Disaster-related Hydrological Index and Emergency Warning

- JMA’s challenges for disaster prevention -

Yoshiro TANAKA
International Strategy Officer for Meteorological Observations
Observation Department
Japan Meteorological Agency
• Improved Observation (WIGOS)
• Improved NWP
• Improved IT technology
• Improved International Data Exchange (WIS)

...realized the general public receive
weather forecasts better than ever before
(indicating when, where and to what extent)

*However, we are still facing challenges...*
### Example: Shizuoka city (south)

<table>
<thead>
<tr>
<th>Warning</th>
<th>Parameters</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy rain (inundation)</td>
<td>Precipitation</td>
<td>Plain land: 110 mm (3 hour) Others: 100 mm (1 hour)</td>
</tr>
<tr>
<td>Heavy rain (sediment disaster)</td>
<td>Soil Water Index</td>
<td>135</td>
</tr>
<tr>
<td>Flood</td>
<td>Precipitation</td>
<td>Plain land: 110 mm (3 hour) Others: 100 mm (1 hour)</td>
</tr>
<tr>
<td></td>
<td>Runoff Index</td>
<td>Okitsu river basin: 22 Nagao river basin: 10</td>
</tr>
<tr>
<td>Storm</td>
<td>10-min average wind</td>
<td>Land: 20 m/s Sea: 25 m/s</td>
</tr>
<tr>
<td>Snow storm</td>
<td>10-min average wind</td>
<td>Land: 20 m/s, with snow Sea: 25 m/s, with snow</td>
</tr>
<tr>
<td>Heavy snow</td>
<td>Snowfall depth</td>
<td>10cm / 24 hours (Mountain: 20 cm/24 hours)</td>
</tr>
<tr>
<td>High waves</td>
<td>Significant wave</td>
<td>6.0 m</td>
</tr>
<tr>
<td>Storm surge</td>
<td>Tidal level</td>
<td>1.5 m</td>
</tr>
</tbody>
</table>
Heavy rain warning (inundation), Flood warning …inland flood type

Precipitation criteria

(Example) Target inundation disasters: 10 housing or more are inundated above floor level

Flood warning …longer term inundation type

Combination criteria

Runoff index criteria

Flood warning …river water inundation type

Setting Criteria of Warning/Advisory

Scatter diagram (target disasters vs parameters)

Longer-term Parameter (ex. Runoff index)

Shorter-term Parameter (ex. 1 hour precipitation)
Step 1. Observation of Precipitation (Quality assured composite Radars and AWS)

Step 2. Analysis and Forecast of Precipitation (QPE and QPF)

Step 3. Hydrological Index (Soil Water Index and Runoff Index)

Step 4. Issue Warning etc (if meet criteria)
Step 1. Observation of Precipitation (Quality assured composite Radars and AWS)

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Japan’s example: heavy rain (inundation and landslides) and flood warnings
JMA WIGOS (Raingauge and Radar)

- **Raingauge**
  - JMA: 1,300
  - MLIT (Ministry of Land, Infrastructure, Transport and Tourism): 3,400
  - Local Government: 5,700

- **Radar**
  - JMA Radars: 20
  - MLIT Radars: 26
Step 1. Observation of Precipitation
(Quality assured composite Radars and AWS)

Step 2. Analysis and Forecast of Precipitation
(QPE and QPF)

Step 3. Hydrological Index
(Soil Water Index and Runoff Index)

Step 4. Issue Warning etc (if meet criteria)

Japan’s example: heavy rain (inundation and landslides) and flood warnings
Radar/Raingauge-Analyzed Precipitation - QPE

Precipitation amounts observed by radar normally do not agree with those observed by raingauges, and radar data are therefore calibrated with raingauge data.

The calibrated radar data are made into a single composite data set.

The correlation coefficient is 0.975.

- 1-hr precipitation
- Every 30 min.
- 1 km resolution
- 15 min. after obs.
Q: What is VSRF?

A: Quantitative precipitation forecast using QPE and meso-scale NWP.

[Notes]
- Issued every 30 min up to 6 hours ahead.
- The longer the forecast time, the higher the weight of NWP (changing merging weight every forecast time).
- Orographic effect of precipitation is considered.
Step 1. Observation of Precipitation
(Quality assured composite Radars and AWS)

Step 2. Analysis and Forecast of Precipitation
(QPE and QPF)

Step 3. Hydrological Index
(Soil Water Index and Runoff Index)

Step 4. Issue Warning etc (if meet criteria)

Japan’s example: heavy rain (inundation and landslides) and flood warnings
Soil Water Index (Potential of Sediment Disaster)

- Water flow in soil
- Storage
- Permeation
- Surface runoff
- Precipitation
- Second tank
- Permeation
- Storage
- "Soil Water Index" is equivalent to the total storage volume of three serial tanks
- Soil Water Index (Potential of Sediment Disaster)
- Shallow runoff
- Groundwater runoff
- First tank
- Third tank
- Tank Model
- Forecast
- Observation
- One Hour Precipitation
- Accumulated Precipitation
- Sediment disaster
- 9/13/2013 to 9/16/2013
Precipitation (QPE, QPF)

Outflow to the river

Travel down the river

Runoff Index calculated every 5 km along rivers more than 15 km (more than 4,000 rivers in Japan)

Runoff Index (Potential of Flood Disaster)

Observation

Forecast

Runoff Index
Runoff Index (Potential of Flood Disaster)

- Water level
- Runoff index
- Rainfall accumulation in the drainage basin
- Time lag between rainfall and runoff
- Time lag in flow
- Target Area
- Drainage basin
- Runoff Index

- Precipitation
- Runoff Index
Step 1. Observation of Precipitation (Quality assured composite Radars and AWS)

Step 2. Analysis and Forecast of Precipitation (QPE and QPF)

Step 3. Hydrological Index (Soil Water Index and Runoff Index)

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Japan’s example: heavy rain (inundation and landslides) and flood warnings
Warnings for each city/town/village

**Warning** (7)  
375 areas

**Advisory** (16)  
375 areas

1,769 areas  
(every municipality)

started in 2010

<table>
<thead>
<tr>
<th>Storm</th>
<th>Snow-storm</th>
<th>Flood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy rain</td>
<td>Heavy snow</td>
<td></td>
</tr>
<tr>
<td>Storm surge</td>
<td>High waves</td>
<td></td>
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<table>
<thead>
<tr>
<th>Heavy rain</th>
<th>Gale</th>
<th>Gale and</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy snow</td>
<td>Dense fog</td>
<td>Thunders</td>
</tr>
<tr>
<td>Dry air</td>
<td>Avalanche</td>
<td>Ice (snow)</td>
</tr>
<tr>
<td>Frost</td>
<td>Flood</td>
<td>Low temp</td>
</tr>
<tr>
<td>Storm surge</td>
<td>High waves</td>
<td>Snow-melt</td>
</tr>
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</table>
A forecaster should judge issuing weather information appropriately in a short time.

The forecaster-friendly system automatically proposes target time, area and quantitative levels (when, where, to what extent) to assist a forecaster in issuing warnings etc.
Observation, Forecast, Secondary Product (Index etc)

- Rain-gauge
- QPE
  - Composite map
  - Echo intensity
  - Echo top height
- QPF
- Soil Water Index
- RADAR
  - Echo intensity
  - Echo top height
- Runoff Index
- NWP
- Tornado Potential
- Lightning Nowcast
Severe Tropical Storm “Talas” (Sep 2011)

5th 00UTC
994hPa, 40kt
NE, 45km/h

4th 00UTC
994hPa, 40kt
N, slowly

3rd 00UTC
982hPa, 50kt
N, slowly

2nd 00UTC
970hPa, 50kt
NNW, 15km/h

1st 00UTC
970hPa, 50kt
NW, slowly

Total rainfall amount (30 Aug - 6 Sep)
QPE: 2000 mm or more (JMA AWS: 1808.5 mm)

Total rainfall amount (30 Aug - 6 Sep)
QPE: 2000 mm or more (JMA AWS: 1808.5 mm)
Plenty of information issued. BUT...

Disasters (on 3 Sep)

Monthly average rain in September (282.7 mm)
Extraordinary Precipitation (over 2,000 mm)

JMA could NOT convey the message “how serious it will be!!”
Unprecedented Disasters Occurs Frequently

- Tsunami
- Earthquake
- Volcanic eruption
- Heavy rain
- Heavy snow
- Typhoon
- Storm surge

...
After Tsunami and Talas in 2011

WHAT CAN WE DO?
The Meteorological Service Act
(Act No. 165 of 1952)

The act was amended by the National Diet. (2013)

Under the new Act, JMA SHALL issue “Emergency Warning” when expected phenomena is extraordinarily unusual level and most probably will cause serious disasters.

And local governments SHALL take actions to notify JMA’s emergency warning to the public in their city/town/villages.
Japanese government amended the Meteorological Service Act (2013) so that JMA can issue “Emergency Warning.” It alerts the public “how serious it is, around you, now!”
■: Target of Emergency Warning precipitation more than the amount statistically expected once in 50 years
Public Awareness, a Key to Success

To-do list when Emergency Warning/Warnings/Advisories is issued

<table>
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<tr>
<th>Weather Warning/Advisory type</th>
<th>Municipal responses</th>
<th>Resident responses</th>
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<tbody>
<tr>
<td>Heavy rain</td>
<td></td>
<td></td>
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<tr>
<td>Sediment Incident</td>
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<td></td>
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<tr>
<td>Inundation</td>
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<td>Warning</td>
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<td>Snowstorm</td>
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- Immediately urge residents to take all possible steps for self-protection
- Alert residents to the issuance of an Emergency Warning and highlight the exceptionally dangerous situation
- Take immediate action for self-protection (head to an evacuation center, or if it is dangerous to go outside, evacuate to a safer place within the building)
- Start voluntary and early evacuation

Emergency Warning Overview

- Check the issuance of Emergency Warning and Advisory
- Pay attention to the latest bulletins and prepare for disaster conditions
- Early action is recommended for people in areas vulnerable to rain/wind-related disasters and people needing assistance to evacuate
- Check whether you’re ready for an impending hazard
- Check emergency supplies
- Check evacuation routes and centers
- Monitor weather bulletins on TV, radio and JMA’s website

On a routine basis

- Check weather bulletins and look out for changes in the weather
- Check emergency supplies
- Check evacuation routes and centers
- Monitor weather bulletins on TV, radio and JMA’s website

Nuts and Bolts

- Take early action even if no Emergency Warning is in effect
- Pay attention to evacuation orders/advisories and other related information issued by municipalities, and start voluntary and early evacuation as needed

Nuts and Bolts

- Immediately urge residents to take all possible steps for self-protection
- Alert residents to the issuance of an Emergency Warning and highlight the exceptionally dangerous situation
- Take immediate action for self-protection (head to an evacuation center, or if it is dangerous to go outside, evacuate to a safer place within the building)
- Start voluntary and early evacuation

Nuts and Bolts

- Cool-headed decisions are important because evacuation requirements depend on the location/structure of domicile, and whether inundation has already occurred. Advance consideration of action to be taken is key in protecting life.

Nuts and Bolts

- Pay attention to the latest bulletins and prepare for disaster conditions.
- Early action is recommended for people in areas vulnerable to rain/wind-related disasters and people needing assistance to evacuate.
- Check whether you’re ready for an impending hazard
- Check emergency supplies
- Check evacuation routes and centers
- Monitor weather bulletins on TV, radio and JMA’s website
Principles of Proactive Action

(1) Act first, when a disaster seems possible
Do NOT wait until the situation becomes clear

(2) Act, supposing the worst case possible
Stop wishful thinking. Do NOT be misled by Normalcy bias. It may be your turn to suffer from unprecedented events.

(3) NEVER fail to issue warnings
Don’t hesitate in issuing warnings (followed by evacuation alert etc. by the local governments)

As a result, even though no disaster occurs...

Oh, I am safe. Thanks God.

Nourish the ultimate world of disaster prevention!
(NMHS forecast will NOT be perfect forever)
Thank you
Flood Warnings for Each River

Each river is target of flood forecasting by JMA and MLIT (289 rivers, 109 water systems) and by JMA and prefectures (123 rivers, 63 water systems)