Effective Early Warning System in Public Weather Service

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Contents

I. Introduction to PWS

Filling Gaps between NMHSs and Users

Background of growing importance of PWS

Advanced technologies

Thanks to a drastic advancement of various technologies in the last 50 years, weather products have been significantly improved in terms of accuracy, precision and diversity. Consequently, the users came to demand the next level of weather service.

Adopted various advanced technologies

Changing Needs for NMHSs

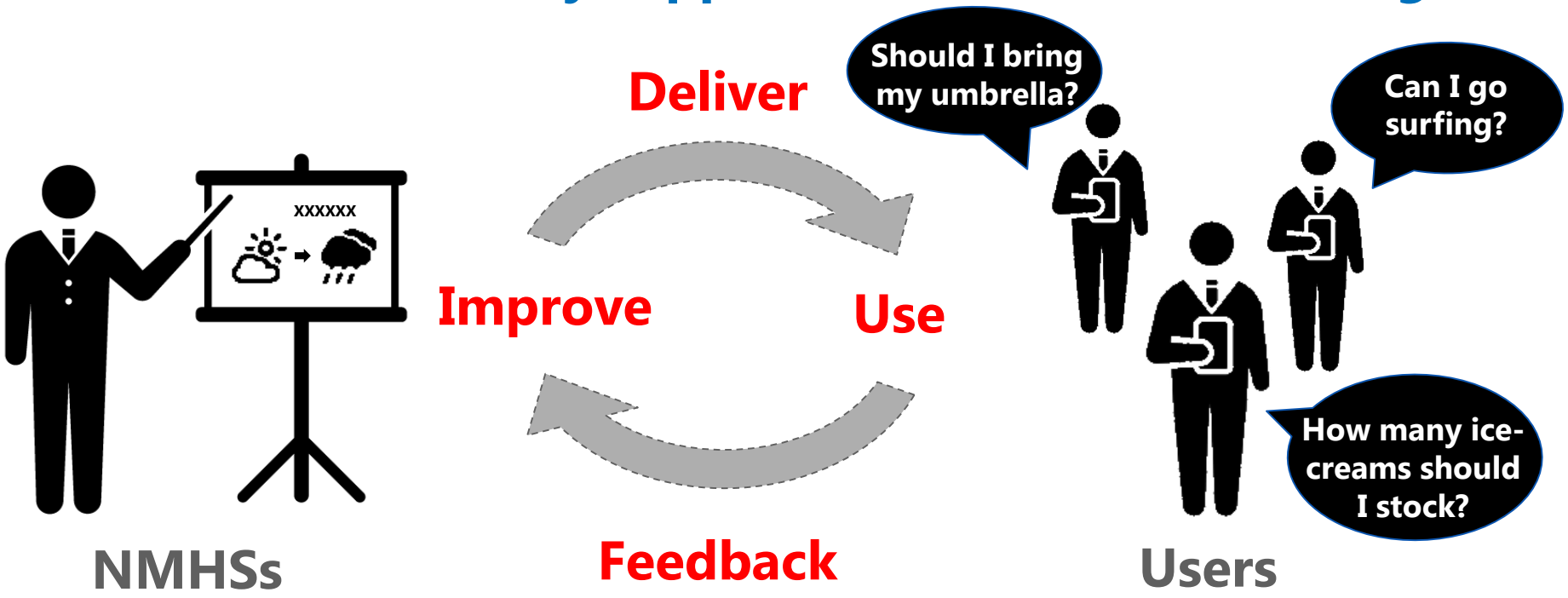
Before

The main mission of NMHSs was to improve weather products.

Changing Needs for NMHSs

Now

Currently, NMHSs are required to provide user-oriented service that effectively supports users' decision making.



PWS for DRR

Probability to result in serious situation

Information for DRR may result in serious situation if it dose not lead to appropriate decision making.

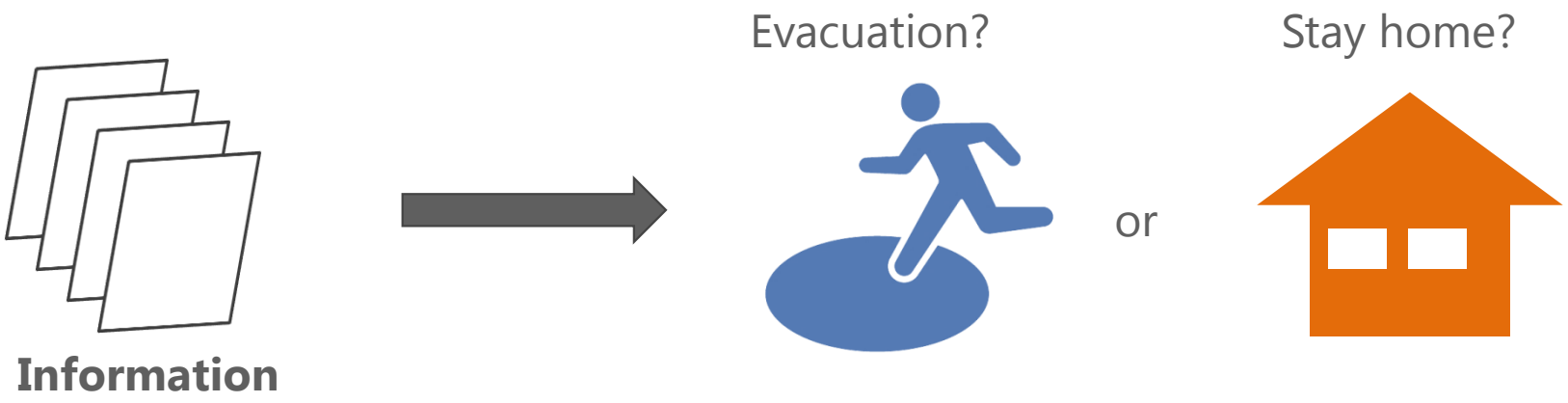
- **For example**
  - ✓ Around 8 p.m., the residents began evacuation to safer facilities based on flood warnings and evacuation instruction.
  - ✓ However, totally 13 people died on the way to these facilities.

➡ **Did the information lead to their appropriate action?**

What should it have been?

- **As a Trigger to Appropriate Action**

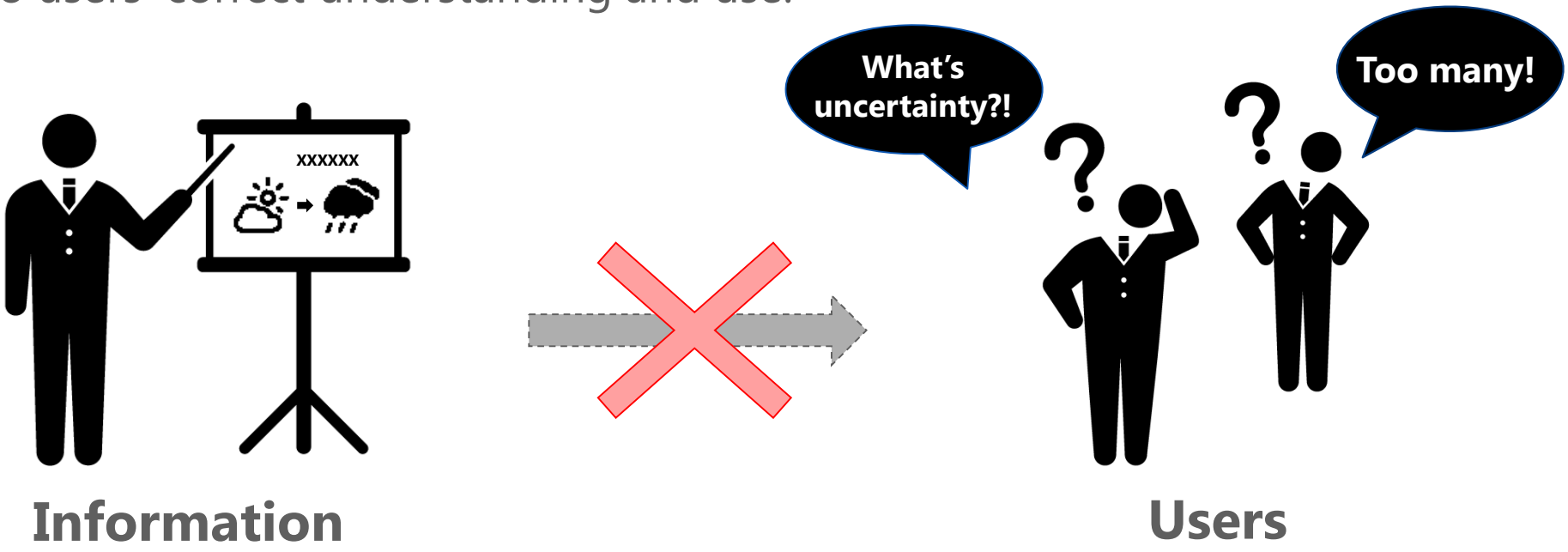
  The information for DRR has to lead people to their appropriate decision according to the situation.
  In addition, NMHSs need to provide information at an appropriate time so that people can make better decision.



What you should do is… fill the gap.

Wider Gap between Providers and Users

In spite of advancement of weather service, gaps between NMHSs and users are still wide, because it is not user-oriented enough in terms of not leading to users' correct understanding and use.

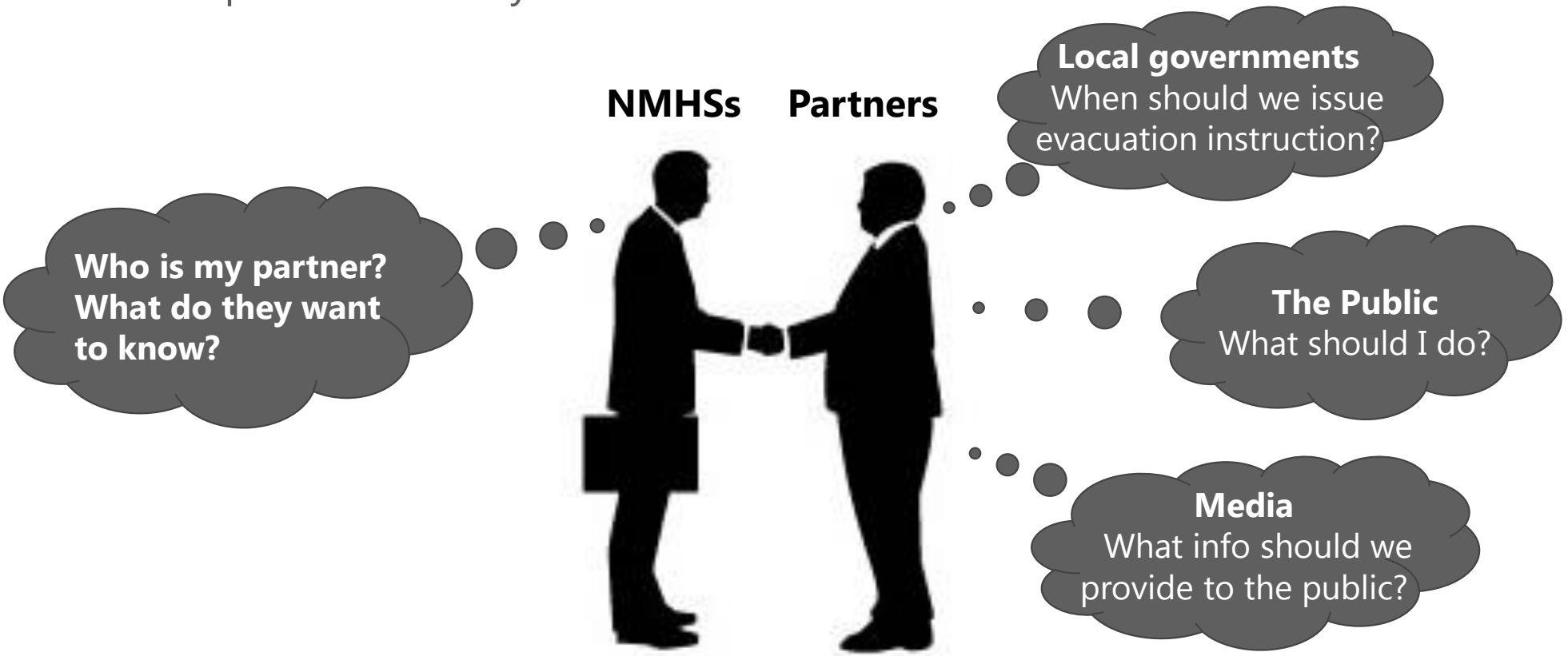


Toward user-oriented service, NMHSs should take the following four steps.

Toward User-oriented Services (1)

- **First Step: identify users to develop partnerships**

  You first need to identify your partners who use your information and build a cooperative relationship with them. Potential users could vary depending on responsibilities of your NMHS.



Toward User-oriented Services (2)

- **Second Step: design, develop, and deliver your products/services**

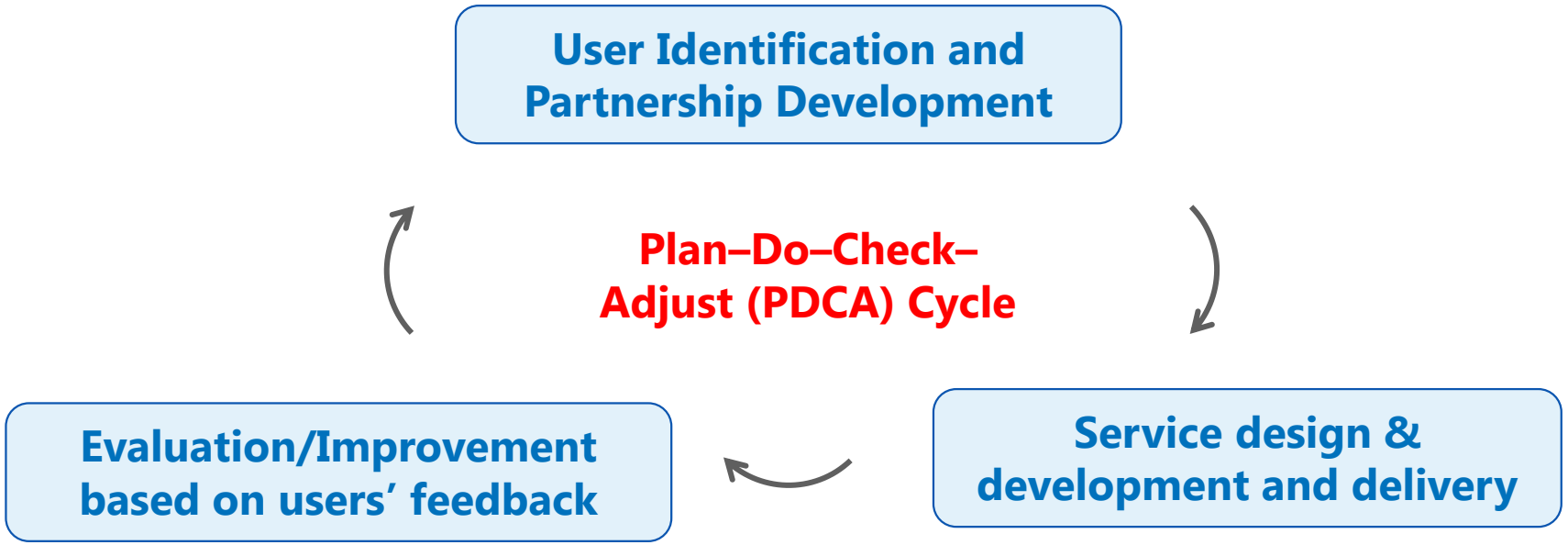
  This is a process, **involving users**, to design, develop, and deliver your products/service ensuring user's needs are met.

  - **Who is the users of your information?**
  - **What kind of information do they want?**
  - **When do they want it? (Timing)**
  - **Why do they want it? (Purpose of the use)**
  - **How do they get it? (Delivery channel)**

Toward User-oriented Services (3)

- **Third Step: monitor and evaluate the products/services**

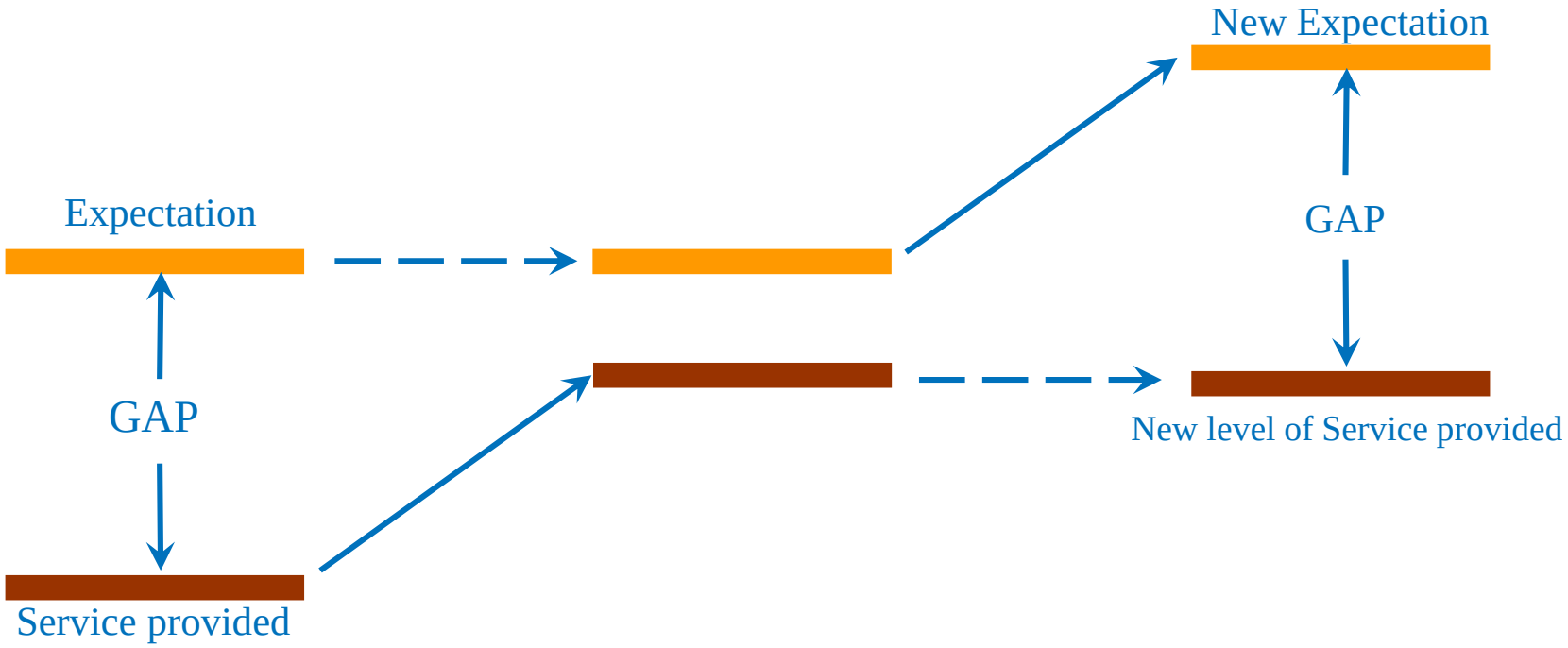
  The products/services should be monitored and evaluated regularly to check whether they satisfy users' needs in terms of accuracy, timelines, effectiveness for users' decision making etc.



Toward User-oriented Services (4)

- **Fourth Step: manage user's expectation**

  As your services/products improve, users will expect even better services/products. Efforts to keep users' expectation at an appropriate level is important to make users satisfied and **value your services/products**, by having users understand that you provide best services/products in light of the current science and technology and resources available.



User Education & Outreach

Characteristics

Users need to understand characteristics of your services/products, such as lead time and accuracies, to take full advantage of them for their decision making.

Technical Limitation

In addition, you also need to teach users technical limitations of your services/products to avoid their over-expectation/under-evaluation, and inappropriate use for their decision making.

Summary

- It is necessary to fill gaps between NMHSs and users toward user-oriented services that effectively supports users' decision making by taking the step-by-step approach involving users to implement the plan–do–check–adjust cycle:
  - developing partnership between providers and users
  - involving users to design, develop and deliver products/services
  - practicing PDCA-cycle to enhance products/services based on evaluation
  - managing users expectations by raising users understanding for the characteristics of products/services

II. Effective Early Warning System

DRR-oriented service enhancement

DRR Legal Framework

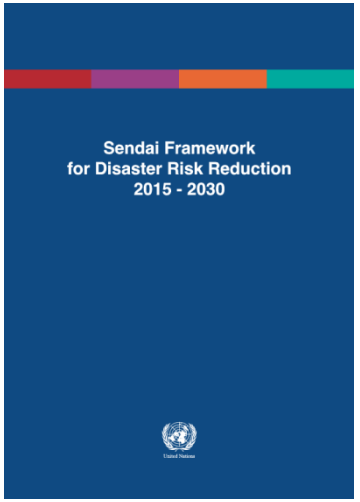
As a precondition for an effective EWS

DRR Legal Framework

Precondition for an effective EWS

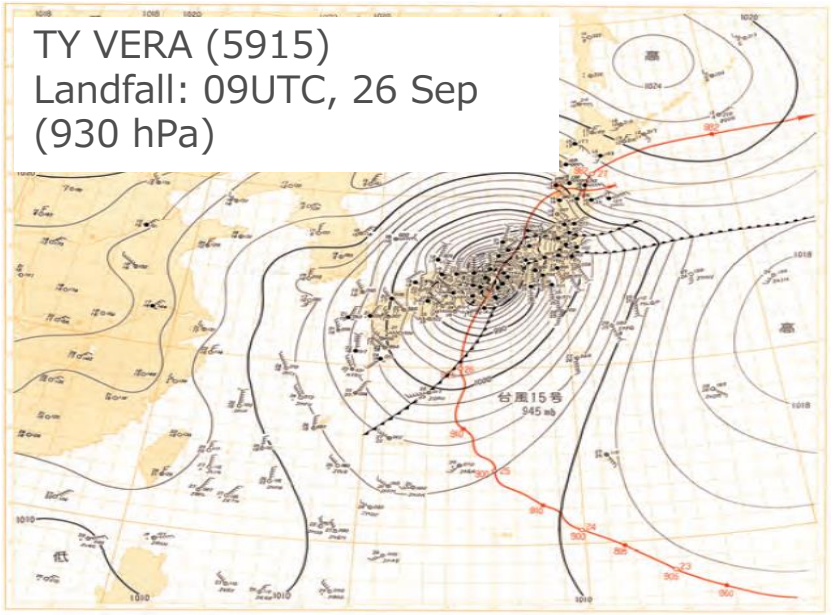
National and regional strategy for DRR is a precondition for an effective EWS and the strategy and plans for implementation need to be stipulated as a legal framework.

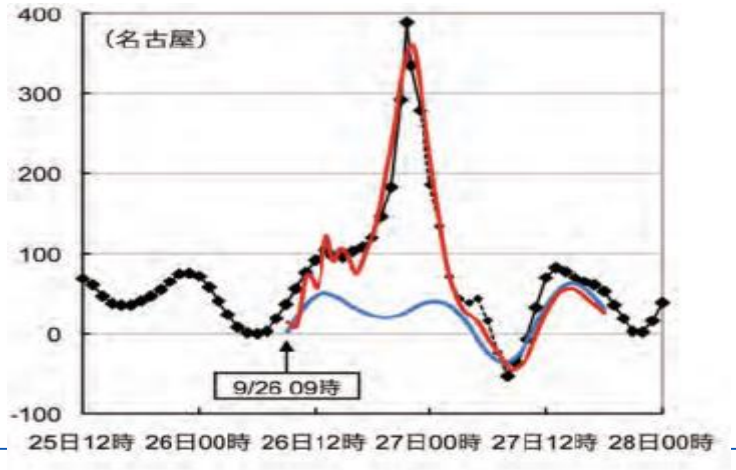
- **Emphasized in *"Sendai Framework for DRR 2015-2030"***
  - Priority 2: Strengthening disaster risk governance to manage disaster risk
    - Disaster risk governance at the national, regional and global levels is of great importance for an effective and efficient management of disaster risk...
  - At national and regional levels,
    - Adopt and implement national and local disaster risk reduction strategies and plans, across different timescales with targets, indicators and time frames, ...



NMHSs need to play a role in establishing and implementing an effective EWS, which is one component of an overall DRR strategy and plan at national and regional levels.

TY Vera (5915) in September 1959





Dead and Missing: 5098
Injured persons: 38,921
Submerged houses: 157,858

Disaster Countermeasure Basic Act (1961)

National Level

Prime Minister

⇕

Central Disaster Management Council

⇕

Designated Government Organizations
Designated Public Corporations

Prefectural Level

Governor

⇕

Prefectural Disaster Management Council

⇕

Designated Local Government Organization
Designated Local Public Corporations

Municipal Level

Mayors of Cities, Towns and Villages

⇕

Municipal Disaster Management Council

- **Clarification of Responsibility and Demarcation**
- **Development of Disaster Management Plan**

→ Basic Disaster Management Plans

→ Disaster Management Operation Plans

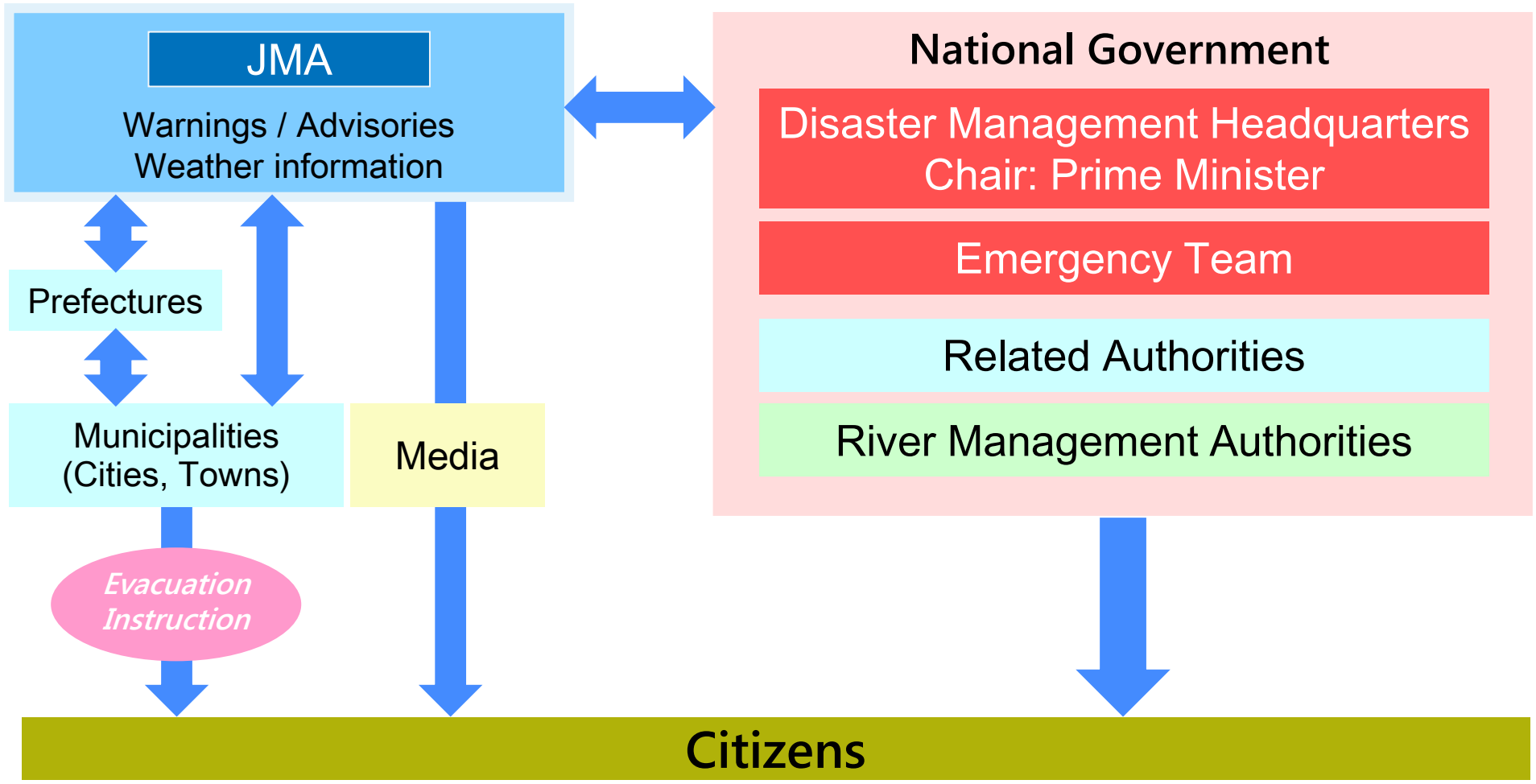
- **Designated Government Organizations**
  24 ministries and agencies
- **Designated Public Corporations**
  56 organizations including independent administrative agencies, Bank of Japan, Japanese Red Cross Society, NHK, electric and gas companies and NTT.

→ Prefectural Disaster Management Plans

→ Local Disaster Management Plans

JMA's responsibility under DRR framework

JMA plays a vital role in national disaster management as a provider of meteorological information necessary for disaster prevention and preparedness.



Multi-Hazard concept

- **Multi-hazard**

  (1) the selection of multiple major hazards that the country faces, and (2) the specific contexts where hazardous events may occur simultaneously, cascadingly or cumulatively over time, and taking into account the potential interrelated effects

- **Multi-hazard Early Warning System (MHEWS)**

  Multi-hazard early warning systems address several hazards and/or impacts of similar or different type in contexts where hazardous events may occur alone, simultaneously, cascadingly or cumulatively over time, and taking into account the potential interrelated effects.

Advantages

A multi-hazard early warning system with the ability to warn of one or more hazards **increases the efficiency and consistency of warnings** through coordinated and compatible mechanisms and capacities, involving multiple disciplines for updated and accurate hazards identification and monitoring for multiple hazards.

Reference: UNISDR (https://www.unisdr.org/we/inform/terminology)

Joint Issuance for better actions

Collaboration with other organizations

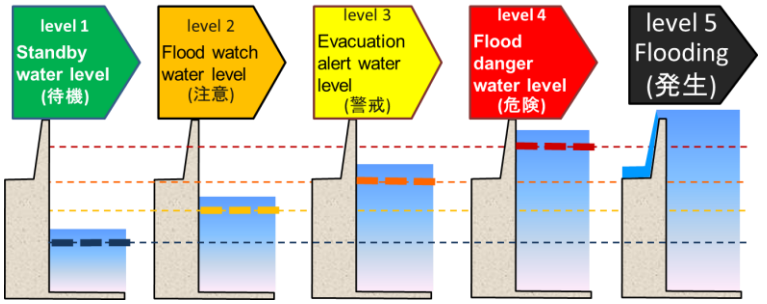
In Japan, landslide information is issued by JMA and local governments. Also, flood information is issued by JMA in collaboration with MLIT. This ensures the consistency in information as well as the easiness for local governments to take actions.

For landslide information, JMA collaborates with local governments

Increased risk of sediment disaster	Evacuation information to be considered for issue to sediment disaster risk areas and hazard zones in accordance with the mesh contained on p31-37 of the Cabinet Office Guidelines
Actually exceeding sediment disaster alert criteria ※1	Evacuation Directive
Exceeds criteria for sediment disaster alert	Evacuation Order
Exceeds criteria for heavy rain warning	Evacuation Preparation Alert
Exceeds criteria for heavy rain caution	—
Below criteria for heavy rain caution	—

※1 Sediment Disaster Alerts, Heavy Rain Warnings and Heavy Rain Cautions are issued based on the anticipation that criteria will be exceeded, but in this case the criteria have already been exceeded, and the situation is extremely dangerous, with the possibility of a sediment disaster at any moment.

For flood information, JMA collaborates with Minister of Land, Infrastructure, Transport and Tourism, and Local governments

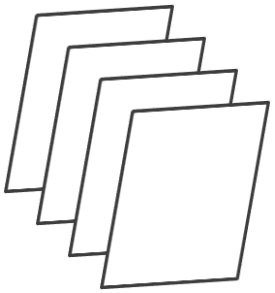


Improvement of Early Warning System

What's Effective Early Warning System?

Effective Early Warning System

Effective early warning system enables users to understand changing weather conditions and make timely decision to take necessary measures without hesitation.

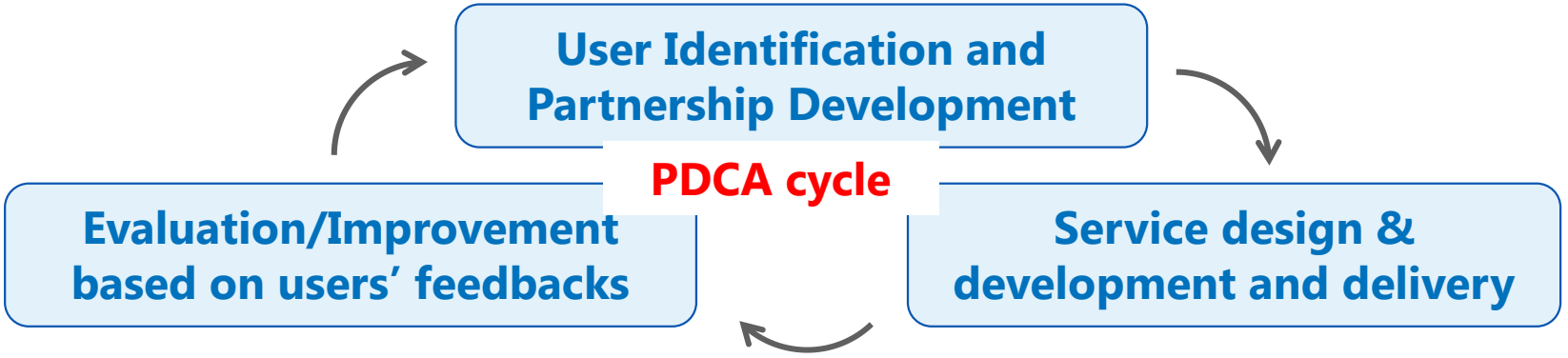


Information

trigger!

Decision-making

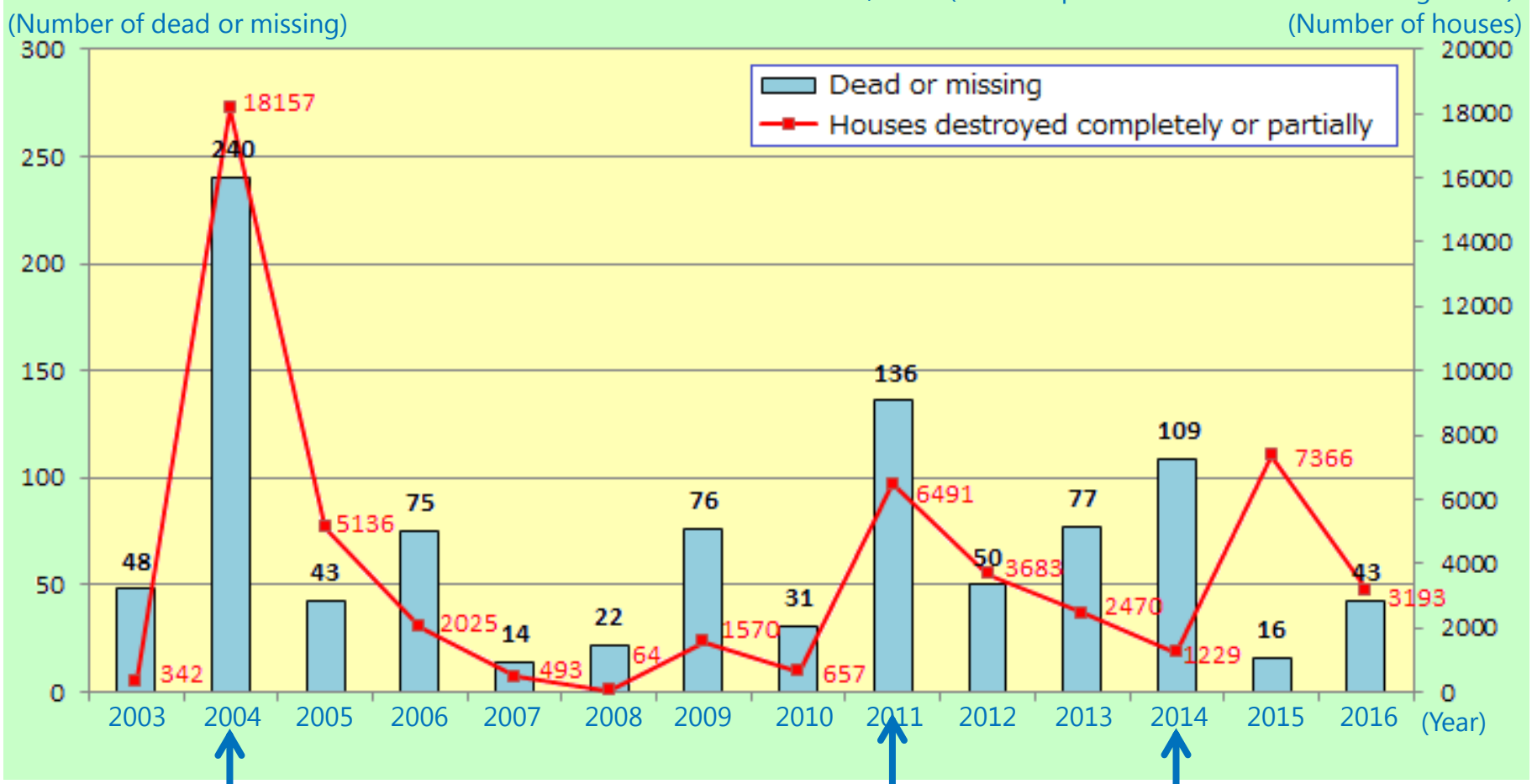
- ✓ evacuate
- ✓ close down schools/stations
- ✓ postpone large events
- ✓ Prepare for prevention system etc.



Timeline of major met/hydro-disasters and accompanying improvement of warning services

Damages caused by heavy rain, flood and storms

Source: *Shobo Hakusho 2013, 2017* (White Paper on Fire and Disaster Management)



2004: 10 typhoons struck Japan

2011: Heavy rain caused by STS Talas

2014: Heavy rain disaster in Hiroshima

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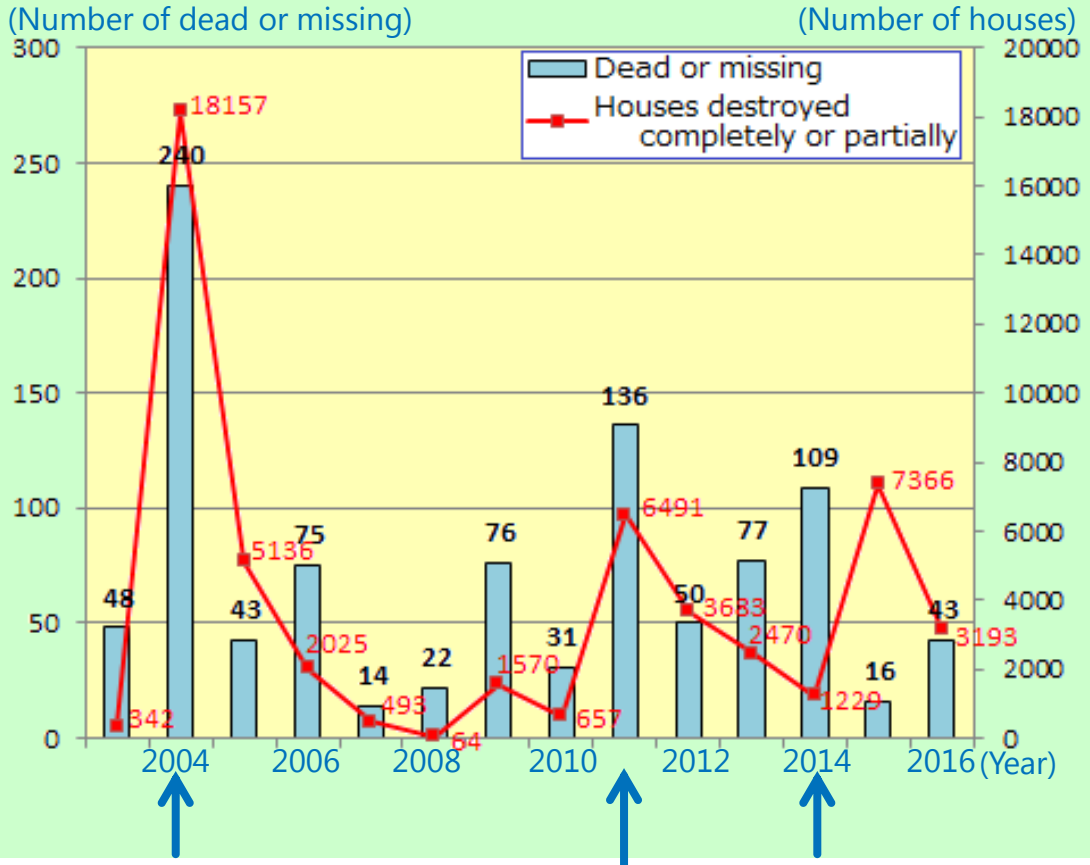

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2 grades; Warnings/Advisories

2004 ten typhoons

Restructuring warnings
- Subdividing warning zones
- Corresponding warning criteria to evacuation order criteria

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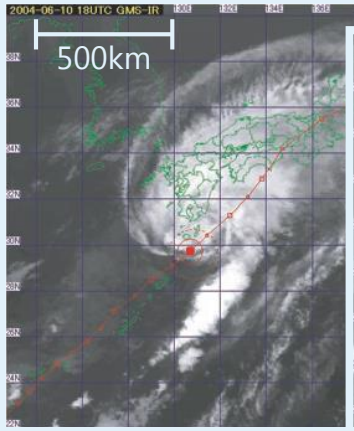
2013 Emergency Warnings as effective messages in emergency situation

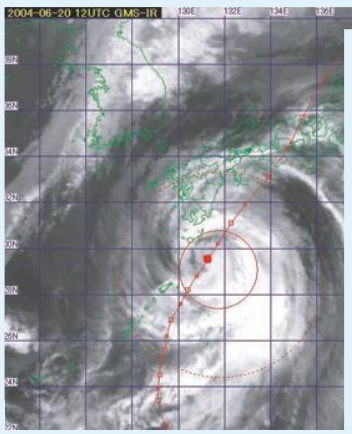
2014 Heavy rain disaster in Hiroshima

2017 Probability of Warnings
2015-2017 Real-time Risk Map

10 Typhoons struck Japan in 2004



T0404
(landed on Japan around
16:00JST, Jun 11)



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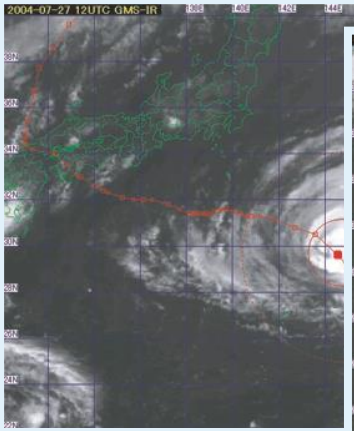

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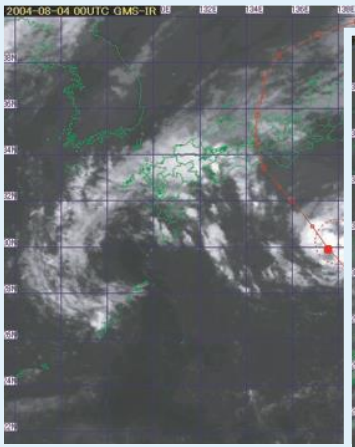

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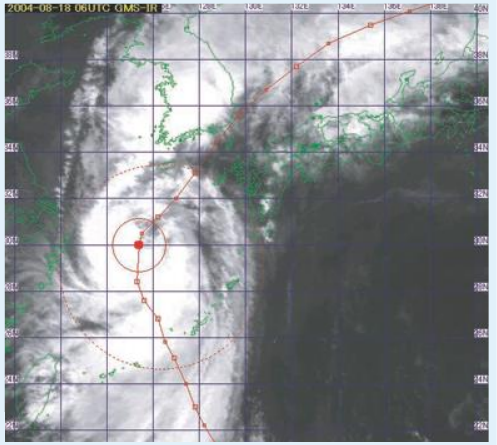

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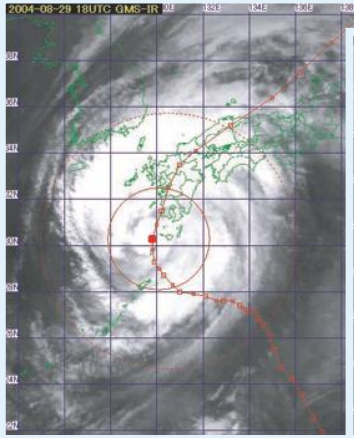

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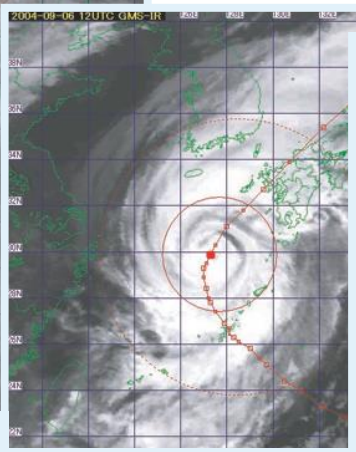

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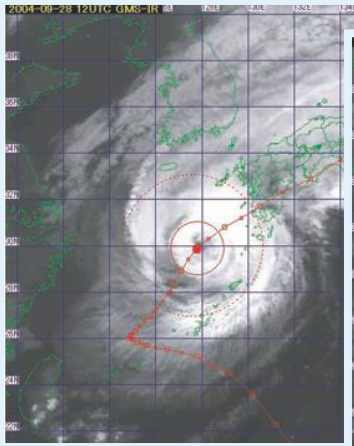

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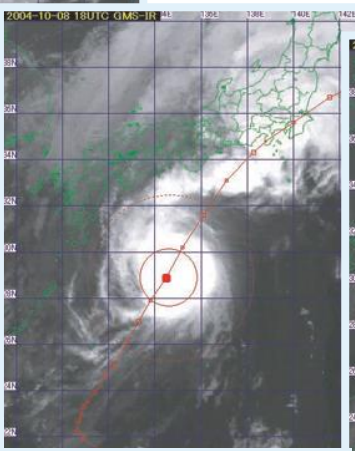

T0422
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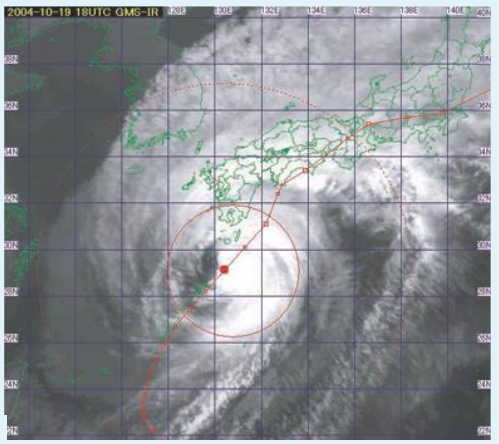


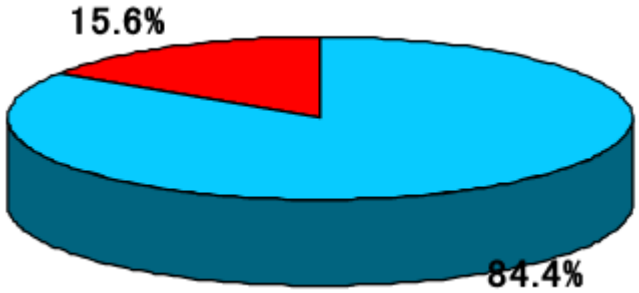
T0423
(landed on Japan around
13:00JST, Oct 20)

“Guidelines for Producing a Decision and Dissemination Manual for Evacuation Advisories and Orders” (Cabinet Office, 2005)

During the disasters in 2004, mayors did not issue the evacuation advisory / order for appropriate hazardous areas in a timely manner.

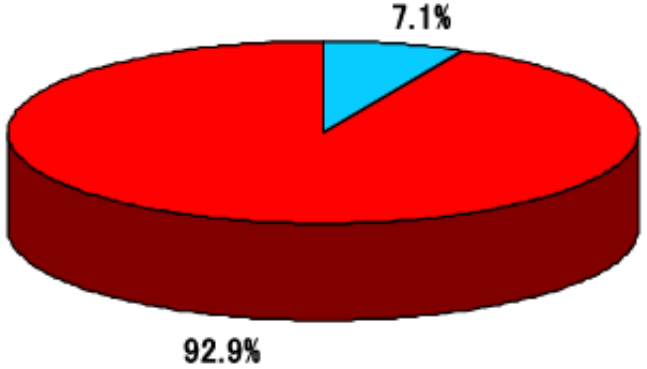
Background:
Mayors can not make decision because they have not pre-determined specific criteria for evacuation advisory / order.

Not determined: 15.6%



Criteria is pre-determined: 84.4%

Specific criteria is pre-determined: **7.1%**



Not determined: 92.9%

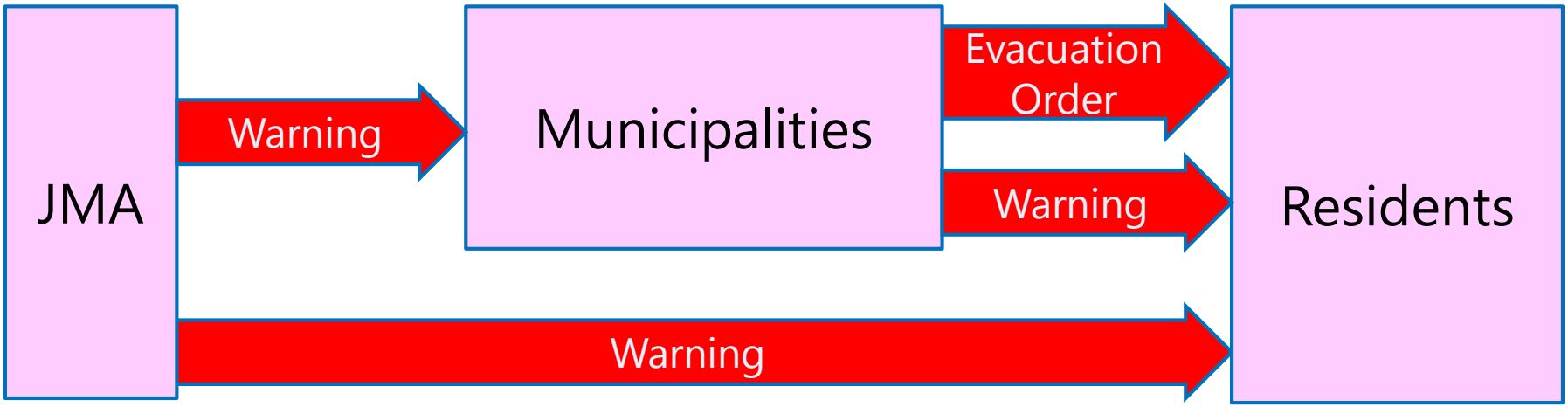
Source: Cabinet Office, 2004

Municipalities should determine specific criteria.

"Guidelines for Producing a Decision and Dissemination Manual for Evacuation Advisories and Orders" (Cabinet Office, 2005)

- The Cabinet Office created a Guideline for municipalities to make a manual on evacuation order to help decision making on evacuation orders by DRR emergency managers.
- The guideline describes how various information, including JMA's warning messages and water levels monitored by river managers, is to be used for decision making on evacuation orders.
- It describes JMA's warnings as examples of decision criteria for evacuation orders.

Improvement of Warning

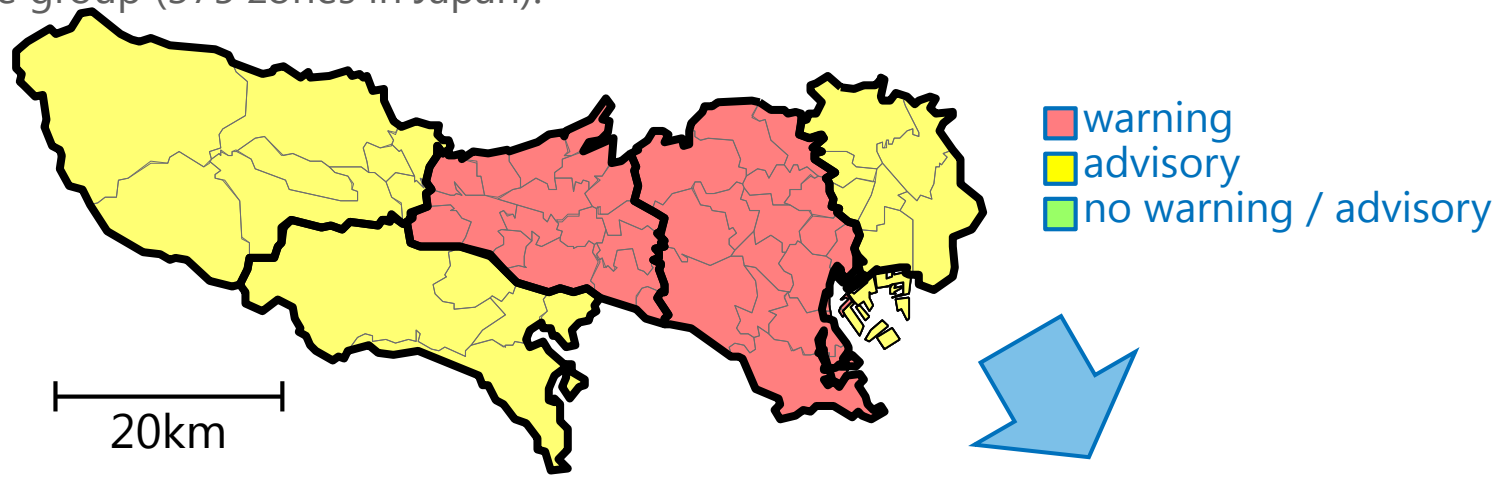


In order that JMA's warnings help mayors' decision...

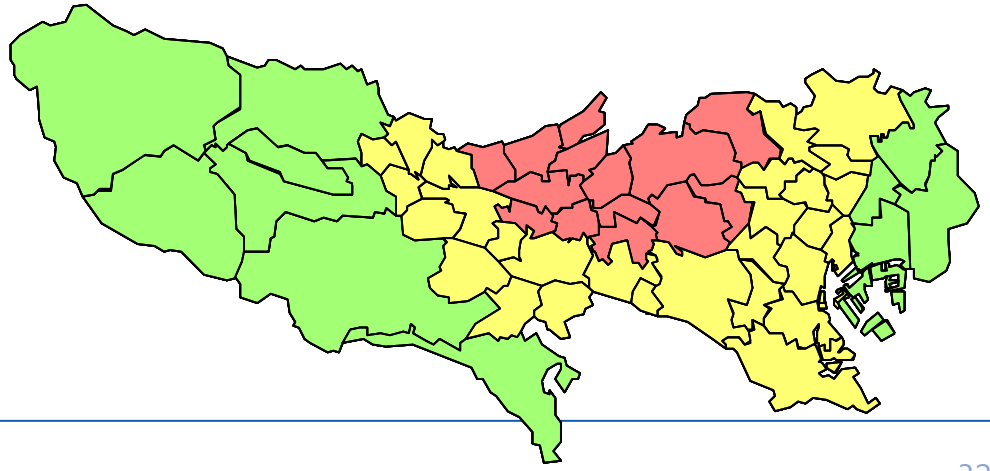
1. Warnings should be issued to city / town / village respectively.
2. Warning criteria should be consistent with the criteria for evacuation advisory and order.

Warning for each municipality

Warnings were issued to zones that include several cities, towns and villages together in the same group (375 zones in Japan).



JMA divided warning zones into city, town and village basis in 2008 (more than 1,700 zones in Japan).



[Example] Warning Criteria for Storm Surge

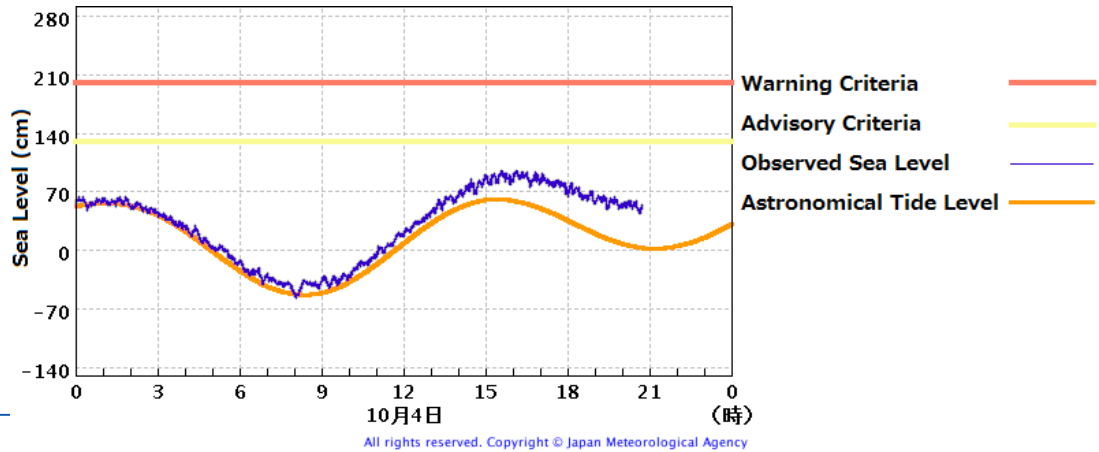
Criteria recommended in the Guideline

Mayor's Decision	Criteria
Evacuation Order	✓ Sea level has reached "**Storm Surge Danger Level**." ✓ Tidal embankment is broken.
Evacuation Advisory	✓ Sea level is expected to reach "**Storm Surge Danger Level**" in certain hours*. *: Necessary time for people to evacuate, however, storm will be also expected as the typhoon approaching, mayors should consider the advisory when it meets the criteria for preparation information.
Evacuation Preparation Information	✓ Sea level is expected to reach "**Storm Surge Danger Level**" in certain hours*. *: Necessary time for people who require assistance to evacuate

JMA set the criteria for storm surge warning consistent with "**Storm Surge Danger Level**."

1. If the municipality already set the "**Storm Surge Danger Level**", JMA set the level as the warning criterion for the city, town or village.

2. If the municipality is NOT set the "Storm Surge Danger Level", JMA set the warning criterion based on the survey (e.g. design high tide level for embankment, lowest altitude of the wharf).



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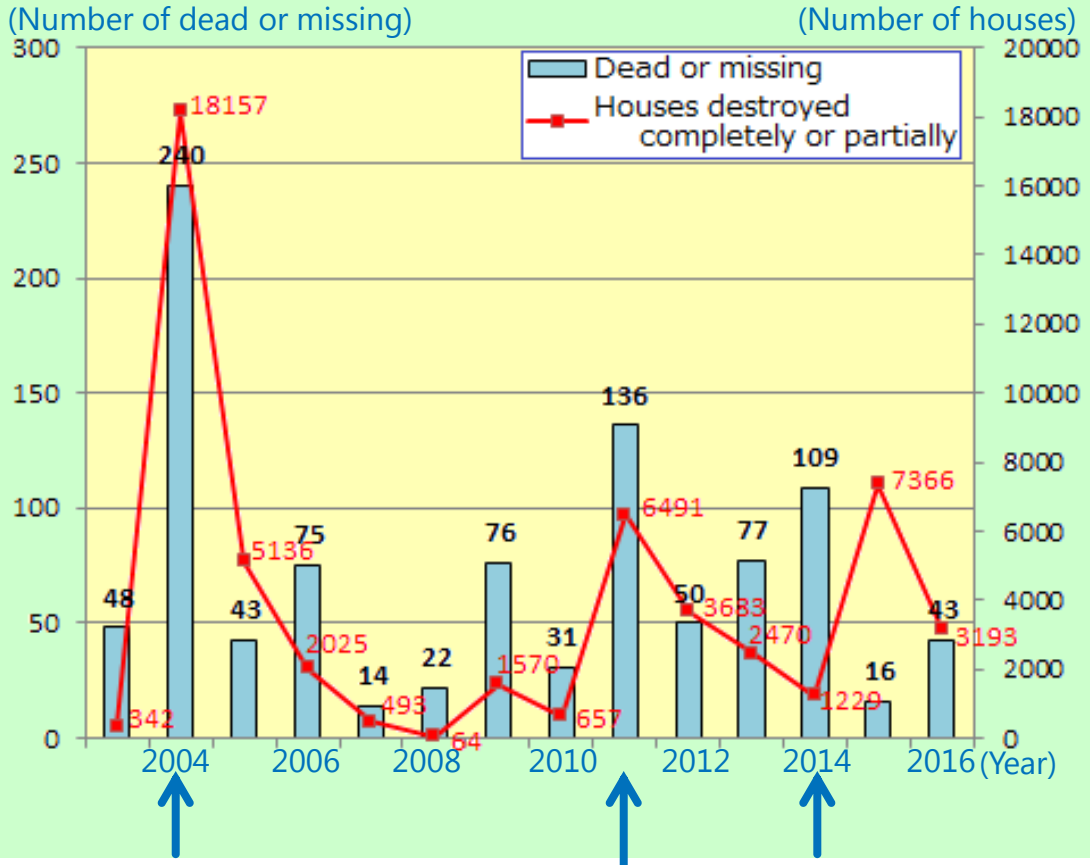

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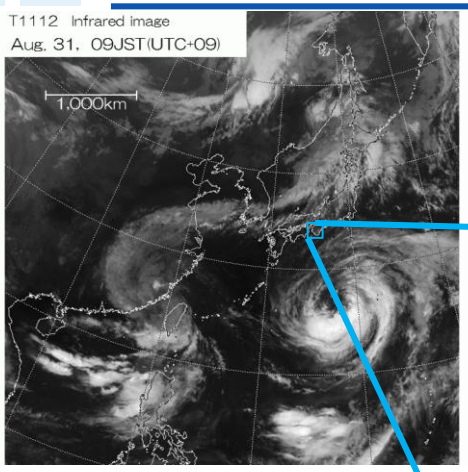
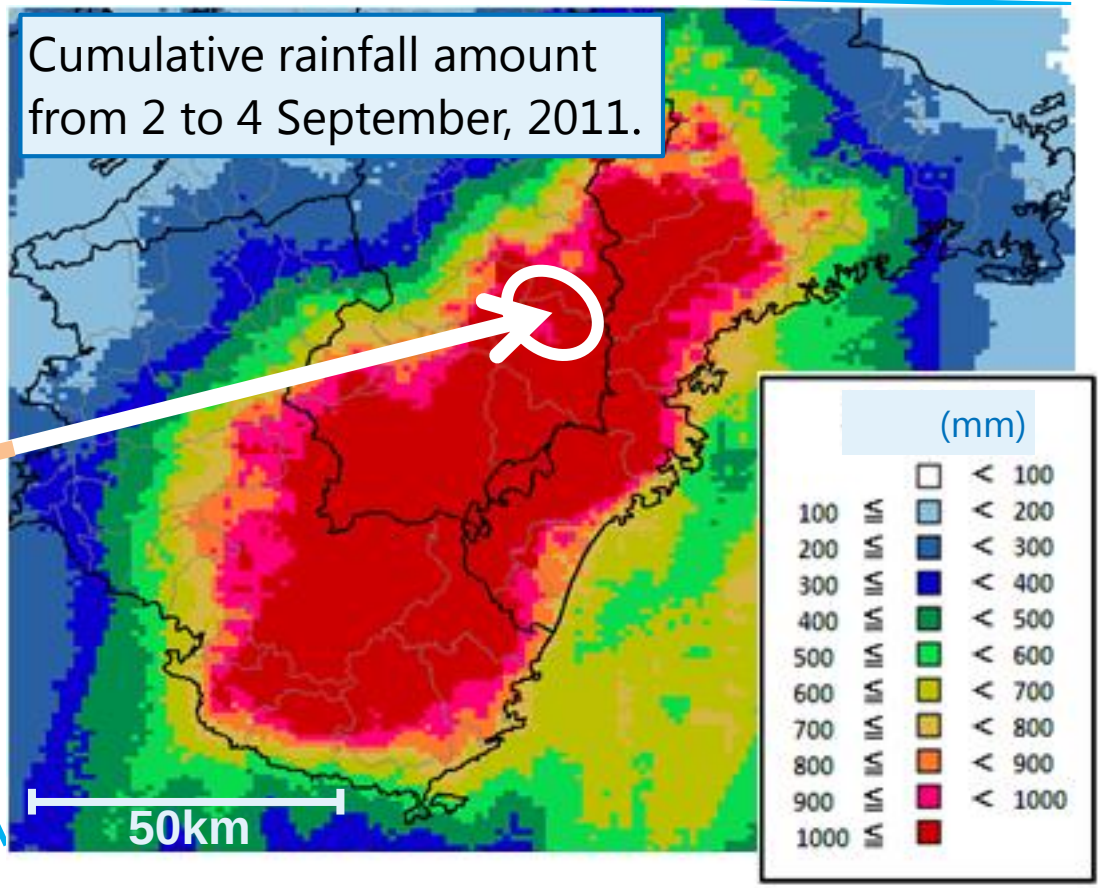
Typhoon Talas Brought a Long-term Heavy Rainfall in 2011

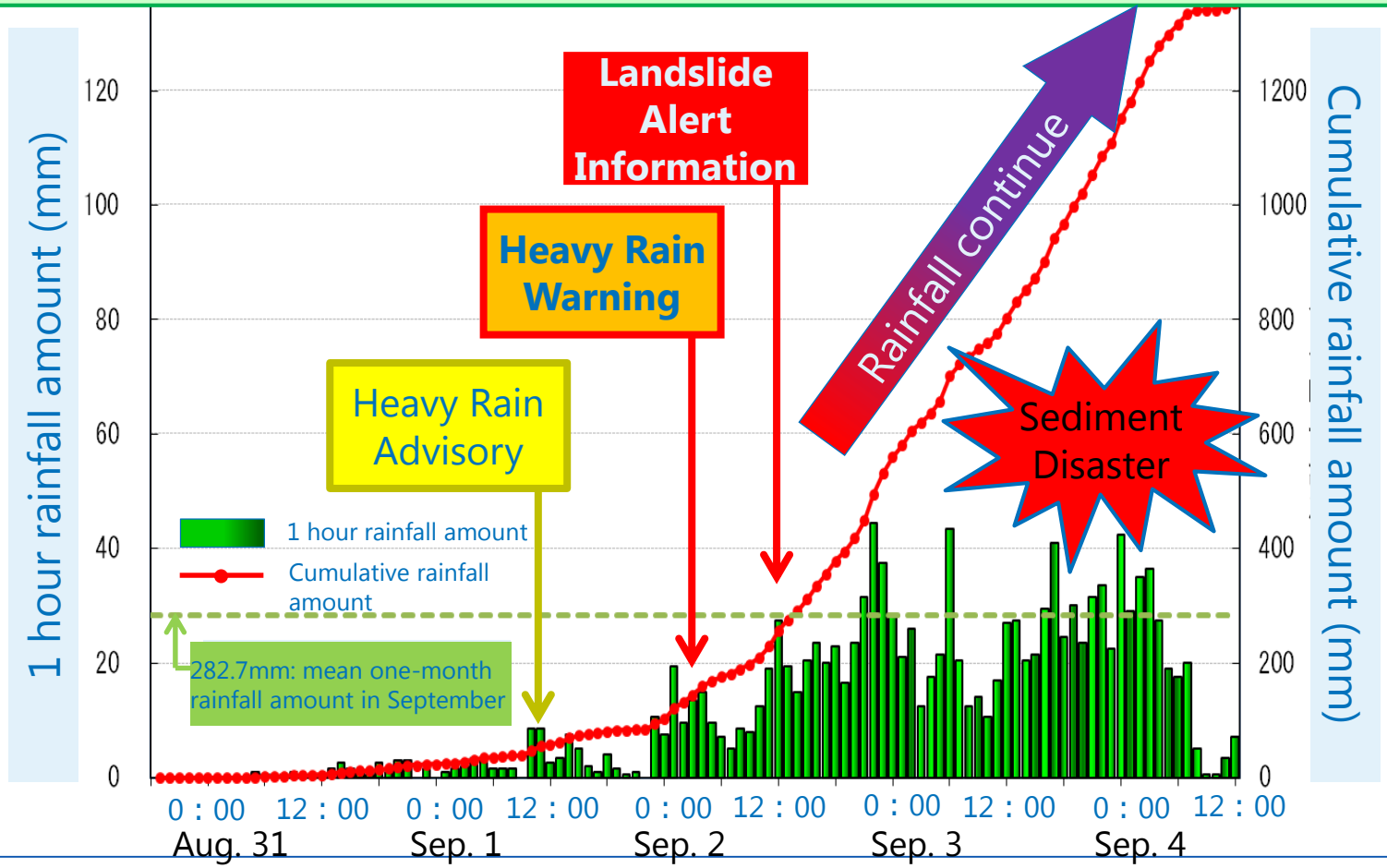


Kamikawa Village, Yoshino-gun, Nara Pref.



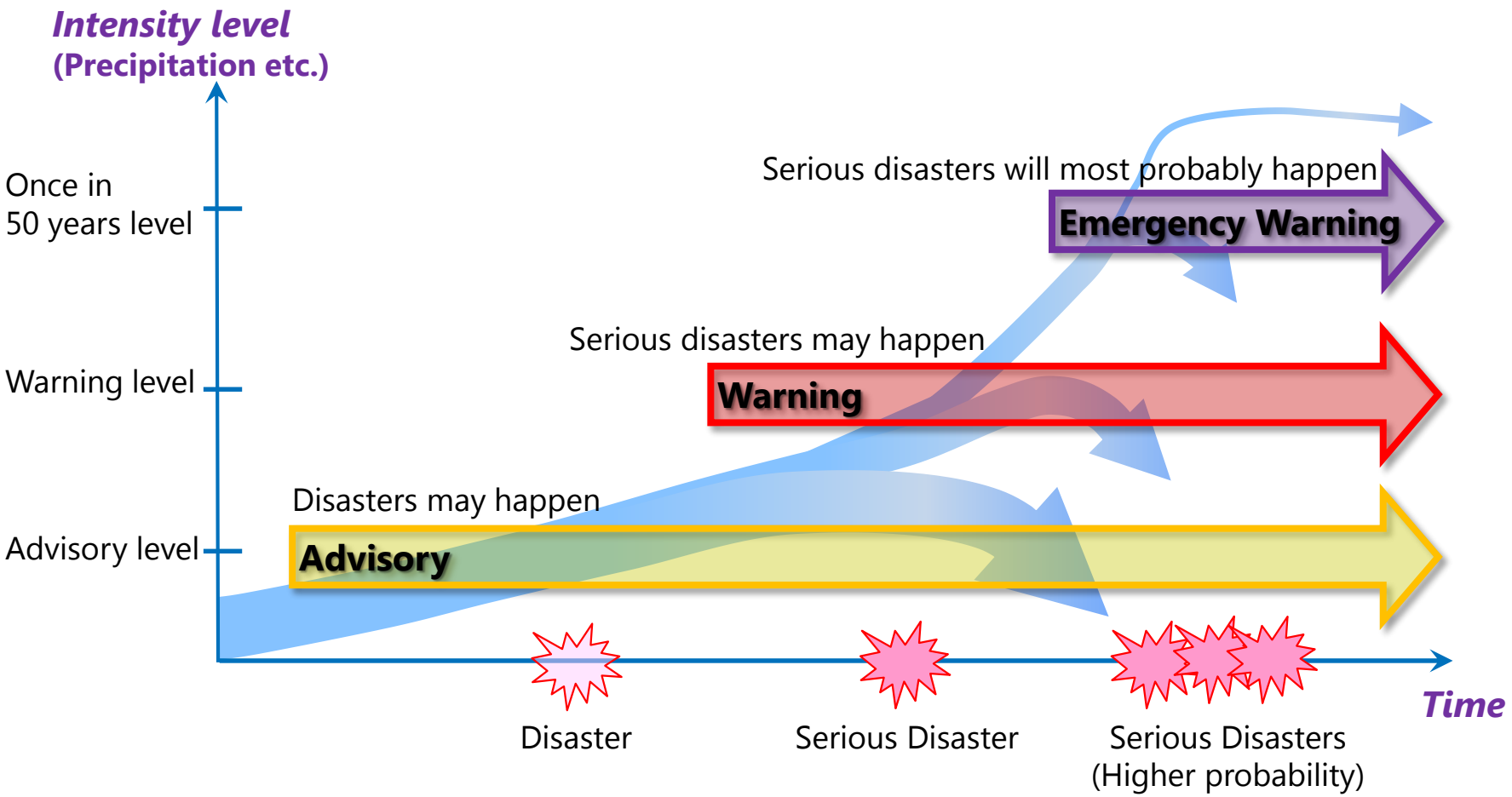
Warnings during the Heavy Rain by Talas

Rainfall continued after JMA had issued warning, and the situation became worse and worse. However, there was no effective way to inform the public of the catastrophic situation we have never experienced!



Observed Rainfall Amount at Kazeya in Totsukawa village, Nara prefecture

Establishment of "Emergency Warning"



Warnings / Advisories Lineup

Emergency Warnings (6)

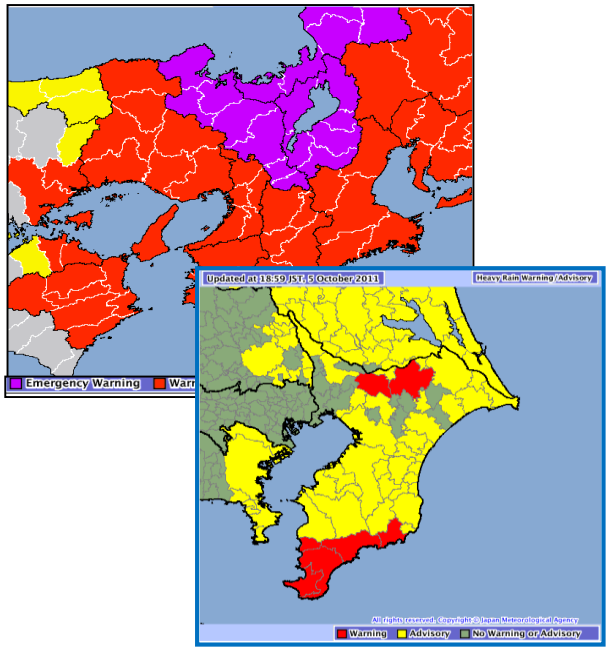
Storm	Snow-storm	
Heavy rain	Heavy snow	
Storm surge	High waves	

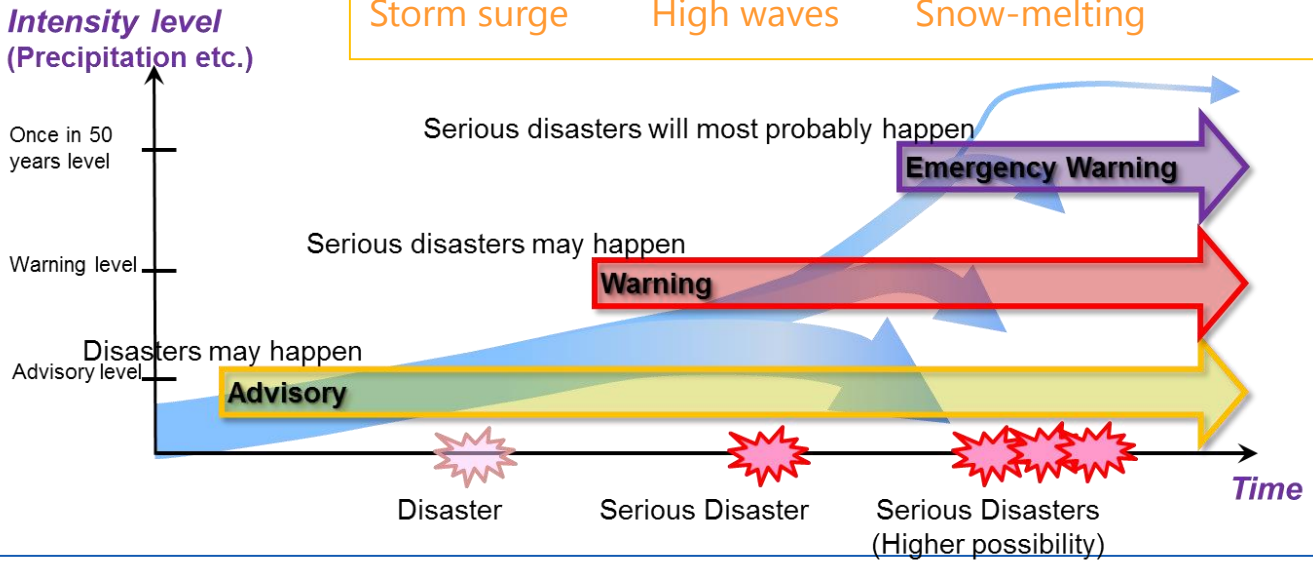
Warnings (7)

Storm	Snow-storm	Flood
Heavy rain	Heavy snow	
Storm surge	High waves	

Advisories (16)

Heavy rain	Gale Gale and snow	
Heavy snow	Dense fog	Thunderstorm
Dry air	Avalanche	Ice (snow) accretion
Frost	Flood	Low temperature
Storm surge	High waves	Snow-melting





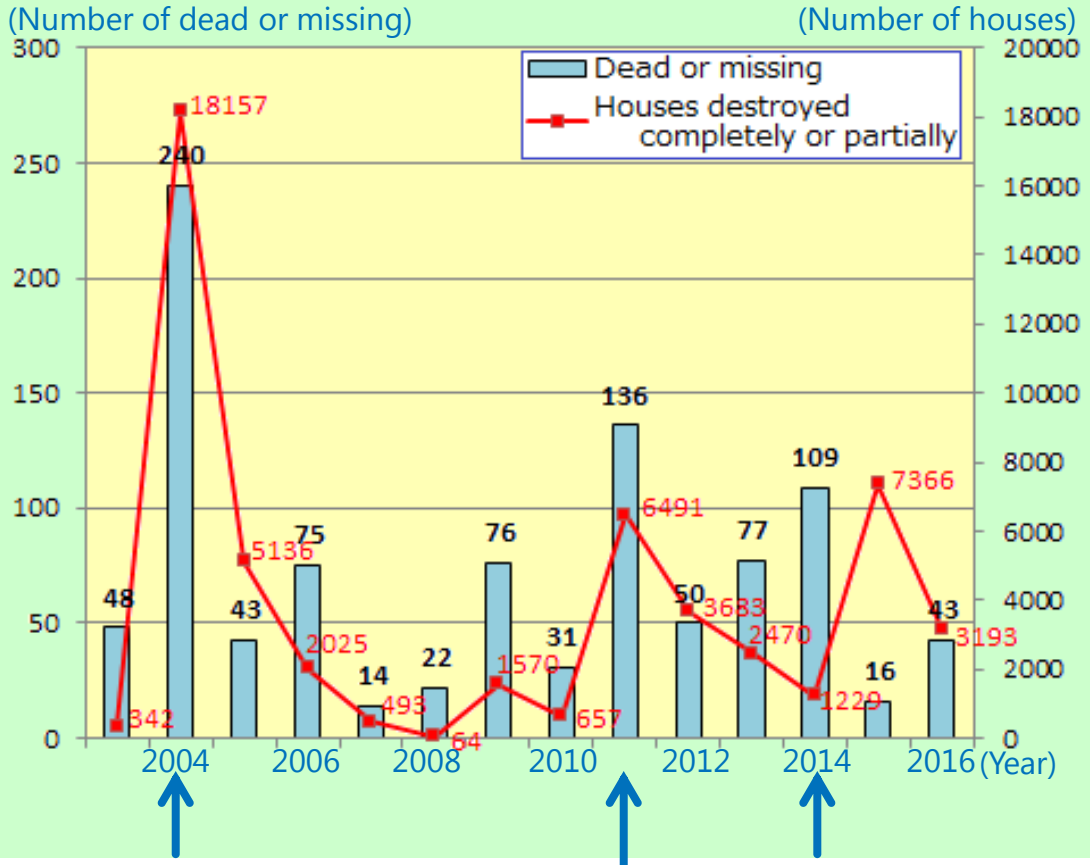
Warning zone is divided into municipalities

Issued by Local Met. Offices

Timeline of major met/hydro-disasters and accompanying improvement of warning services

Damages caused by heavy rain, flood and storms

Source: *Shobo Hakusho 2013, 2017* (White Paper on Fire and Disaster Management)



2004: 10 typhoons struck Japan

2011: Heavy rain caused by STS Talas

2014: Heavy rain disaster in Hiroshima

2 grades; Warnings/Advisories

2004 ten typhoons

Restructuring warnings
- Subdividing warning zones
- Corresponding warning criteria to evacuation order criteria

2011 Heavy rain caused by STS Talas

2013 Emergency Warnings as effective messages in emergency situation

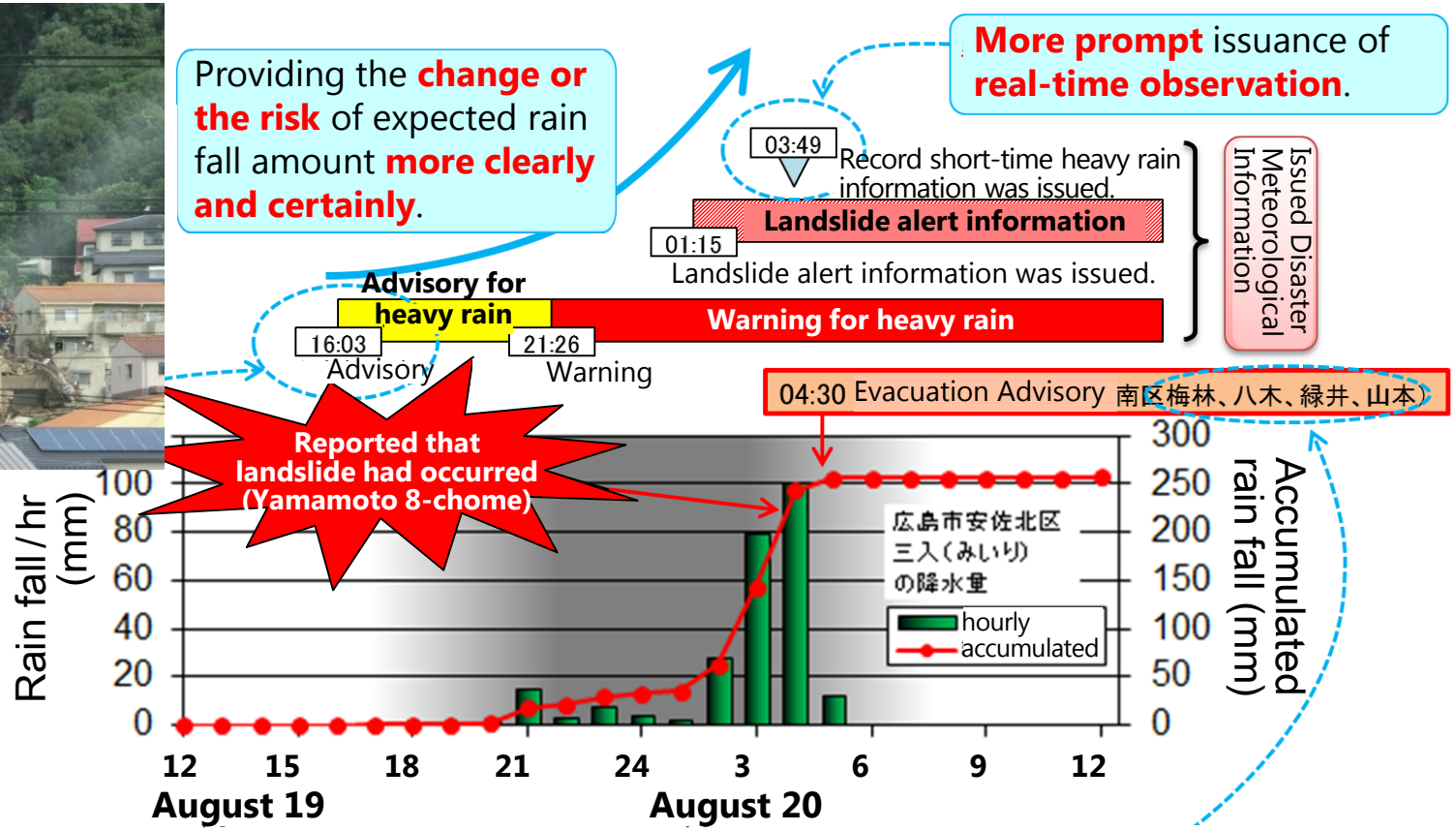
2014 Heavy rain disaster in Hiroshima

2017 Probability of Warnings
2015-2017 Real-time Risk Map

Heavy rain disaster in Hiroshima in 2014

Providing the **change or the risk** of expected rain fall amount **more clearly and certainly**.

More prompt issuance of **real-time observation**.



Providing the probability of warning issuances **at an earlier stage** to avoid evacuation during night, even if the accuracy is not quite high.

Need to **enrich mesh information and promote its use** to support decision making which area to issue an evacuation order.

Note: Report time of landslide occurrence and evacuation advisory issuance is from the "Results of evaluation for evacuation measures against the heavy rain on 20 August 2014" created by Hiroshima-City (reported in January, 2015, at the WG of evaluation for evacuation measures against the heavy rain on 20 August).

Probability of Warnings

Probability of Warning-class Phenomenon

JMA started the operation of probability information on the risk of severe weather phenomena that may have significant impacts with a lead time of up to 5 days in May 2017.

Image

From today to tomorrow

From day after tomorrow to five days ahead

Southern ○○ Prefecture	Probability of warnings					
Target	3 Sun	4 Mon		5 Tue	6 Wed	7 Thu	8 Fri
	18-6	6-24				
Heavy rain	[Mid]	–		–	–	[Mid]	–
Storm(Gale)	–	[High]		–	[Mid]	[High]	–
High waves	–	[High]		–	[Mid]	[High]	–

Provide probability of warnings from tonight to early tomorrow morning by evening to avoid evacuation in midnight

Provide probability of warnings from the day after to five days ahead to support the preparation of DRR stakeholders

[High]: A warning is currently in effect, or phenomena with levels of intensity exceeding the warning criteria are expected.
[Mid]: Phenomena may have levels of intensity exceeding the warning criteria.

Time series of Expected Warnings

Time series of expected warnings in a table format

JMA started the operation of providing time series of expected warnings in a table format with color corresponding to risk to enable users to understand risk and urgency more visually and easily than previous text format

Text format

気象警報・注意報　平成○年○月
根室市
【発表】暴風，波浪警報　大雨，雷，濃霧注意報
【継続】高潮注意報
特記事項　浸水注意
８日昼前までに大雨警報（浸水害）に切り替える可能
８日昼前までに高潮警報に切り替える可能性がある
風　警戒期間　８日明け方から ８日夕方まで
注意期間　８日夜遅くにかけて 以後も続く
ピークは８日昼過ぎ
北の風
陸上　最大風速　２５メートル
海上　最大風速　３０メートル
波　警戒期間　８日明け方から ８日夜
注意期間　８日夜遅くにかけて 以
ピークは８日昼過ぎ
波高　９メートル
浸水　警戒期間　８日昼前から ８日夕方まで
注意期間　８日明け方から ８日夜のはじめ頃
１時間最大雨量　５０ミリ
雷　注意期間　８日明け方から ８日夜遅くまで
高潮　警戒期間　８日９時頃から ８日２４時頃にかけて 以後
注意期間　８日２４時頃にかけて 以後も続く
ピークは８日１５時頃
最高潮位　標高　２．０メートルの高さ
濃霧　注意期間　８日明け方から ８日夜遅くまで
視程　２００メートル以下
付加事項　突風　ひょう

Time series in table format

Updated at 21:19 JST, 7 October 2015 Expected Warnings, Advisorie
Nemuro-shi:
【Announcement】 Gale, High waves　Heavy rain, Thunderstorm, Dense fog
【Continuation】 Storm surge

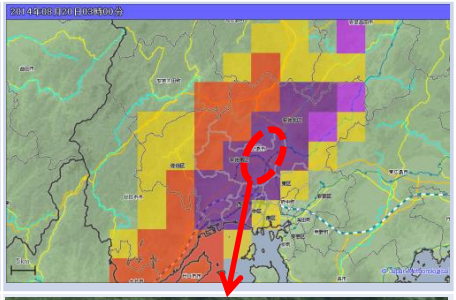
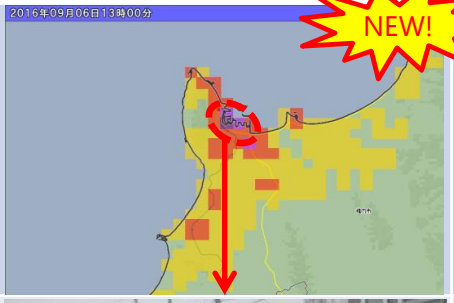
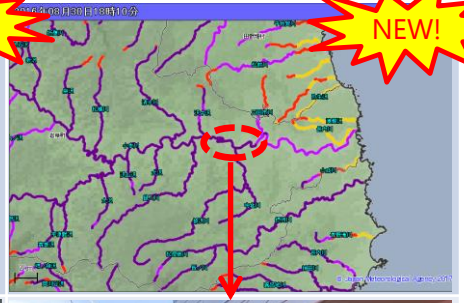
Nemuro-shi			Phenomenon development (■Warnings ■Advisories)									Remarks
Current Warnings and Advisories			7 Fri	8 Sat								
			21–24	0–3	3–6	6–9	9–12	12–15	15–18	18–21	21–24	
Heavy rain	(Inundation) Maximum hourly precipitation (mm)		10	10	30	30	50	50	50	30		Inundation
Storm	Wind direction/speed (arrows/m/s)	Land	15	18	20	22	22	25	18	15	15	Advisory still active
		Sea	20	22	25	28	28	30	22	20	20	Advisory still active
High waves	Wave height (m)		5	5	8	8	8	9	8	7	7	Warning still active
Storm Surge	Tide level (m)		0.7	0.7	0.8	1.0	1.8	2.0	1.8	1.2	1.2	Warning still active Peak: around 15 JST on 8th
Thunder storm												hail
Dense fog												less than 200m

Enable us to understand easily period and peak timing of warning-level phenomena

Real-time Risk Map

Technical development for landslide, inundation and flood warnings

To develop information formats easier to understand risks of hazardous phenomena and the urgency, JMA started the operation of Real-time Risk Map that provides spatially specific information on risk-level of landslide, inundation and flood in colors using a standardized color code.

	Landslide (2015-)	Inundation (2017-)	Flood (2017-)
Risk Map High / Risk / Low Extreme risk High risk Warning Caution Check weather bulletin		 NEW!	 NEW!
Related Disaster			
Resolution/Update Interval/Lead time	5 km/10 min/2 hours	1 km/10 min/1 hour	1 km/10 min/3 hours

Summary of Improvement of EWS

Covey proactively risks, even if the probability is not high

NEW!

Probability of Warnings

Convey increase of risks

Advisories

Warnings

etc.

Convey increase of risks

DRR stakeholders

Residents

Understand the detail of risks

Check time and area of risks

Explain or visualize warnings

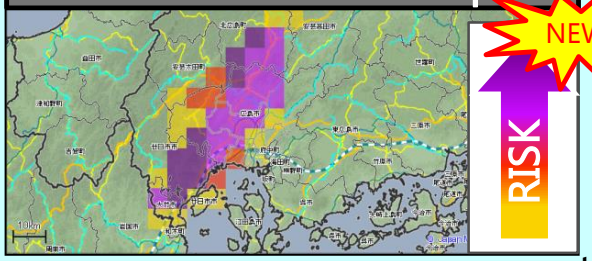
Time series of Expected Warnings

NEW!

○○市 警報・注意報等		今後の推移（■警報級 □注意報級） 7日 18時	21時	0時	3時	6時	8日 9時	12時	15時	18時	
大雨	雨量(ミリ)	10	30	60	60	50	30				
	(浸水害)										浸水注意
	(土砂災害)										土砂災害注意
洪水	(洪水害)										
雷											竜巻、ひょう

Real-time Risk Map

NEW!



etc.

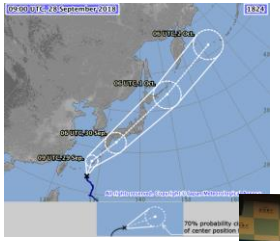
- Lead to more appropriate emergency response
  - Prompt judgements of issuing evacuation orders by Mayors
  - Proactive evacuation of residents

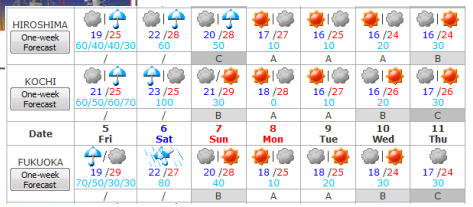
Time-Series of Information Issuances and Other Supportive Actions

A series of Information for Timely Responses

Evacuation route Leaflets etc.

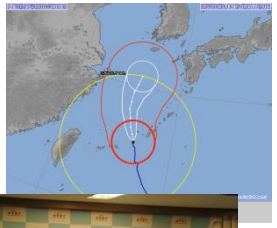
Weekly forecast 5-day TC forecast etc.

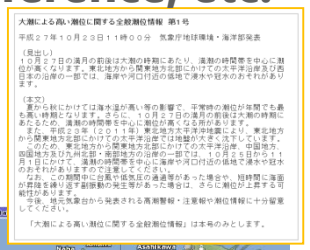


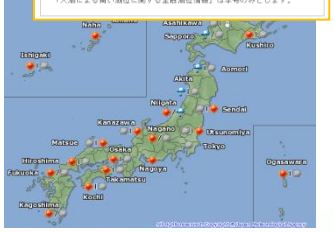


HIROSHIMA One-week Forecast	19 /25 60/40/40/30	22 /28 60	20 /28 50 C	17 /27 10 A	16 /25 10 A	16 /24 20 A	16 /24 30 B
KOCHI One-week Forecast	21 /25 60/50/60/70	23 /25 100	21 /29 30 B	18 /28 0 A	16 /27 10 A	16 /26 20 B	17 /26 30 C
Date	5 Fri	6 Sat	7 Sun	8 Mon	9 Tue	10 Wed	11 Thu
FUKUOKA One-week Forecast	19 /29 70/50/30/30	22 /27 80	20 /28 40 B	18 /25 10 A	18 /25 20 A	18 /24 30 B	17 /24 30 C

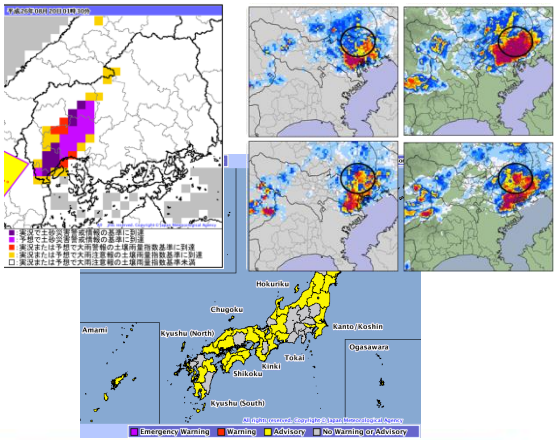
Daily forecasts, Bulletins, Press conference, etc.



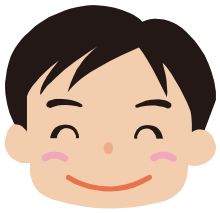




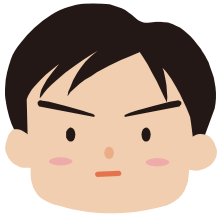
Warnings/advisories Real-time mesh info. etc.



1 week ~ a few days before → A few days ~ 12 hours before → 12 hours ~ 2 hour before → As soon as possible



Check dangerous areas beforehand



pay attention to updated info.

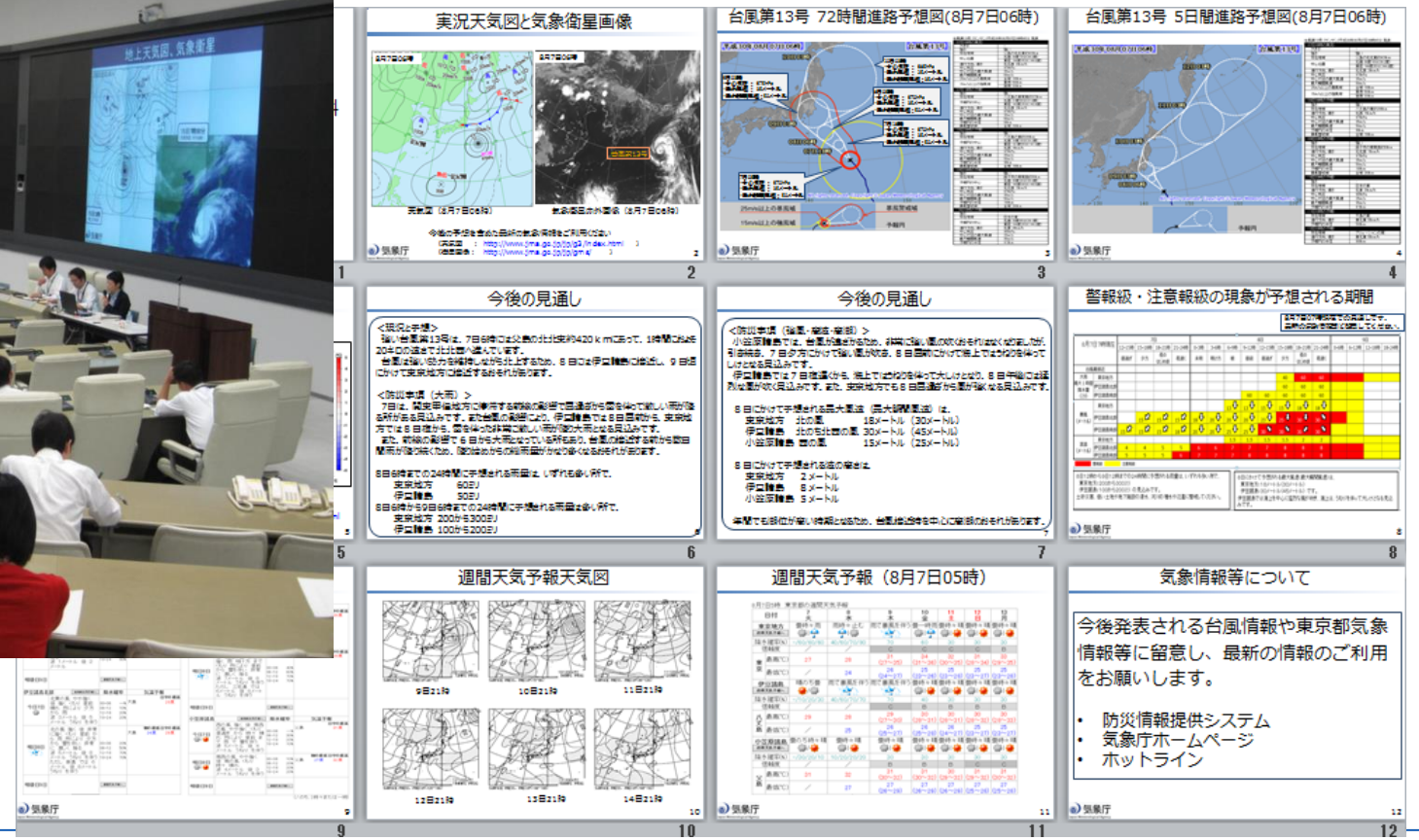
Prepare for evacuation

Evacuate/ Take action

[Example] Briefing to Local Gov. before Typhoon

Example

JMA holds a briefing to local municipalities, expected to be affected by a tropical cyclone, 1 – 2 days in advance.



Briefing material used for TC1813 to Tokyo Metropolitan Government

[Example] Press Conference

Example

JMA holds press conferences with enough lead-time to call for caution/attention.

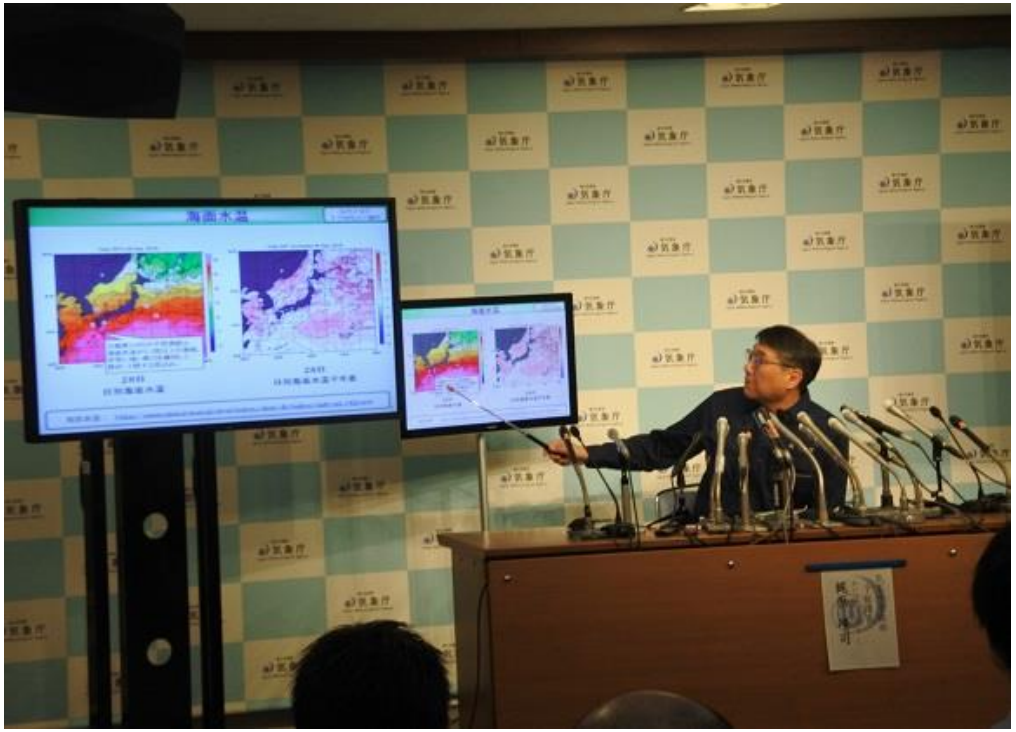


Photo of Press Conference

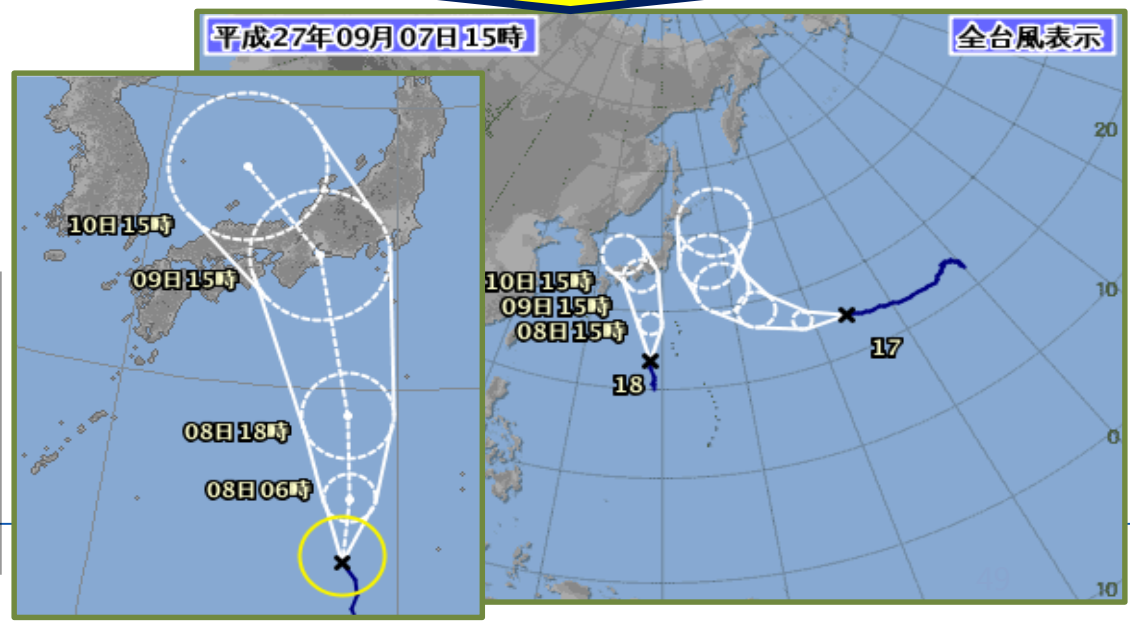
[Example] Time-series of Information Issuance

Weather condition	Information issued by JMA	
A few days to 1 day before heavy rain Probability of heavy rain increases	**Probability of Warnings**	**Bulletin for Heavy rain**
Half a day to a several hours before heavy rain It starts raining Rain strength increases	**Heavy rain Advisory**	
A several hours to 2 hours before heavy rain Rain becomes heavy Rain becomes very heavy	**Heavy rain Warning**	
Heavy rain only once every 50 years in wide area	**Heavy rain Emergency Warning**	**Landslide Alert Information**

Probability of Warnings

Southern Tochigi Prefecture	Probability of warnings					
Target	7 Mon	8 Tue		9 Wed	10 Thu	11 Fri	12 Sat
	18-6	6-24				
Heavy rain	–	–	[Mid]	–	–	–

Check Typhoon Information



[Example] Time-series of Information Issuance

Weather condition	Information issued by JMA	
	Probability of Warnings	Bulletin for Heavy rain
A few days to 1 day before heavy rain Probability of heavy rain increases		
Half a day to a several hours before heavy rain It starts raining	Heavy rain Advisory	
Rain strength increases		
A several hours to 2 hours before heavy rain	Heavy rain Warning	
Rain becomes heavy		
Rain becomes very heavy	Heavy rain Emergency Warning	Landslide Alert Information
Heavy rain only once every 50 years in wide area		

Probability of Warnings

Southern Tochigi Prefecture	Probability of warnings					
Target	8 Tue	9 Wed		10 Thu	11 Fri	12 Sat	13 Sun
	18-6	6-24					
Heavy rain	[Mid]	[High]		[High]	–	–	–

Check Bulletin

平成２７年台風第１８号に関する栃木県気象情報　第２号

平成２７年９月８日１６時５６分　宇都宮地方気象台発表

（見出し）

台風第１８号と前線の影響で、栃木県では９日朝から１０日にかけて大雨となるでしょう。土砂災害、河川の増水、はん濫に警戒し、低い土地の浸水、落雷や竜巻などの激しい突風に注意してください。

（本文）

＜＜中略＞＞

Period of severe weather phenomena

［防災事項］

＜大雨・雷・突風＞

栃木県では、９日朝から１０日にかけて１時間に４０ミリの激しい雨が降る見込みです。山地を中心に総雨量が多くなり、大雨となるおそれがあります。

９日１８時までの２４時間に予想される雨量は、多い所で、
北部、南部ともに　２００ミリ
の見込みです。

Expected hourly rainfall amount

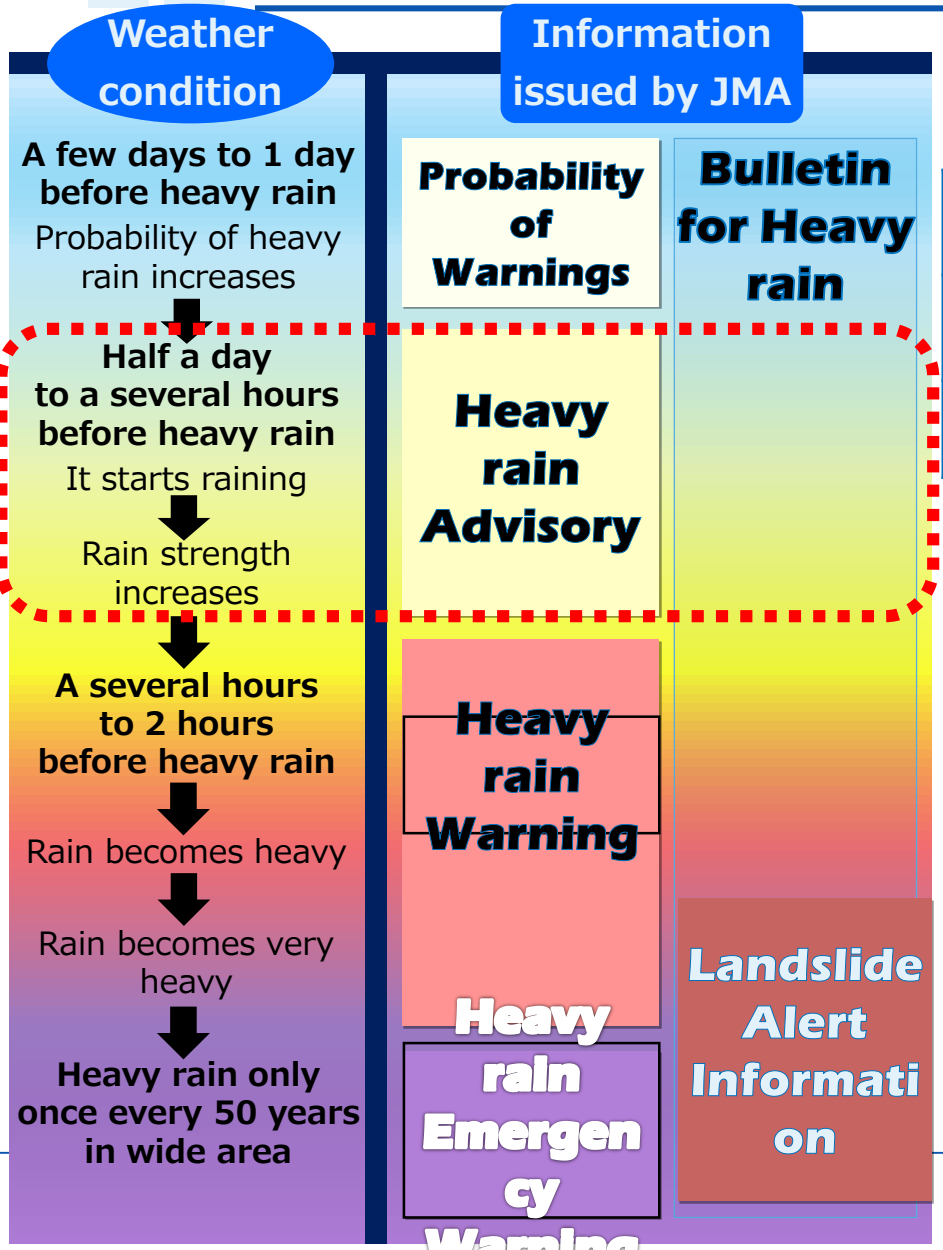
その後、９日１８時から１０日１８時までの２４時間に予想される雨量は、多い所で、
北部、南部ともに　１００ミリから２００ミリ
の見込みです。

Expected 24-hour rainfall amount

土砂災害、河川の増水、はん濫に警戒してください。

＜＜後略＞＞

[Example] Time-series of Information Issuance



Probability of Warnings

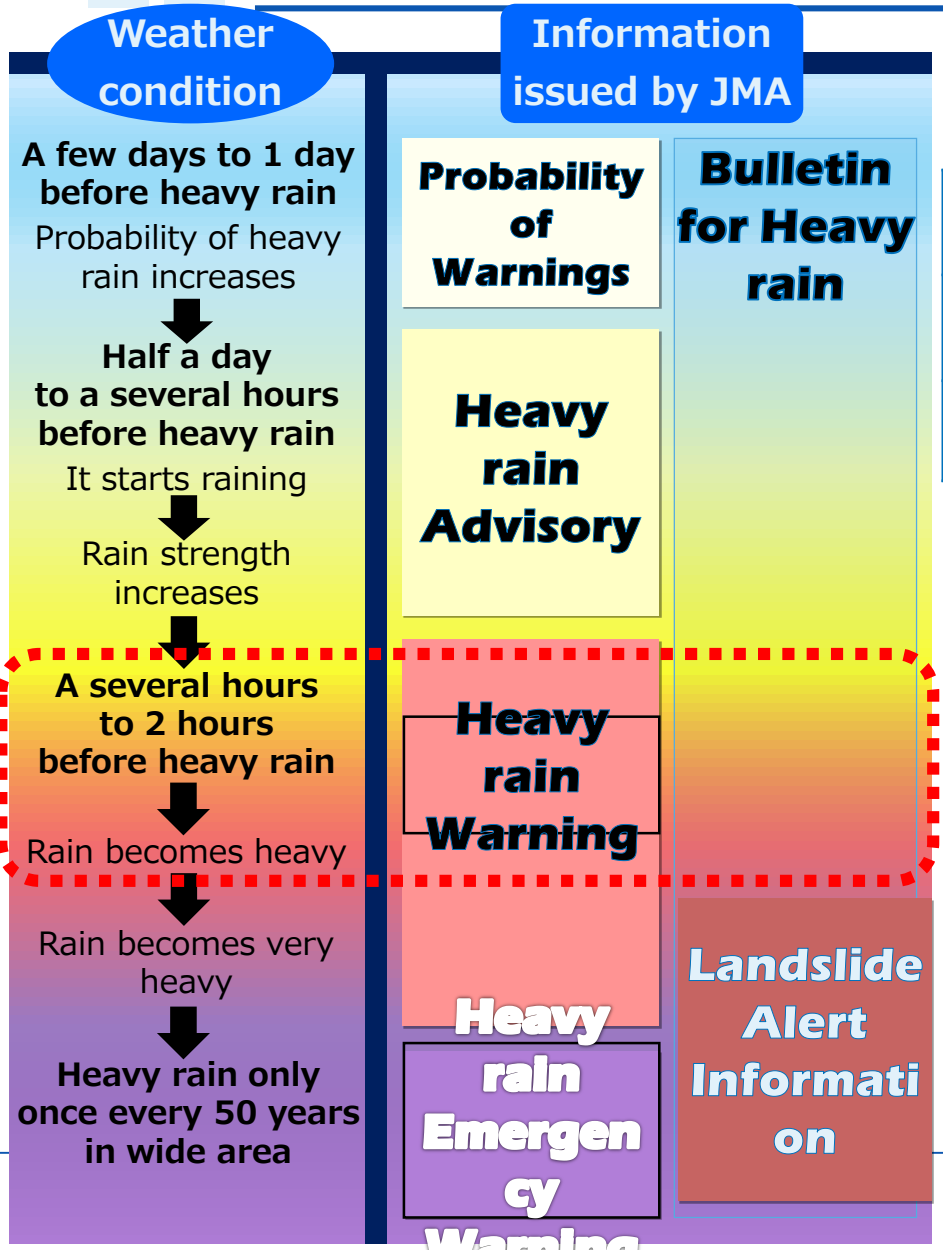
Southern Tochigi Prefecture	Probability of warnings				
Target	9 Wed		10 Thu	11 Fri	12 Sat	13 Sun
	6-18		18-24			
Heavy rain	[Mid]		[High]	–	–	–

Check Advisory

Kanuma-shi	Phenomenon development (■Warnings □Advisories)									Remarks
Current Warnings and Advisories	9 Wed						10 Thu			
	6-9	9-12	12-15	15-18	18-21	21-24	0-3	3-6	6-9	
Heavy rain: Maximum 1-hr rainfall (mm)	40	40	50	50	50	40				
Heavy rain: Inundation										
Heavy rain: Landslide										Warning-class further ahead

Warning-class From Early night

[Example] Time-series of Information Issuance



Probability of Warnings

Southern Tochigi Prefecture	Probability of warnings					
Target	9 Wed		10 Thu		11 Fri	12 Sat	13 Sun
	12-18	18-6	6-24			
Heavy rain	[Mid]	[High]	[High]		–	–	–

Check Warning

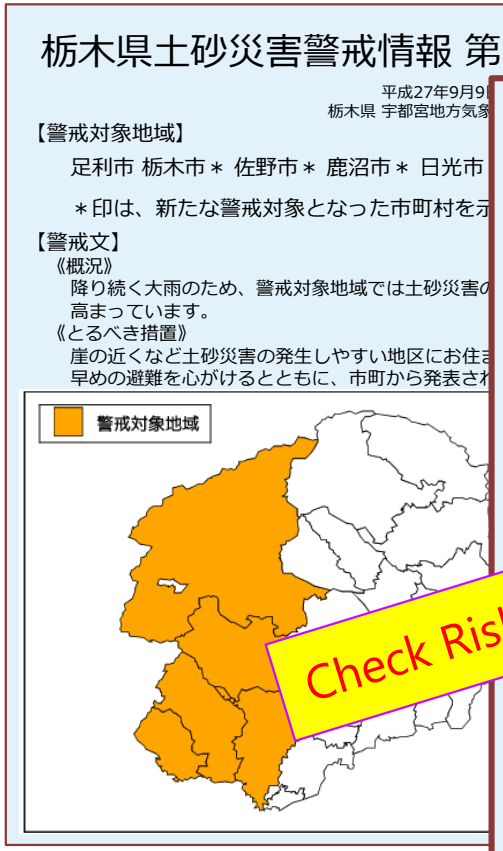
Kanuma-shi	Phenomenon development (■Warnings □Advisories)									Remarks
Current Warnings and Advisories	9 Wed				10 Thu					
	12-15	15-18	18-21	21-24	0-3	3-6	6-9	9-12	12-15	
Heavy rain: Maximum 1-hr rainfall (mm)	50	50	50	50						
Heavy rain: Inundation										
Heavy rain: Landslide										Warning-class further ahead

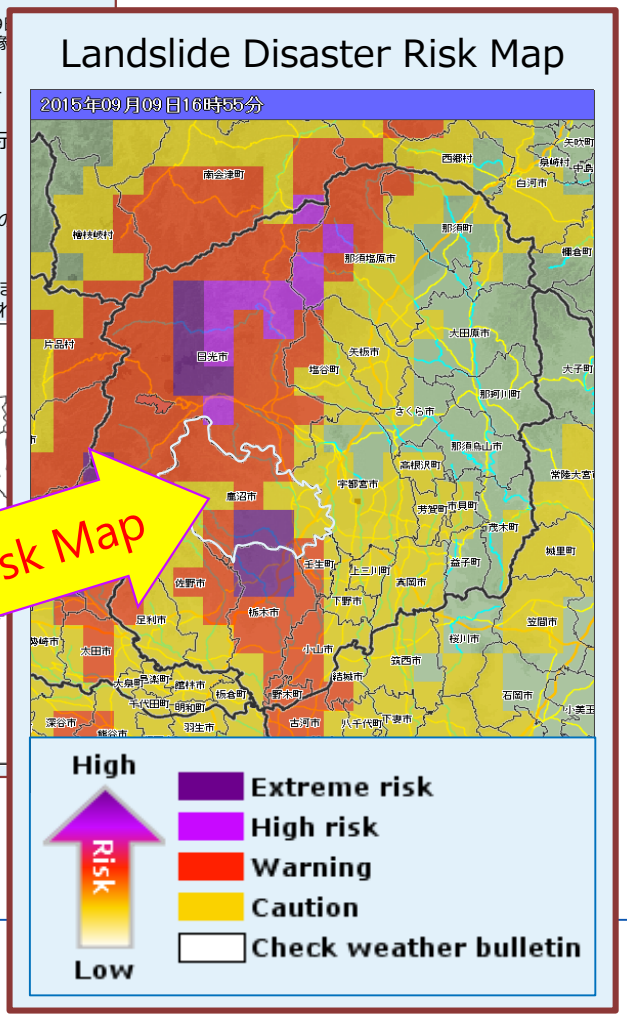
Warning-class From evening

[Example] Time-series of Information Issuance

Weather condition	Information issued by JMA	
	Probability of Warnings	Bulletin for Heavy rain
A few days to 1 day before heavy rain Probability of heavy rain increases		
Half a day to a several hours before heavy rain It starts raining	Heavy rain Advisory	
Rain strength increases		
A several hours to 2 hours before heavy rain	Heavy rain Warning	
Rain becomes heavy		
Rain becomes very heavy	Heavy rain Emergency Warning	Landslide Alert Information
Heavy rain only once every 50 years in wide area		

Landslide Alert Information





[Example] Time-series of Information Issuance

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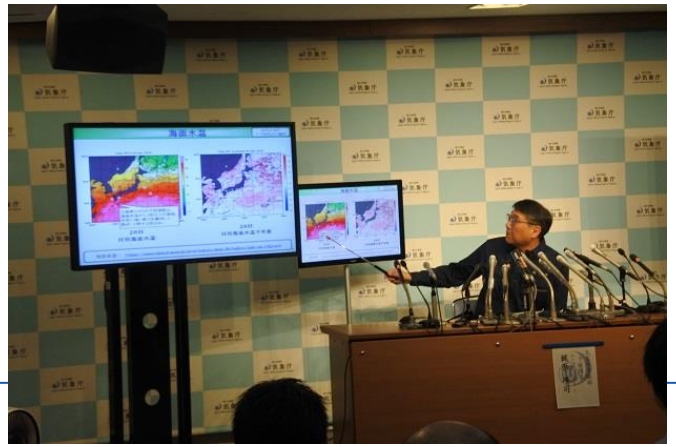
A several hours to 2 hours before heavy rain	Heavy rain Warning	
Rain becomes heavy		
Rain becomes very heavy	Heavy rain Emergency Warning	Landslide Alert Information
Heavy rain only once every 50 years in wide area		

Emergency Warning

Kanuma-shi		Phenomenon development (■Emergency Warnings ■Warnings □Advisories)									Remarks
Current Warnings and Advisories		10 Thu								11 Fri	
		0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	0-3	
Heavy rain	Maximum 1-hr rainfall (mm)	80	80	40	40						
	Inundation										
	Landslide										



Press conference

[Example] Time-series actions to be taken

Lead-time for TC landfall	MLIT	Traffic Services	Municipalities	Residents
TC generates				
3 days	○ TC forecast	Early building of system/structure	Early notice of the possibility of service suspension	Early notice of the possibility of wide-area evacuation
Possibility of TC landfall is identified	○ Press conference on TC	○ Contact system is checked. ○ Cooperative structure with related organizations is checked.	○ Traffic service suspension is announced in advance.	○ Wide-area evacuation system is checked and announced.	○ Emergency supplies are prepared.
1 day				Early start of wide-area evacuation
Possibility of disaster is identified	○ Press conference on TC (Possibility of Emergency Warning) ○ Warning for heavy rain, flood, etc. ○ Flood warning information	○ Liaison officers are dispatched. ○ Administrative facilities are inspected.	○ Procedures for service suspension is checked and officially announced.	○ Wide-area evacuation advisory/order is issued. ○ Wide-area evacuees are guided and accepted.	○ Wide-area evacuation starts.
12 hours	○ Emergency Warning for heavy rain, storm, storm surge, etc. information			Completion of evacuation before TC landfall
TC approaches		○ Emergent situation is notified to heads of municipalities.	○ Service is suspended. ○ Facility maintenance and shunting are completed.	○ Evacuation advisory/order is issued.	○ Indoor safety is secured.
No Lead Time				Service suspension for earlier recovery and resumption
TC lands	○ Flooding information	○ TEC-FORCE activity. (e.g., Elimination of road obstacles) ○ Damage situation is grasped. ○ Emergency transportation roads are secured.	○ Damage situation is grasped. ○ Facilities are inspected. ○ Prospect of service resumption is officially announced.	○ Support is requested.	

Quoted and arranged a document used in the 2nd meeting for the concept of disaster prevention and mitigation corresponding to the new stage: http://www.mlit.go.jp/saigai/newstage.html

Simplified a document at the Headquarters for water-related disaster management.

Summary

- Legal framework is a foundation for effective Early Warning System and it responds to various kinds of disasters based on a concept of "multi-hazards."
- A multi-hazard early-warning system can issue a warning against one or more hazards and contributes to higher efficiency and consistency.
- In Japan, as an example, the Disaster Countermeasure Basic Act* was enacted in response to damages caused by TY Vera. Thereafter, the warning system has also been improved in response to severe disasters in 2004, 2011 and 2014.
- Providing series of information at a proper time supports timely response to disasters risks. This concept is called "timeline."

* The Act clearly defines responsibilities and roles that national, prefectural and municipal governments and requests each government to prepare disaster management plans and implement them

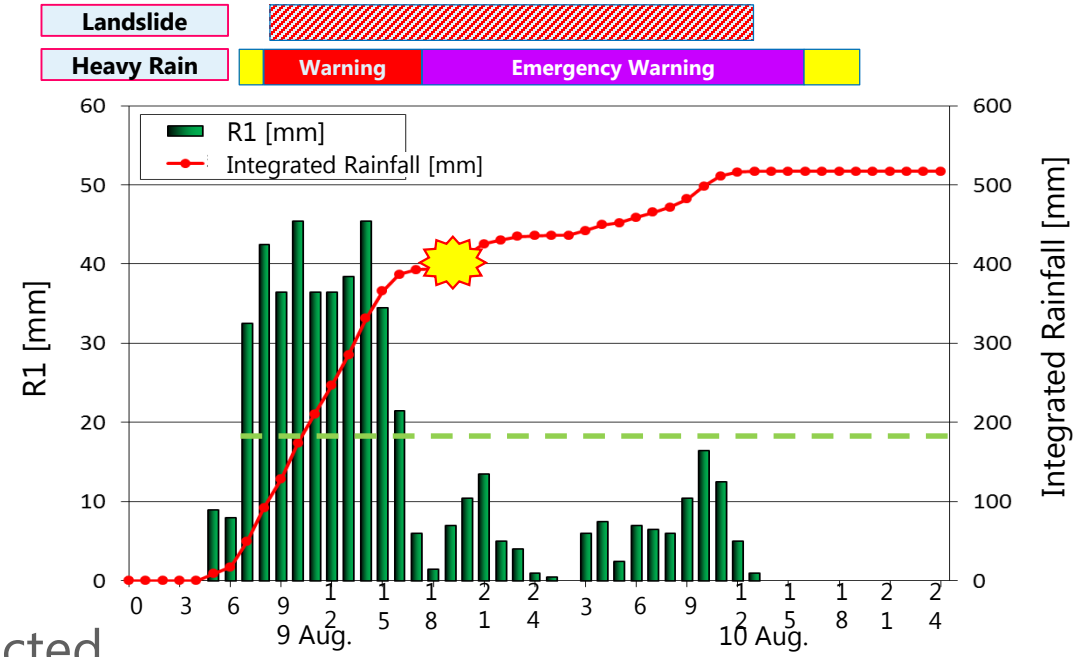
III. Other Factors for Successful EWS

Warning Evaluation and Public Survey

Review and evaluation of issued warnings

Review is an important step of the process to improve DRR actions based on the actual experience.

- Was the timing of warning issuance appropriate?
- Could local governments take proper actions based on our information?



Public survey

Public survey is sometimes conducted.
This is also a good method to grasp how much and well the information is used/understood. The results will lead to an appropriate improvement.

Various Communication Tools

Choose appropriate communication media

NMHSs need to understand advantages and disadvantages of various communication media, including SNS, and choose appropriate ones depending on content and timing of information they issue.

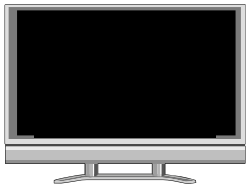
Newspaper

Radio

Smart/mobile phone

Fax

TV



Internet/ Social media

[Example] Hot Line in Emergency

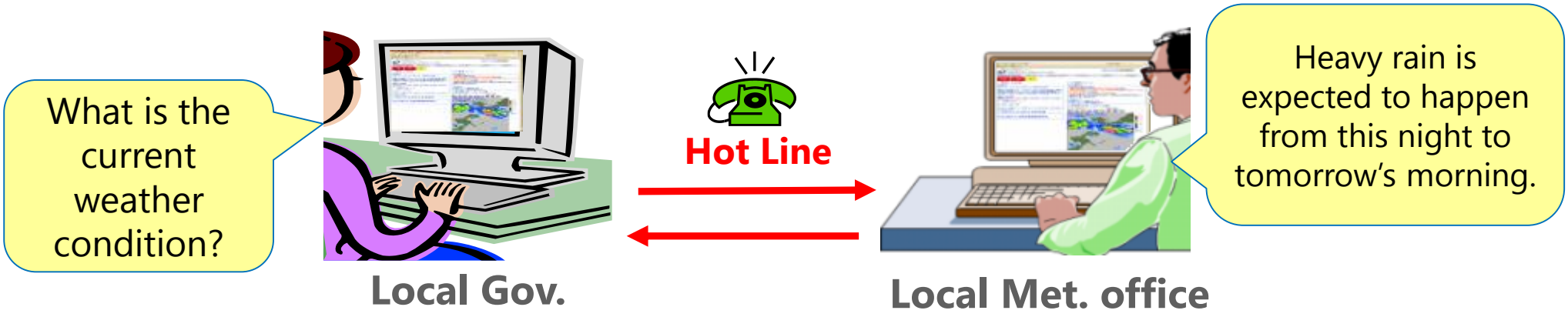
"Hot Line"

In addition to forecasts/warnings, a dedicated telephone line is adopted between Local governments and Local Met. offices.

<Advantages>

- ✓ It is easier for staff at Local Gov. to ask Met. staff about weather condition.
- ✓ Met. staff can directly convey the current severity to Local Gov. staff

This is helpful for decision-making of Local Gov. (issuing evacuation instruction)



Enhancement of Top-Level Communication

Top-level communications

【Construction of face-to-face relationship with municipalities】

Regular visits, communications on SNSs, joint training/drill activities

Meeting with Mayor of Ikutsu

Mayor of North Akita on Facebook

Meeting with Governor of Akita Prefecture

Advice in disaster situation

【Weather commentary from Director-General of Meteorological Office 】

Sharing the risk of approaching disaster, issuing instructions for prompt evacu… orde… of resi… …tion

Collaboration Activities with Local Governments

Normal Situation

- Coordination on warning criteria
- Dispatch of experts for local DRR to local government
- Advice on revision of Local Disaster Management Plan and "Decision and Dissemination Manual for Evacuation Advisories and Orders"
- Instruction and training about how to use JMA's information
- Collaborative emergency drilling and DRR awareness activities
- Development and maintenance of information dissemination system

Disaster situation

- Forecaster briefing
- Hotline consultation
- Participation in local government's disaster management headquarters

After Disaster

- Provision of customized meteorological information for supporting disaster relief activities
- Review and improve emergency response with local government's disaster management team

JETT (JMA Emergency Task Team) since 1 May 2018

JMA has established a team JETT on 1 May 2018, aiming at strengthening the support for local governments' disaster response in case disaster has occurred or is expected to occur.

Cooperate

Branch Office

Prefectural Office

Municipal Office

- During emergency, JMA dispatches experts to municipal governments or disaster management HQs.
- JMA supports disaster response based on the needs and the situation or activities being taken by those offices.

Experts present detailed weather information on-site at prefectural offices and councils, or via video conference when disaster conditions are expected.

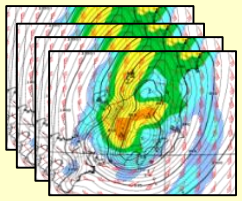
JETT
(JMA Emergency Task Team)

Local Met. Office

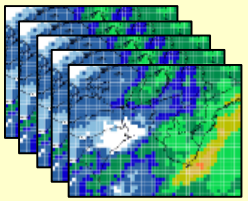
Forecasters or other experts

Other Local Meteorological Office

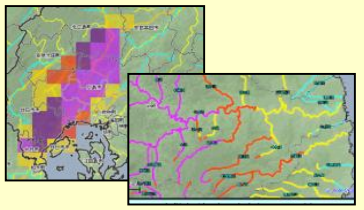
1. Clarification of current weather conditions and provision of updates in real time.
2. Prompt provision of information from disaster management HQ to local meteorological offices on the situation and scale of damage.



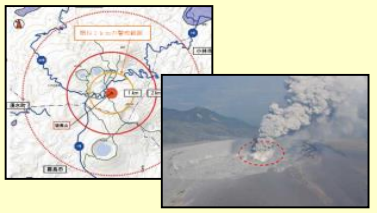
NWP Results



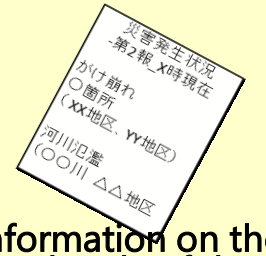
QPE



Real-time Risk Map



Volcano Information



Information on the state and scale of damages

Summary

To build Effective EWS, it is necessary to …

- Fill gaps between NMHSs and users toward user-oriented services that effectively supports users' decision making by taking the step-by-step approach to implement the plan–do–check–adjust cycle involving users.
- Understand how the EWS is located in country's overall disaster management framework, which responds to various kinds of disasters based on a concept of "multi-hazards."
- Provide series of information at a proper time to support timely response to disasters risks based on a concept of "timeline".
- Enhance the cooperation with related organization in from normal situation, disaster situation, to after disaster situation.

Thank you for your attention.