Moving towards impact-based forecasts and risk-based warnings

1A-2

Key techniques for Japan's Risk-based Warning Services for Heavy-rain Related Disasters

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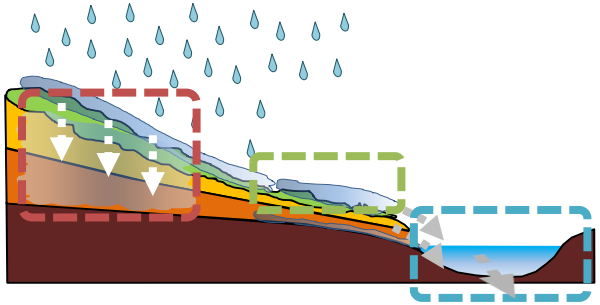
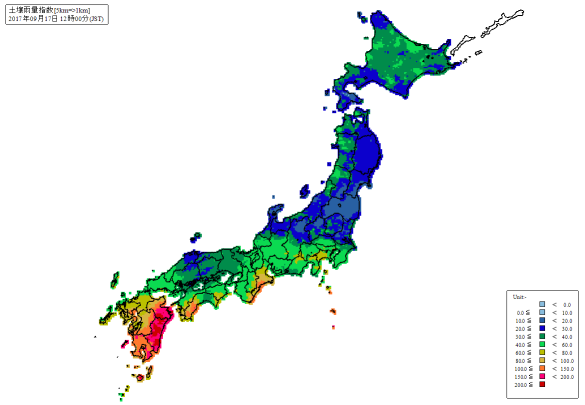
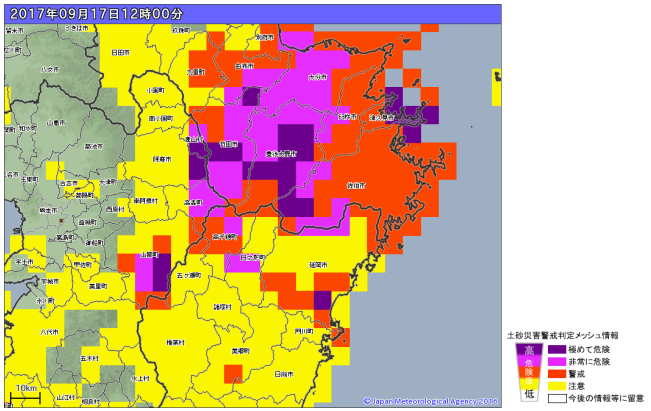
Contents

- Japan's Risk-based Warning System
- Real-time Risk Maps for Landslides, Inundation and Flood
- Opportunities and Challenges of Real-time Risk Maps
- Summary







Warnings / Advisories

Emergency Warnings (6)

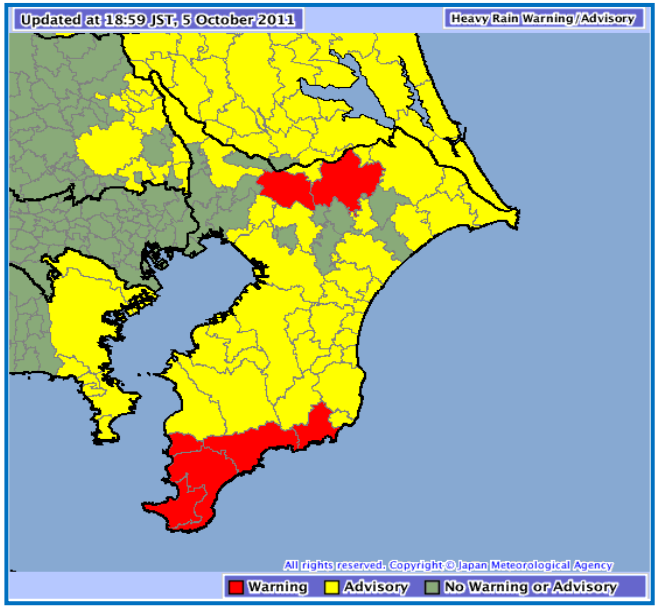
Storm	Snow-storm	
Heavy rain	Heavy snow	
Storm surge	High waves	

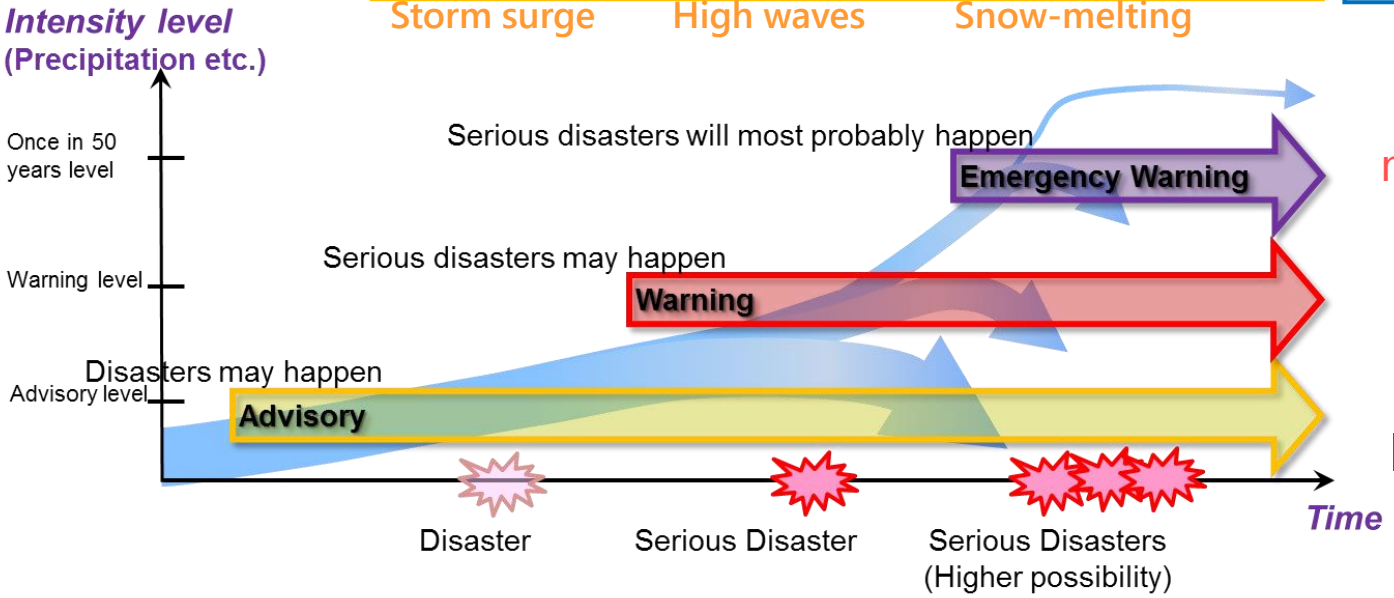
Warnings (7)

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 targets each municipality, whose Mayor is responsible for issuing evacuation information

Issued by Local Offices

Criteria for Warnings / Advisories

- Pre-determined warning criteria through coordination with the local government
- Use of hazard potential indices

Example: Shizuoka city (south)

Warning	Parameters	Criteria
Heavy rain (inundation)	Inundation Potential Index	25
Heavy rain (landslide)	Landslide Potential Index	Each 1 km^2 grid has own value. The minimum value in Shizuoka city is 156.
Flood	Flood Potential Index	Tomoe river basin: 27.7 …etc.
	Combination of Flood and Inundation Potential Indices	Tomoe river basin: Runoff Index: 10 Surface Water Index: 22.9
Storm	10-min average wind	Land: 20 m/s Sea: 25 m/s
Snow storm	10-min average wind	Land: 20 m/s, with snow Sea: 25 m/s, with snow
Heavy snow	Snowfall depth	10 cm / 24 hours (Mountain: 20 cm / 24 hours)
High waves	Significant wave	6.0 m
Storm surge	Tidal level	1.5 m

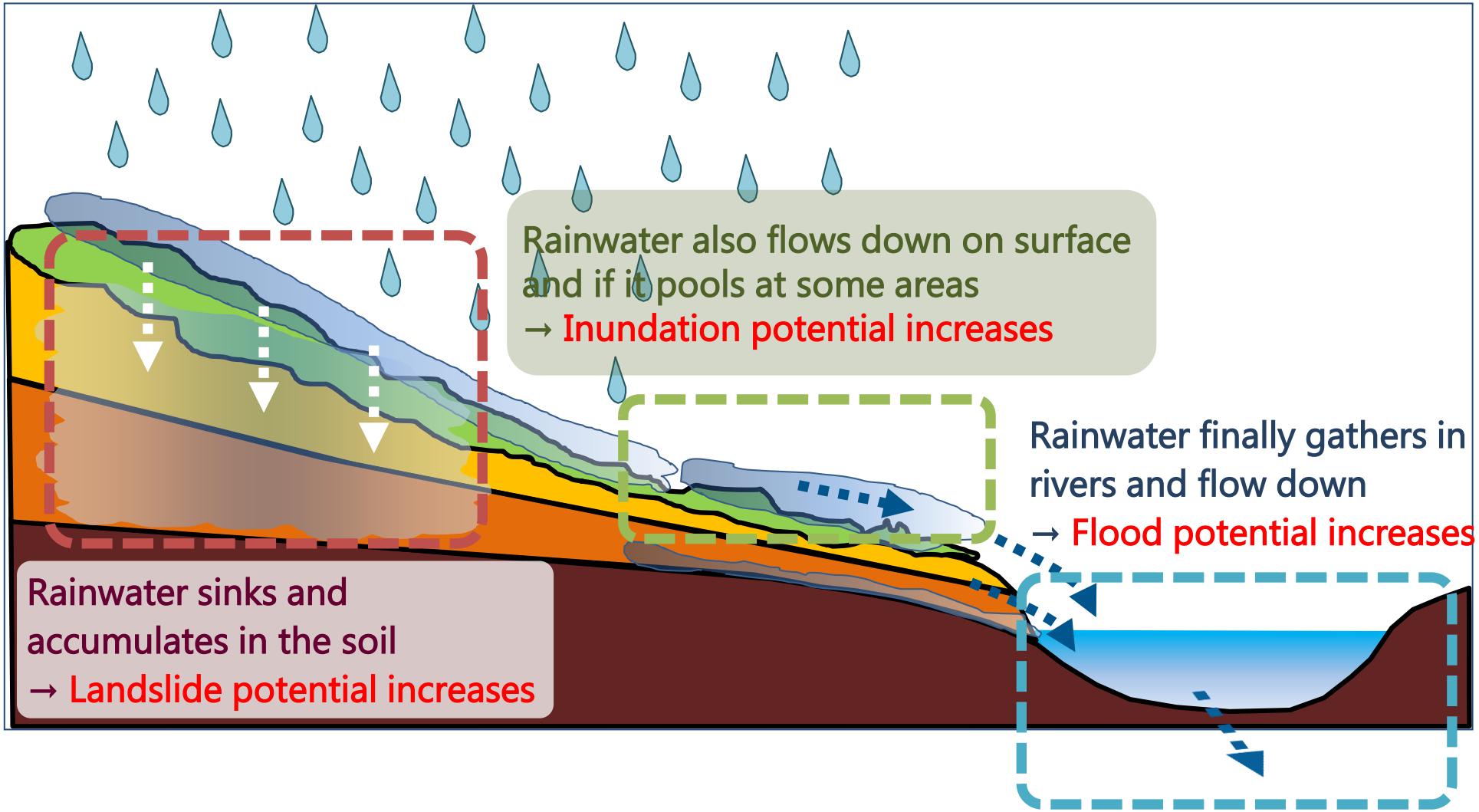
Utilize the indices for rainfall-related warnings instead of direct observation data

Coordination for warning criteria with local government

- Share understanding regarding disasters targeted by warning/advisory with local government.
- Disaster statistics collected by local government are used to determine warning criteria.
- Warning criteria based on disaster statistics are authorized by local government (municipality).

Three indices of Rainfall-related Hazards Potential

Rainfall increases potentials of **three types of hazard**



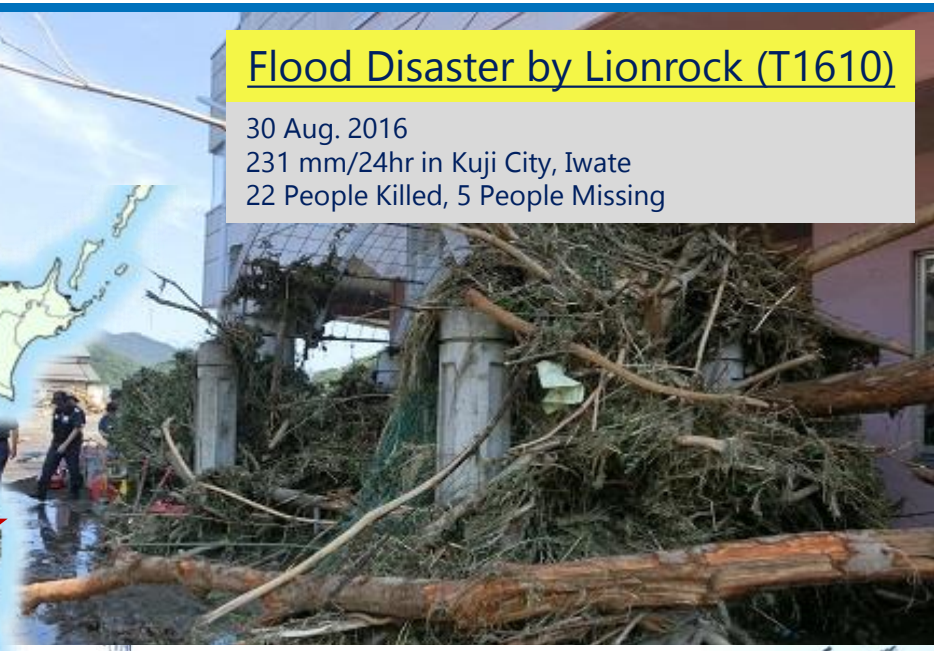
Recent Rainfall-related Disasters in Japan

Landslide Disaster in Hiroshima in 2014

20 Aug. 2014
217.5 mm/3hr in Hiroshima City
74 People Killed

Flood Disaster by Lionrock (T1610)

30 Aug. 2016
231 mm/24hr in Kuji City, Iwate
22 People Killed, 5 People Missing



5 Jul. 2017
129.5mm/1hr, 545.5mm/24hr in Asakura City, Fukuoka
40 People Killed, 2 People Missing

Flood Disaster in Fukuoka in 2017

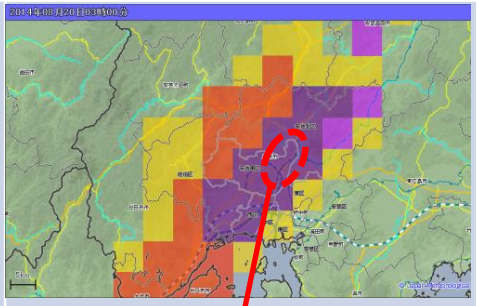
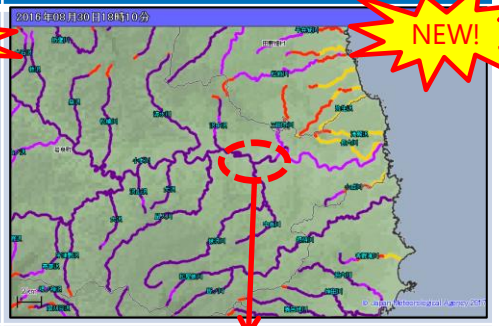
16 Oct. 2013
122.5mm/1hr, 824.0mm/24hr in Izu-Oshima
35 People Killed, 4 People Missing

Landslide Disaster by Wipha (T1326)

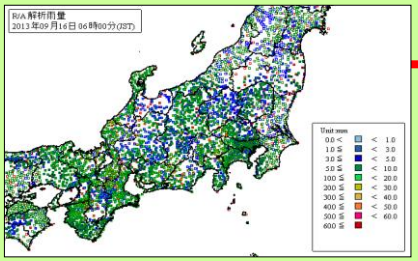
Real-time Risk Maps

Real-time Risk Map for Rainfall-related Hazards

- Real-time Risk Map is a colored-grid information that indicates how close current and forecasted hazards potential is to pre-defined warning criterion at each point.
- Provide **spatially specific information about risk-level** of landslide, inundation and flood in colors using a standardized color code

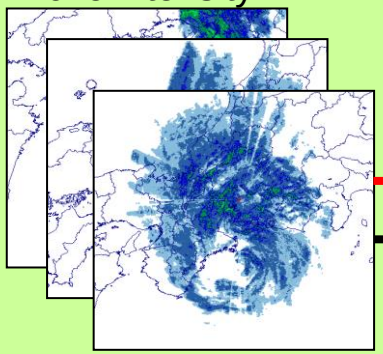
	Landslide (2015-)	Inundation (2017-)	Flood (2017-)
Risk Map		 NEW!	 NEW!
Related Disaster			
Resolution/Update Interval/Lead time	5 km / 10min / 2 hours	1 km / 10min / 1 hour	1 km / 10 min / 3 hours

Rain-gauge

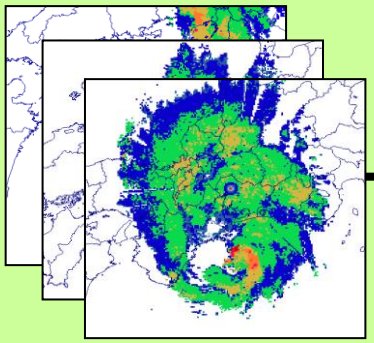


RADAR

Echo intensity

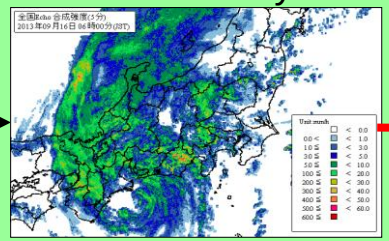


Echo top height

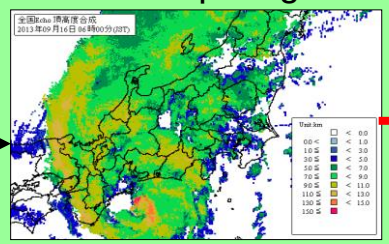


Composite map

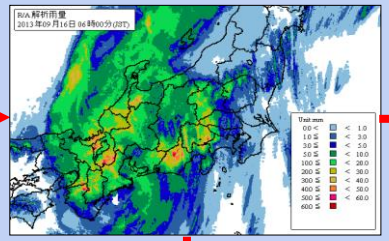
Echo intensity



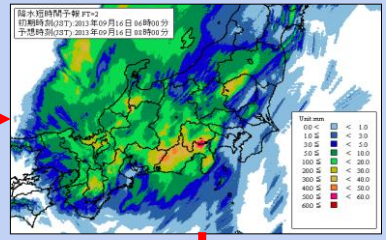
Echo top height



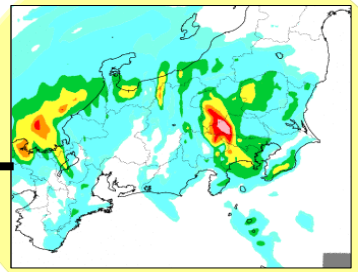
QPE



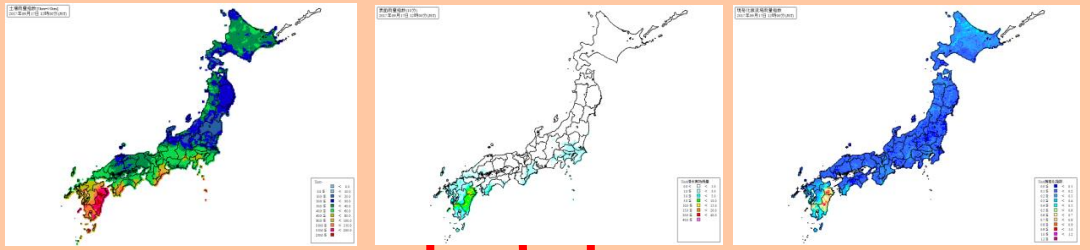
QPF



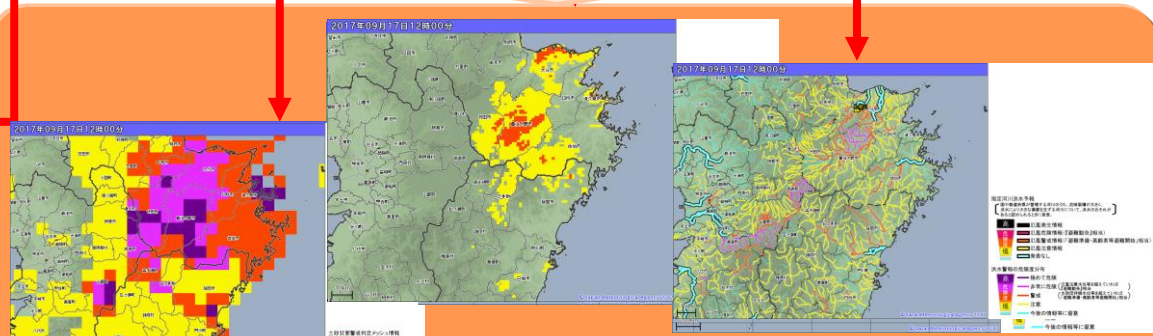
NWP



Hazard potential indices

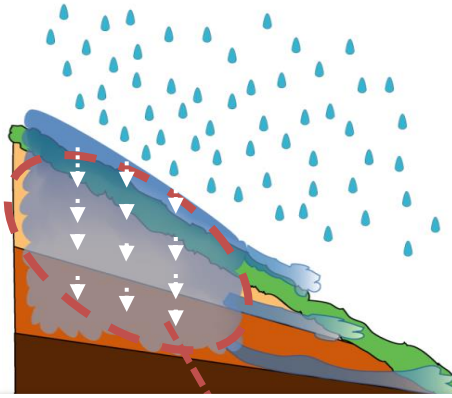


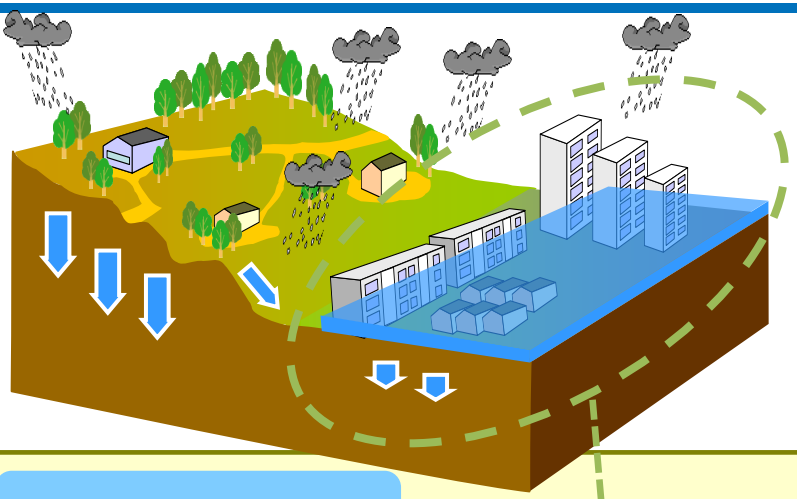
Warning criteria based on disaster statistics

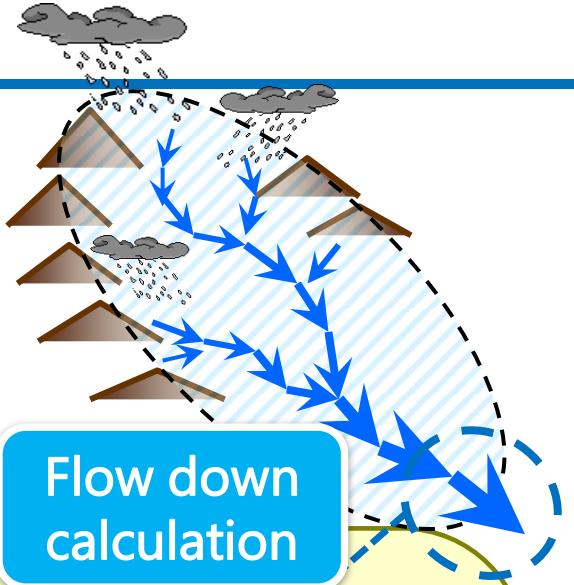


Real-time Risk Maps

Hazard Potential Indices







Simple Tank model

QPE / QPF

Flow down calculation

Total amount of water in the three tanks

surface

middle

depth

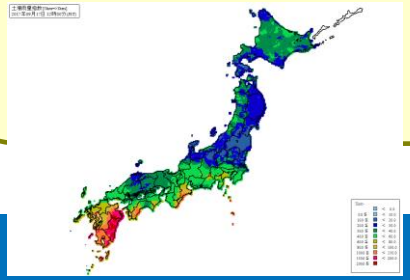
Total amount of water coming out from the tanks

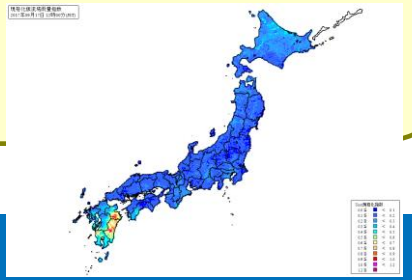
Total amount of water flowing down to rivers

Landslide Potential Index

Inundation Potential Index

Flood Potential Index



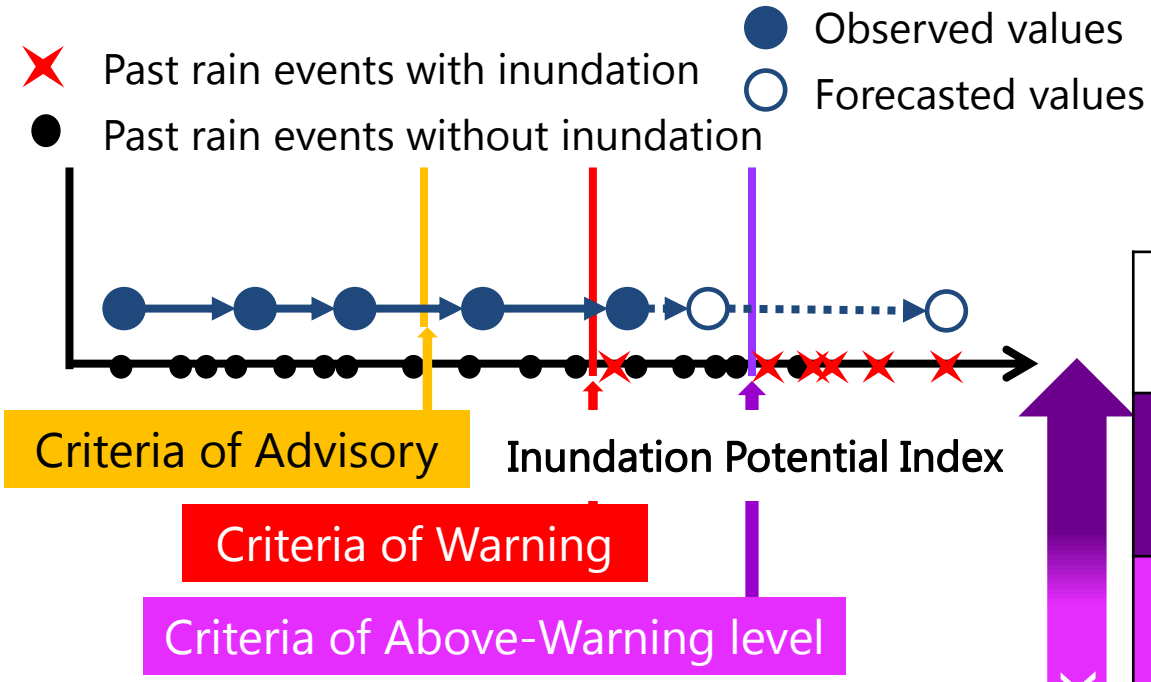


Hazard Potential Indices and Risk Maps

- **Hazard potential indices** indicate the amount of water in the soil, water accumulated in certain places and/or a river, which are one of hazard potential factors, but not directly linked to heavy-rain related disaster risks.
  - Indices take into account geology, land use (urban area or not), altitude, inclination, but not drainage system and pumps.
- JMA uses past **disaster statistics** to determine the level of hazard potential indices that have disaster risks, and therefore warning criteria depends on locations.
  - In some places, landslides/inundation/floods can be triggered by a relatively small amount of rain, while in other places, by only a large amount.
- Locations where hazard potential indices are close to warning criteria at the point, have high disaster risks.
- We need to visualize **the level of disaster risk**, not hazard potential indices (the level of hazard potential).

Warning Criteria and Risk Levels

Criteria of heavy rain warning (inundation) and Risk-map for inundation



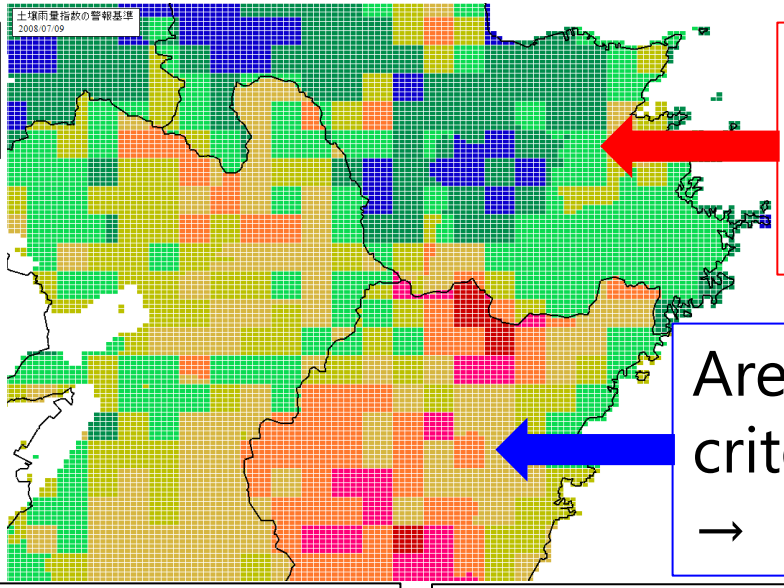
Color code	Expected Response actions	Definition
	Evacuation Order	Equivalent to above-warning level (based on observed value)
	Evacuation Advisory	Equivalent to above-warning level (based on forecast value)
	Evacuation Preparation	Equivalent to warning level
	–	Equivalent to advisory level
	–	Below advisory level

1. Criteria are determined based on potential index of past rain events with inundation.

2. Risk levels are determined based on where the current and forecasted conditions are relative to pre-determined criteria of Advisory, Warning and Above-Warning level.

Example of Hazard Potential Index and Risk Map

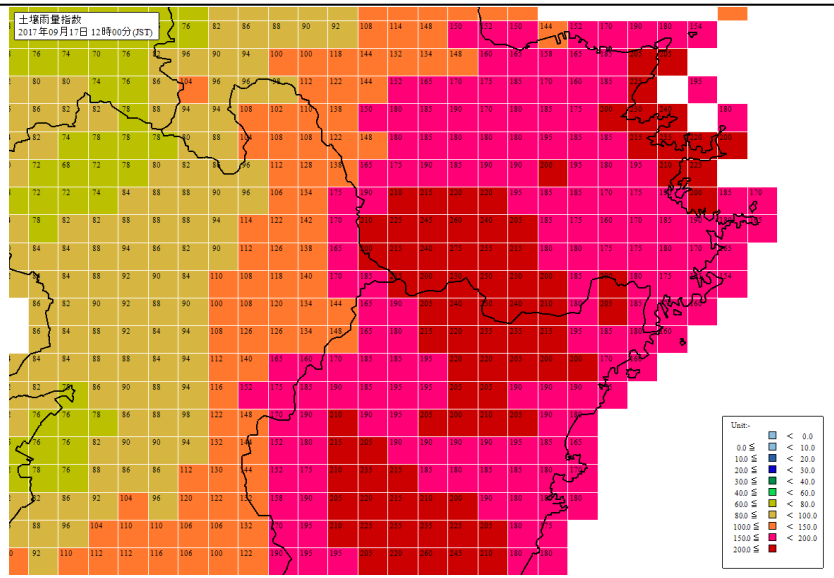
Warning criteria for Landslide



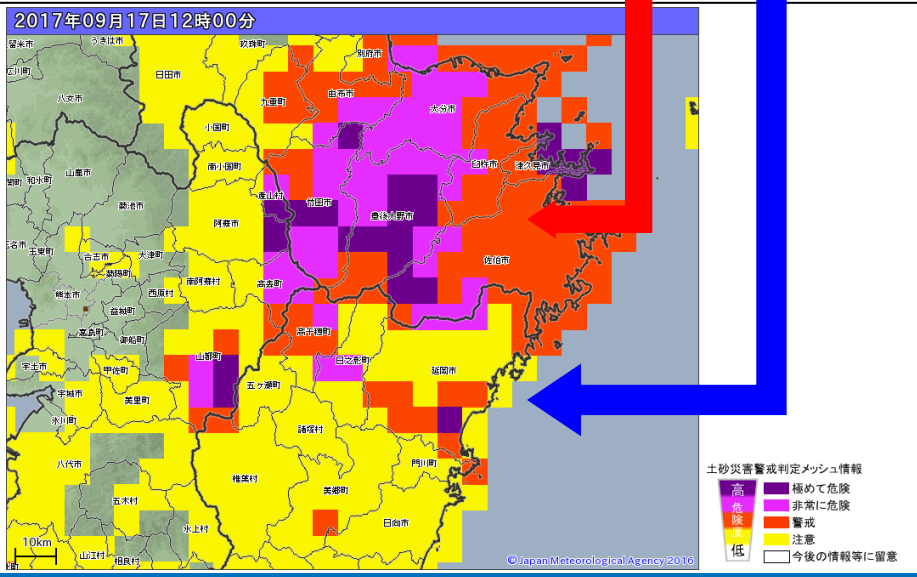
Areas where warning criteria is low
→ Risk is high

Areas where warning criteria is high
→ Risk is low

Landslide Potential Index, 12UTC, Sep. 17, 2017



Risk Map for landslide, 12UTC, Sep. 17, 2017



Use of Real-time Risk Map

Warning Message

- Heavy rain Advisory
- Heavy rain Warning
- Landslide Alert Information
- etc.

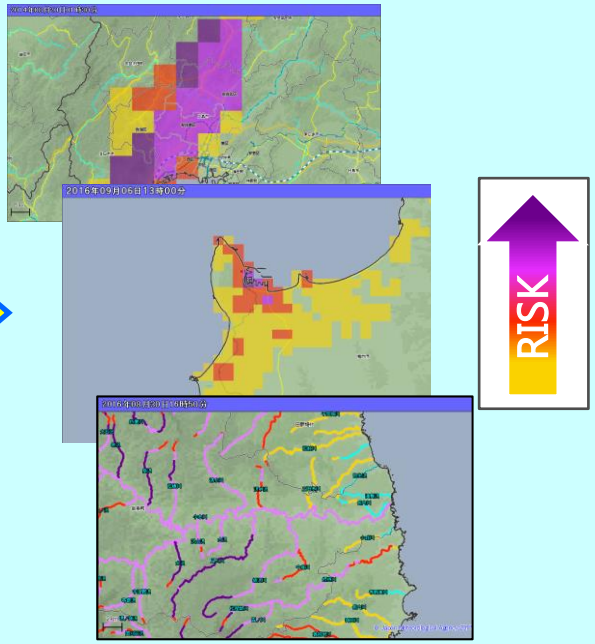
Inform Increase of Risk

DM Authorities

General Public

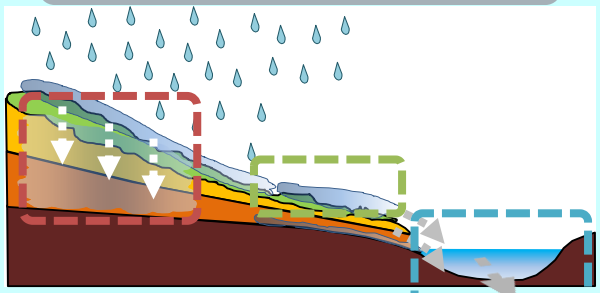
Check the risk area in detail

Real-time Risk Map



Used as warning criteria

Hazard Potential Index

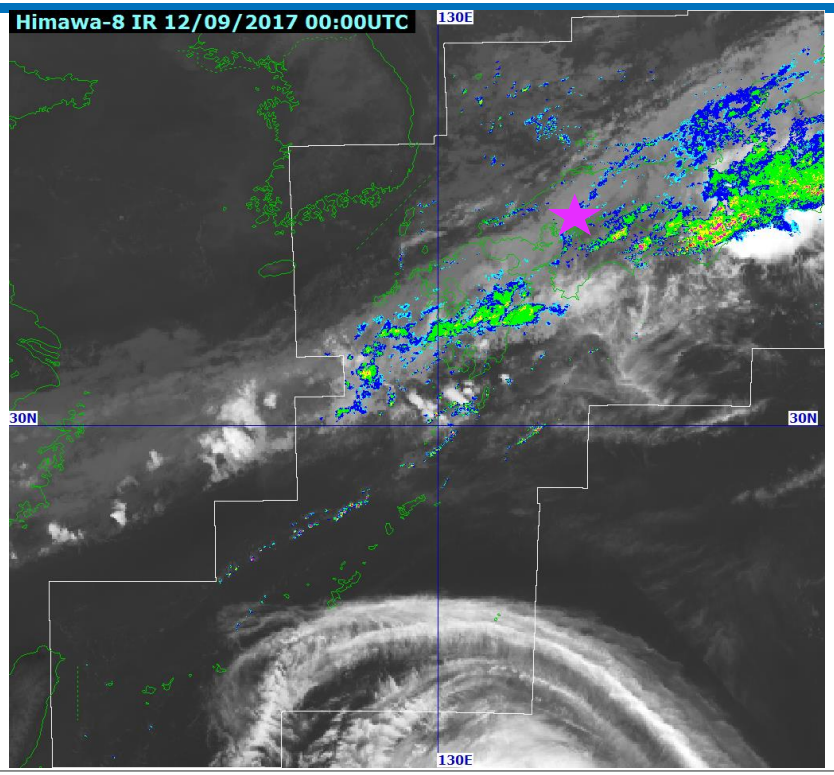


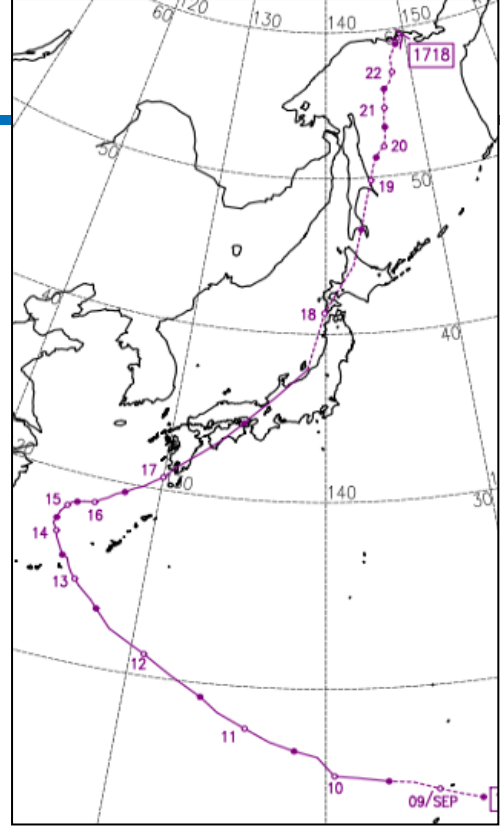
Translated into risk level

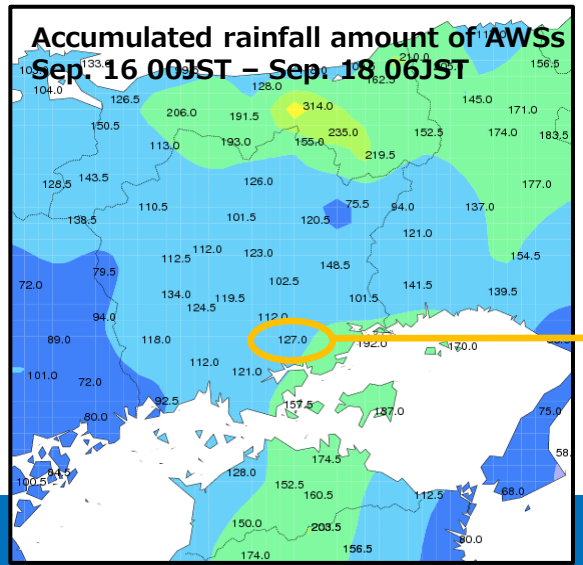
Opportunities and Challenges

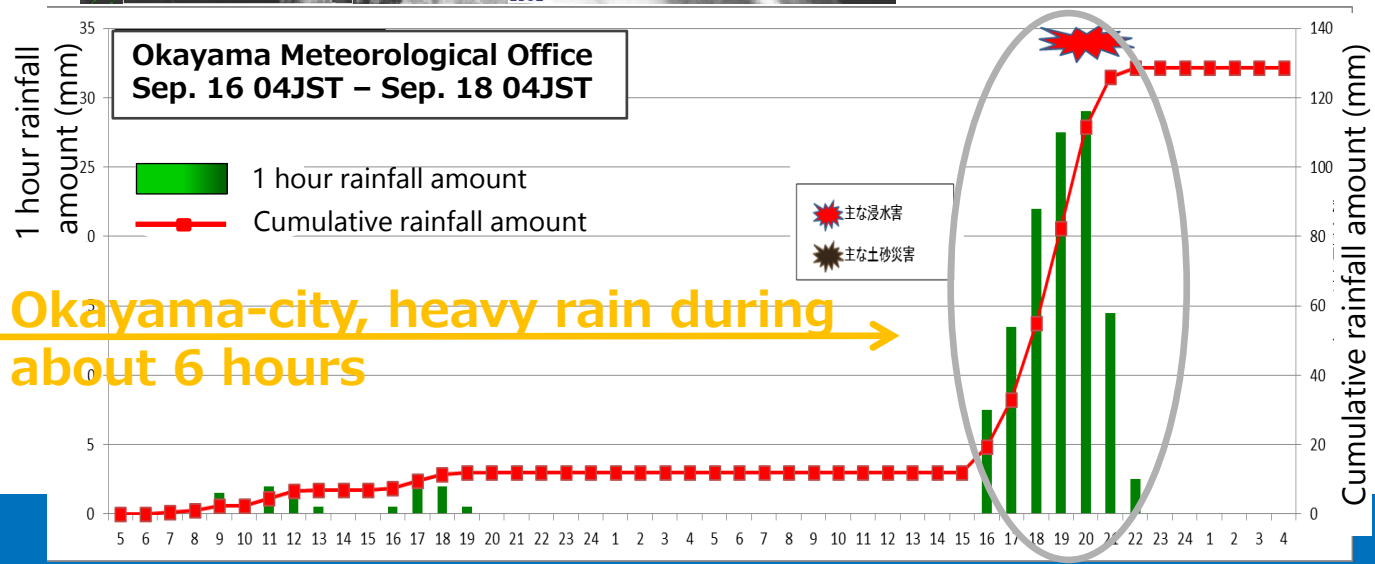
Heavy rain brought by T1718 (Talim)

- Made Landfall on Japan a few times on Sep. 17
- Strong winds and heavy rains in Okayama prefecture from the evening to midnight Sep. 17





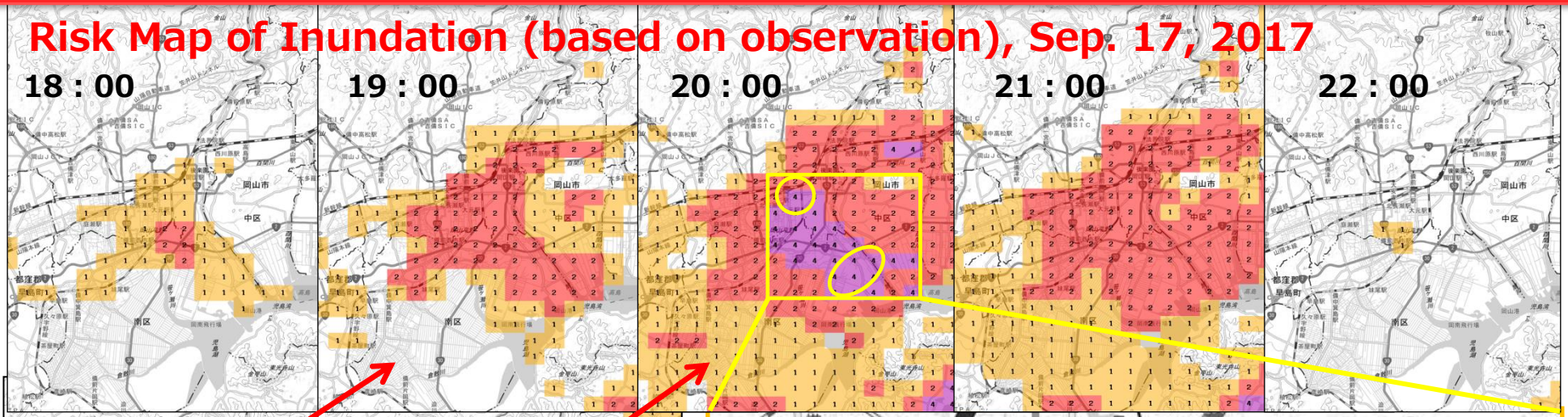




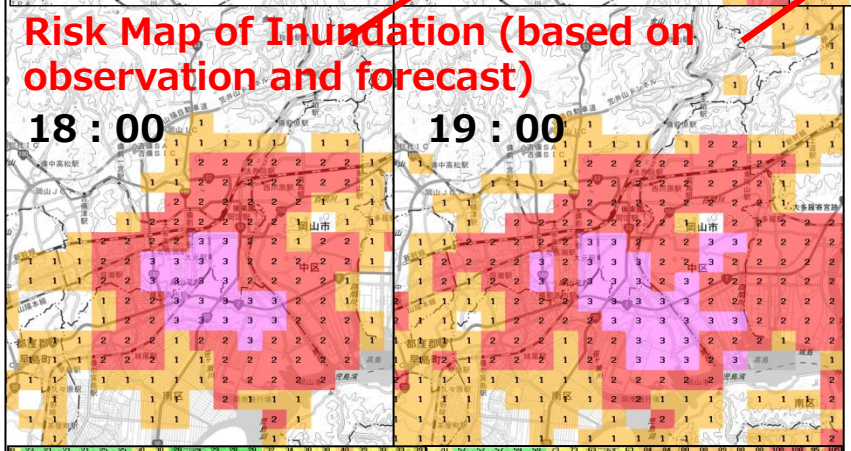
Okayama-city, heavy rain during about 6 hours

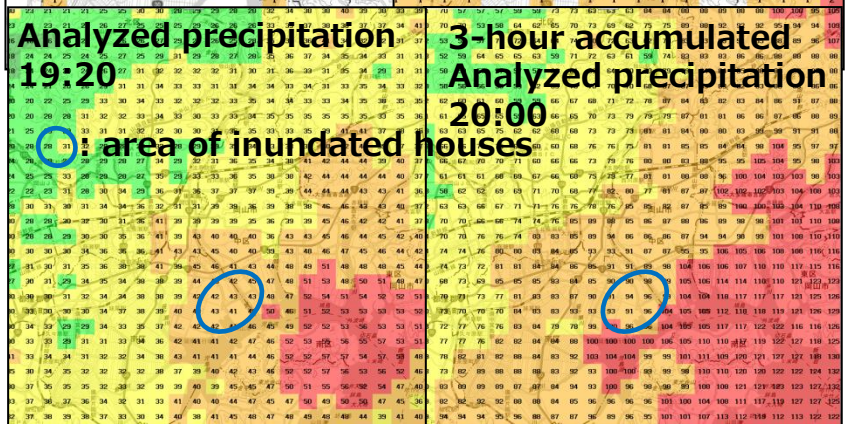
Heavy rain brought by T1718 (Talim) September 17, 2017

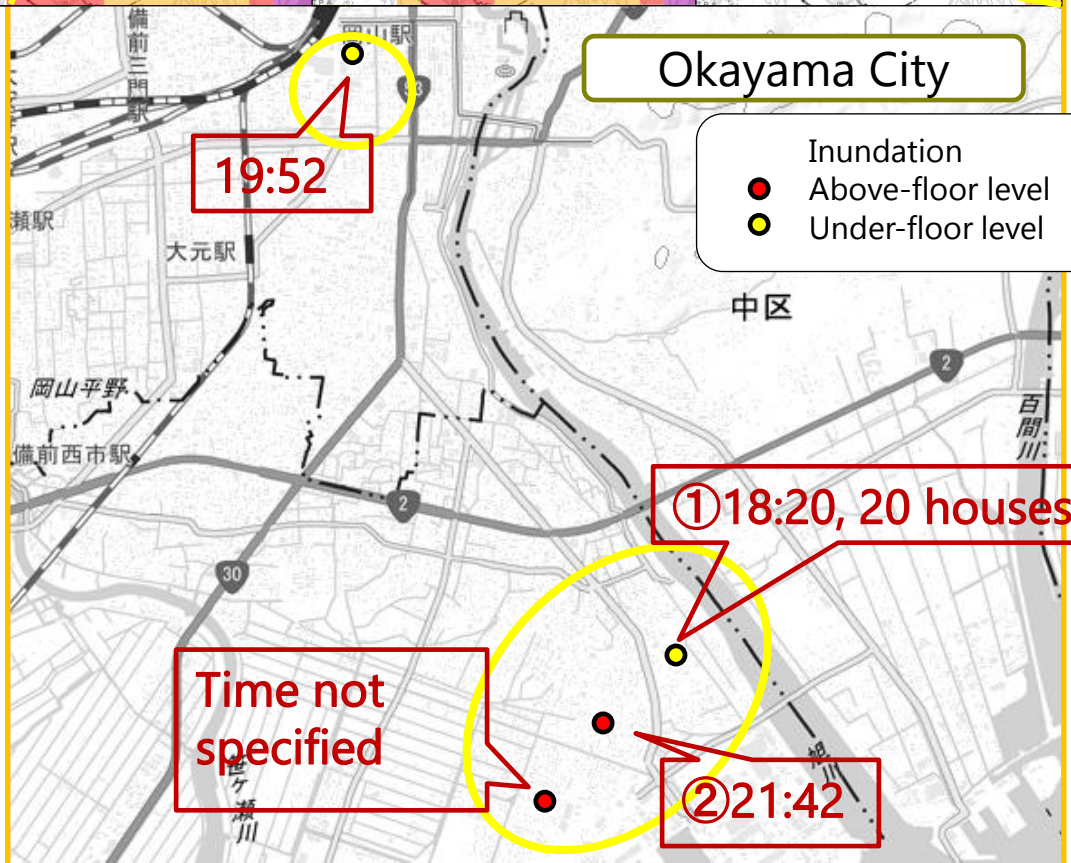
Risk Map of Inundation (based on observation), Sep. 17, 2017



Risk Map of Inundation (based on observation and forecast)







Challenges for Uptake of Real-time Risk Maps

Identified challenges

- There are not yet enough events to evaluate the relevance and reliability of Real-time Risk Maps.
- There is not yet an established guideline for its use and response actions.
- Water levels are used more than Risk Maps.
- Values change quickly and difficult to interpret and to use for decision making.

Required actions

- Demonstrate the relevance of Risk Maps in real heavy rain events.
- Review heavy rain events together with local government team and share understanding of challenges.
- Communicate the levels of Risk Maps and expected action at each level.
- Assist the development of a standard operating plan that describes how Risk Maps should be used.

Summary

- Real-time Risk Maps are
  - supplemental information of warnings and aimed at helping users' decision making.
  - computed for landslide, inundation and flood, using three types of hazard potential indices and warning criteria set based on past disaster statistics.
  - operated by cross-departmental efforts and partnerships.
    - Observation networks and data (raingauge, radar and water level)
    - Warning criteria
    - Collection of disaster statistics
- Real-time Risk Maps have shown good correlation with disasters in many cases.
- Further communication and coordination is necessary for users' uptake of Real-time Risk Maps.
  - Relevance of Risk Maps
  - Standard operating plan that describes how Risk Maps should be used
  - Communication and education of users about the levels of Risk Maps and expected action at each level

Thank you