Improving Early Warning for Storm Surge in Japan by "Probability of Warnings"

17th Integrated Workshop

ESCAP/WMO Typhoon Committee

29-30 November 2022

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Outline of this presentation

- JMA's early warning information (probability of warning) and how it is communicated with municipalities and the public.

- Upgraded early warning for storm surge in Japan by "Probability of Warnings."

Damage from storm surge disasters in Japan
Tropical cyclone Jebi 2018

Inundation of airport facilities
(Kansai International Airport)

Seawater rushing to the sluice gate due to storm surge and high waves in Osaka.

Photo credits: Kinki Regional Development Bureau

Introduction

- The Japan Meteorological Agency issues an "Early Warning Information (**probability of warning**)" with two levels: "High" and "Medium", when a warning-level event (heavy rain, wind storm, etc.) is forecast for the next five days.

From today to tomorrow

From the day after tomorrow to five days ahead

Southern ○○ Prefecture	Probability of warning issuance								
Target day/time	11/3	11/4				11/5	11/6	11/7	11/8
	18-24	0-6	6-12	12-18	18-24				
Heavy rain	[Mid]		–			–	–	[Mid]	–
Storm(Gale)	–		[High]			–	[Mid]	[High]	–
High waves	–		[High]			–	[Mid]	[High]	–
Storm surge	–		[High]				[Mid]	[High]	

Before six o'clock in the evening –
Provide probability of warning issuance tonight or early the next morning, to avoid evacuation in the middle of the night

Provide probability of warning issuance up to five days ahead to support the preparation needed for DRR stakeholders.

Storm surge early caution information

•The possibility of a storm surge warning level, which was only issued when a typhoon was present, is now issued daily as early warning information (possibility of a warning level), including storm surges caused by factors other than typhoons.

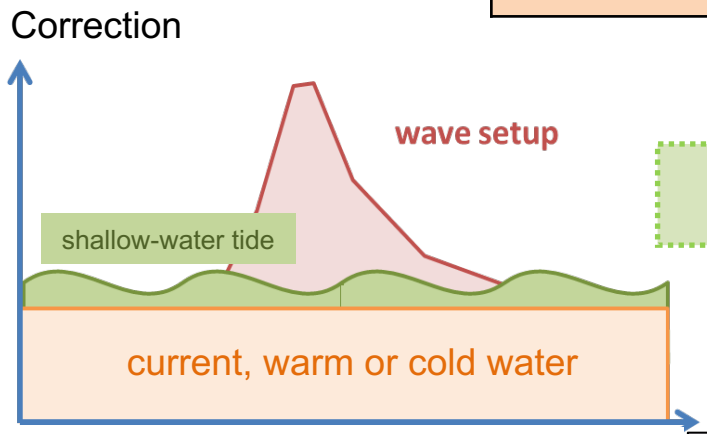
• If the possibility of a warning level for storm surge is [High] or [Medium] in the early warning information, it is placed at Alert Level 1, which requires increased preparedness for storm surge disasters.

Alert Level		New Evacuation Information
5	Disaster occurrence/ Disaster impending	Emergency ※1 Safety Measures
	<Be sure to evacuate by Alert Level 4!>	
4	High risk of disaster	Evacuation ※2 Instruction
3	Risk of disaster	Evacuation of the Elderly, Etc. ※3
2	Weather worsening	Heavy Rain, Flood, or Storm Surge Advisories (Japan Meteorological Agency)
1	Risk of weather worsening	Probability of Warnings (Japan Meteorological Agency)

Hyogo : Northern Region : Probability of warnings										
Issued at 11:00 JST, 19 Oct. 2022										
Hyogo : Northern Region		10/19		10/20			10/21	10/22	10/23	10/24
		12-18	18-24	00-06	06-12	12-24				
Storm Surge	Probability of warnings	-	-		[Mid]		[High]	-	-	-

Outline of storm surge early caution information guidance

Japan storm surge model forecast time 39 or 51hours	Japan Storm Surge Probabilistic Forecast System(only typhoon) Forecast time 132hours	Asian Storm Surge Ensemble Forecast System (only GSM) Forecast time 132hours



Add correction

(Japan area) storm surge guidance (until 39 or 51hours ahead)

Use storm surge early caution information until five days ahead

A final decision by the forecaster based on guidance

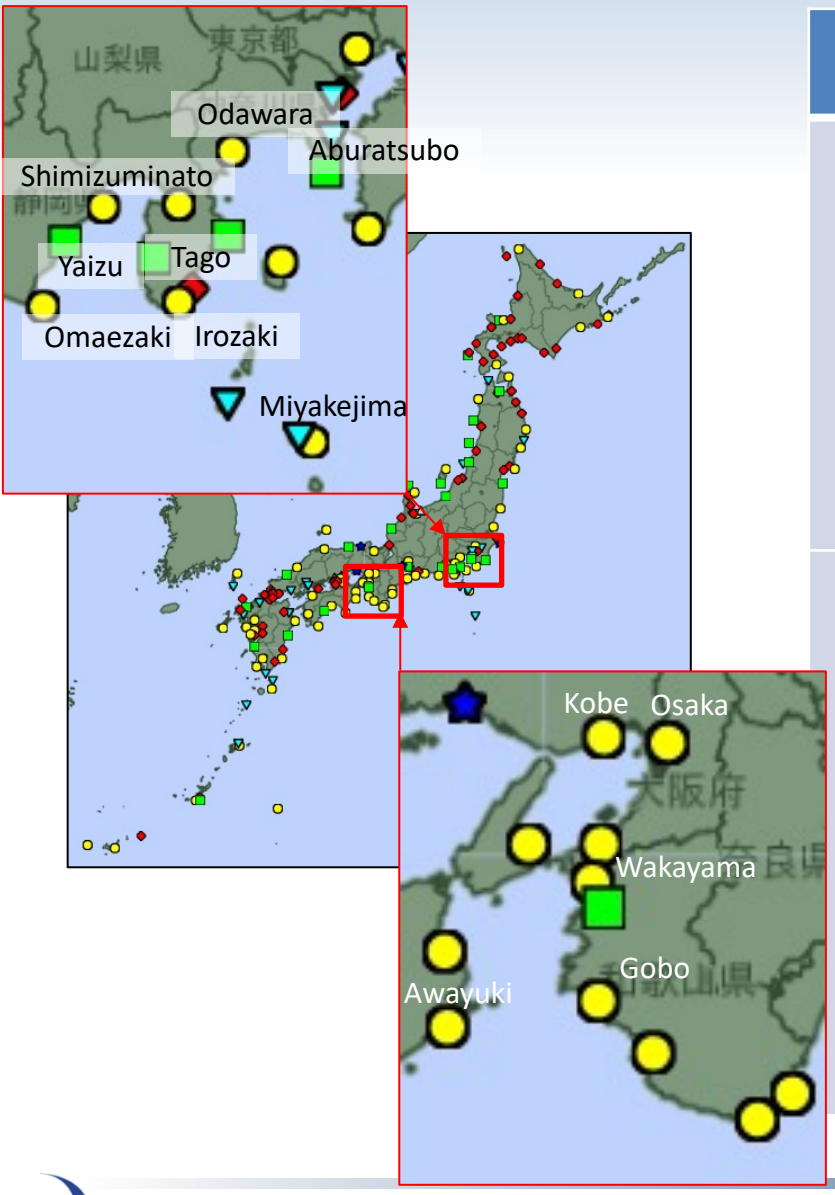
Warning grade possibility

Hyogo:Northern Region:Probability of warnings

Issued at 11:00 JST, 19 Oct. 2022

Hyogo:Northern Region		10/19		10/20			10/21	10/22	10/23	10/24
		12-18	18-24	00-06	06-12	12-24				
Storm Surge	Probability of warnings	-	-		[Mid]		[High]	-	-	-

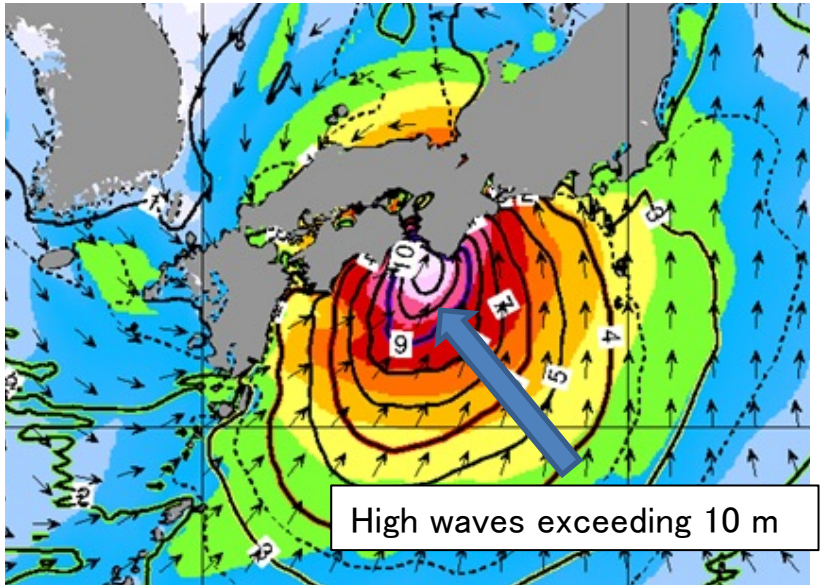
Past Case Studies Results



tropical cyclone	Warning criteria exceeded point	Forecast Results
T1821 (Jebi)	Osaka	Detection of exceeding warning criteria from **4 days** in advance
	Kobe	
	Wakayama	Detection of exceeding warning criteria from **10 hours** in advance
	Gobo	**Miss** (Underpredictions are thought to be due to the Wave Setup effect.)
	Awayuki	
	Irozaki	
T1919 (Hagibis)	Irozaki	Detection of exceeding warning criteria from **4 days** in advance
	Miyakejima	
	Odawara	
	Omaezaki	
	Shimizuminato	
	Yaizu	
	Aburatsubo	
	Tago	Detection of exceeding warning criteria from **8 hours** in advance

Missed Case Results Verification (T1821:Jebi)

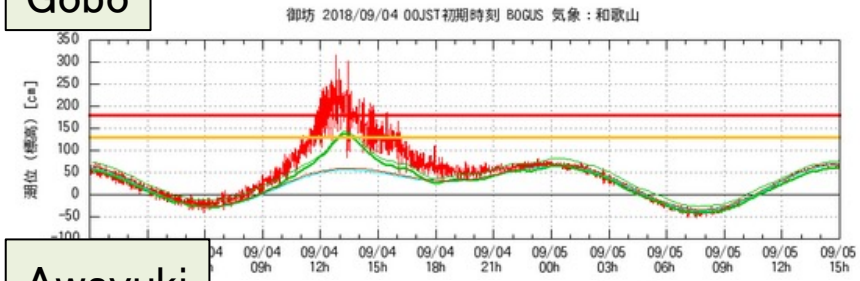
Coastal wave model
2018/09/04 00UTC initial(FT=3)



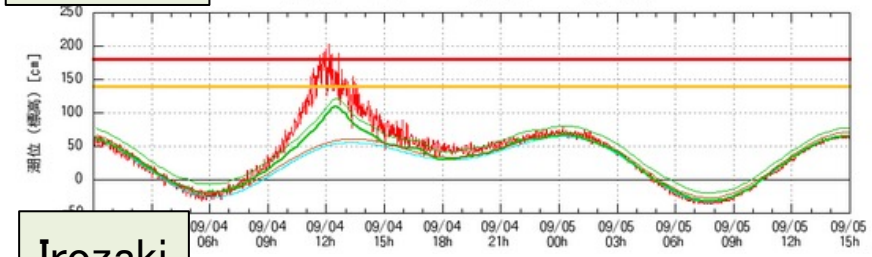
- Wave Setup has problems with the accuracy of guidance correction.

Japan storm surge model (Bogus center course)
2018/09/04日00UTC initial

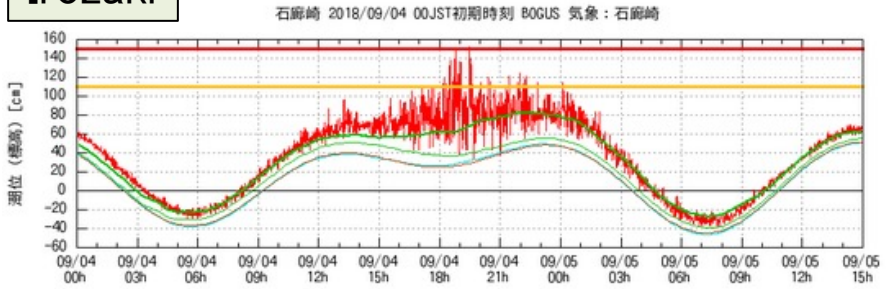
Gobo



Awayuki

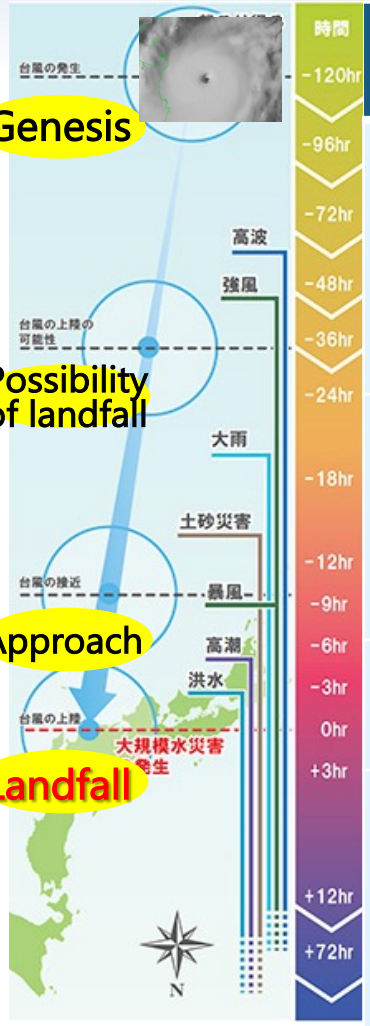


Irozaki



Red line: Observations Thick green line: Guidance Green Thin Line: Model

Timeline for DRR stakeholders – when, who and what



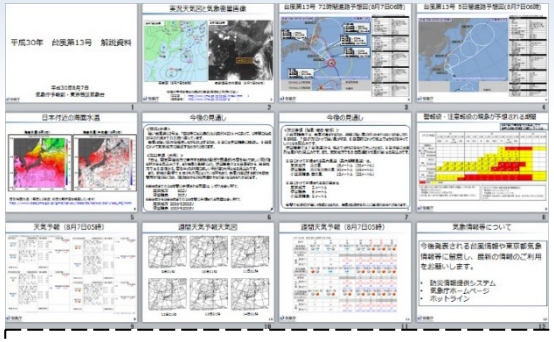
Government		Traffic services services	Municipalities s	Residents ts
TC forecast Press conference Press conference	Disaster response headquarters is established.	Traffic service suspension is announced in advance.	Wide-area evacuation system is checked and announced.	
Press conference Meteorological/ hydrological warning	Liaison officers are dispatched. Impose operations such as dam pre-discharge	Procedures of service suspension is checked and officially announced.	Wide-area evacuees are guided and accepted. Support delayed evacuees.	Wide-area evacuation starts.
Flood danger info.	Liaison officers are dispatched to avoid further damage	Service disruption	Evacuation supporters also evacuate.	Wide-area evacuation completed
Flood occurrence info.	Liaison officers are dispatched to support early recovery		Request of support	

Effective for promoting self-, mutual- and public-help.

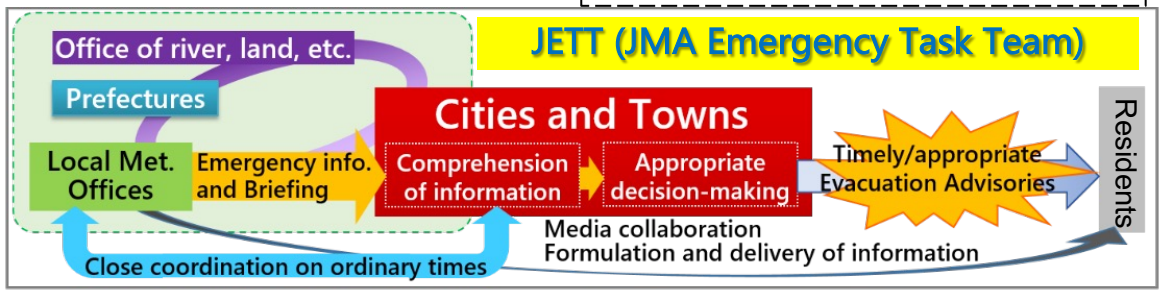
Actions – various approaches to support municipalities and the public

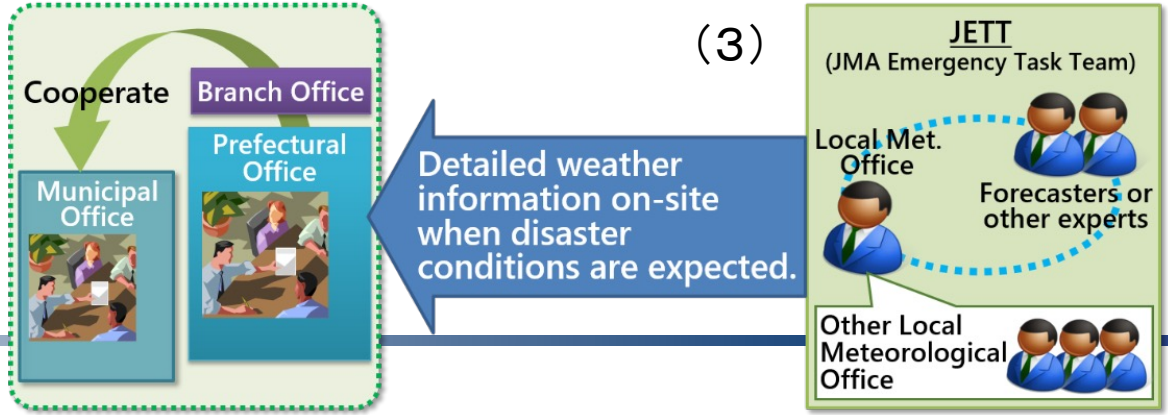
JMA takes all possible actions to support municipalities and encourage the public towards early evacuation

(1)Press conferences
(2)Briefing municipalities
(3)Delivering “JETT” as needed



(2)Various kinds of information (graphs, charts, etc.) are used during the briefing





Summary

- The purpose of storm surge early warning information is to encourage people to check the storm surge hazard map for their area and to frequently check information such as Typhoon Information and Prefectural Weather Information to prepare themselves for storm surge disasters soon as possible.
- Storm surge early warning information guidance is developed using three storm surge models (Japan storm surge model, Japan storm surge probabilistic forecast system (PFS), and Asian storm surge ensemble prediction system (EPS)).
- In some past cases, the storm surge early warning guidance was able to capture the possibility of exceeding the warning criteria from an early stage to some extent. On the other hand, capturing the open ocean locations with significant wave setup was difficult.

Outline of storm surge early caution information guidance

	Today and tomorrow	2 to 5 days ahead
Forecast model	Typhoon approaching	
	Japan storm surge model (MSM or bogus center course) + **Japan Storm Surge Probabilistic Forecast System**	**Asian Storm Surge Ensemble Forecast System** (GSM) + **Japan Storm Surge Probabilistic Forecast System**
	No Typhoon	
	Japan storm surge model (MSM)	**Asian Storm Surge Ensemble Forecast System** (GSM)
Calculation frequency	4 times a day (00,06,12,18UTC)	
Provided Information	①Automatic determination value of the possibility of warning class ([High], [Medium], [Low], [None]) ②High tide (percentile) ③Probability of exceeding the warning criteria	
Forecast publication time	05:00 11:00 17:00JST	11:00 17:00JST
Region	Primary subdivision	Subdivision of the weekly forecast