caused by stationary linear mesoscale convective systems is continuing to fall in the same places. The risk of life-threatening landslides and/or flood disasters is rapidly increasing.

Example of supplemental graphical information
on significant heavy rain



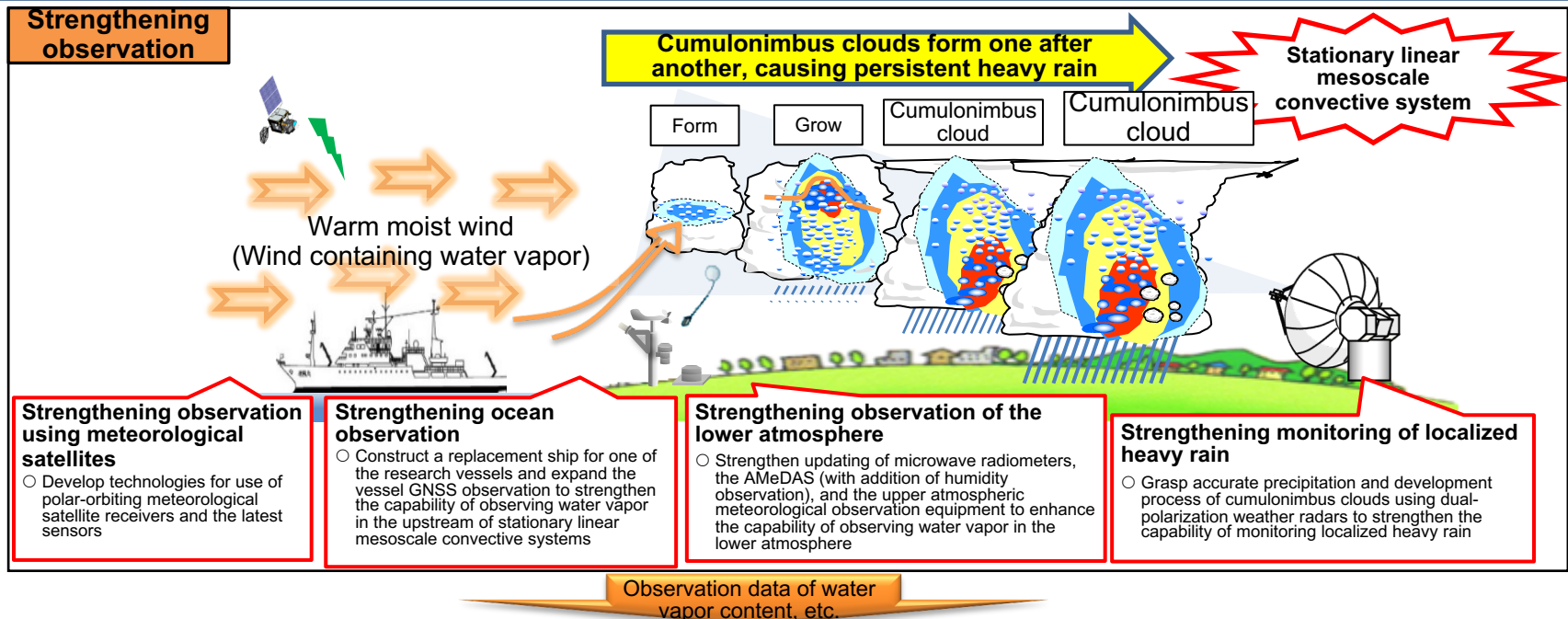
○ The area of rainfall caused by the stationary linear mesoscale convective systems where the risk of heavy rain disaster is rapidly increasing

* Example of movement of rain clouds (High-Resolution Precipitation Nowcasts)

Toward the improvement of prediction accuracy of stationary linear mesoscale convective systems

(1. Strengthening of observation and prediction)

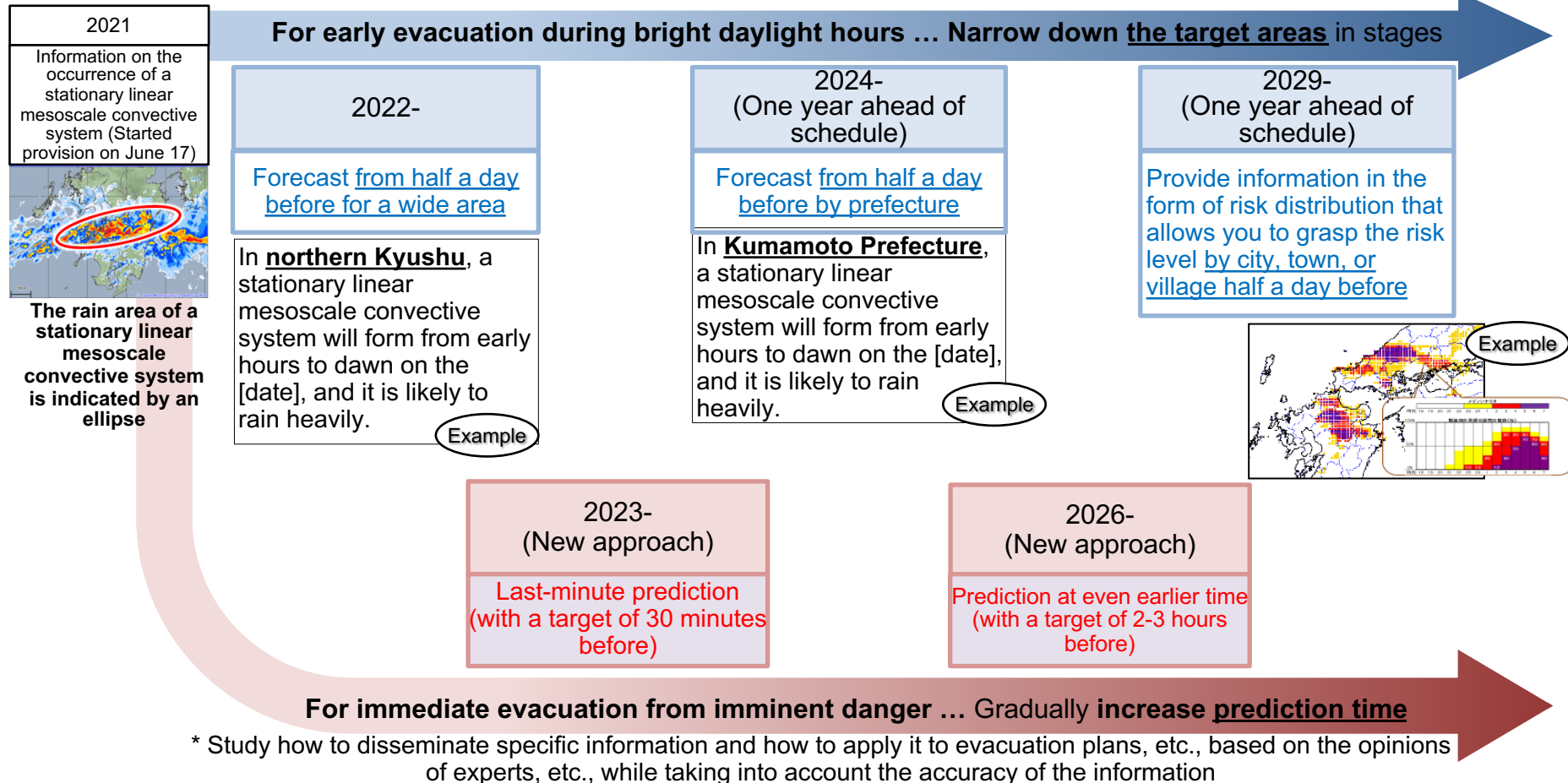
We will urgently push forward with strengthening of water vapor observation, etc. and the Japan Meteorological Agency's supercomputers and development of forecasting technology using the supercomputer Fugaku, and will promptly incorporate them into sophistication of disaster prevention weather information to provide information that contributes to early evacuation of residents.



Toward the improvement of prediction accuracy of stationary linear mesoscale convective systems

(2. Improvement of information provision)

The results of efforts to enhance observation and forecasting had been incorporated successively, and the information had been provided only after the occurrence. In FY2022, we started forecasting the occurrence of stationary linear mesoscale convective systems with the improved forecasting accuracy. Since then, the accuracy has been improved gradually.



Communicate a sense of crisis to each citizen to lead to disaster prevention action

Conclusion

—permanent mindset of JMA—

Instructions from the Director-General of the Japan Meteorological Agency on inauguration of emergency warnings (August 30, 2013)

- (1) First, further strengthen cooperation with local governments
 - (2) Second, systematically strengthen activities including disaster prevention education which promote and spread the awareness and ability of disaster prevention in order to raise such awareness and ability of each and every resident
 - (3) Third, put efforts into making disaster prevention weather information, such as “advisories,” “warnings,” and “emergency warnings” be used comprehensively so that both local governments and residents can take early and prompt action
- Information will not be well utilized without cooperation with local governments and residents and improving the disaster prevention ability