REVIEW OF JAPANESE METEOROLOGICAL SERVICES
AND
LESSONS FOR DEVELOPING COUNTRIES

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Early Warning Systems: Experience of World Bank and Japan
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“はれるん (Harerun)” - JMA’s mascot,
in incorporating elements of the Sun, clouds and rainfalls, with a green
baton representing hopes for a peaceful and disaster-free world

OUTLINE

● Overview of the Report
● Modernization Trajectory over 140 Years
● Today’s Meteorological Services and Major Improvements
  (1) Institutional Frameworks
  (2) Observation, Forecast and Warning Systems and Service Delivery
  (3) International Cooperation
● Closing Remarks towards Future
The Report covers a long history of meteorological services over 140 years and a current wide range of services and stakeholders.

Total volume of the main report and annexes amounts to around 100 and 60 pages in the current final drafting stage.
Early Development Years
- Modernization was initiated 140 years ago (1875) -

- Japan inaugurated its first National Meteorological Service in 1875, and established a nation-wide network of observations.

- The first ever storm warning and weather map followed in 1883, and

- The first national weather forecast was issued to the public in 1884.

What steps did Japan take from these beginning days to the today’s world-class services?
The Oldest Weather Map Archived in JMA
(06 JST, 1st March 1883)

*Weather bulletin when the first storm warning was issued on 26 May 1883.*

“The barometer has fallen much in last eight hours, most over Shikoku and the Inland Sea, an area of low lying between Kochi and Miyazaki, with light to fresh cyclone winds in the SW. The rain area has moved E, Kochi reporting 102 mm for last 24 hours. The weather is generally cloudy except Hokkaido, warmer in Central Japan and Tsugaru Strait.

*Warned the whole coast.*

In those days, weather maps and bulletins are issued with the technical support by experts from Europe.
The modernization of meteorological services in Japan has been made continuously in accordance with the evolution of operational services of JMA over 60 years, mainly driven by 

1. **Growing user requirements** (i.e., societal needs) and 
2. **Technical supports by the advancing information and communication technology (ICT).**

The processes are different from system to system, but are roughly divided into four stages of a decadal scale as follows:

<table>
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<th>Modernization Stage (Years)</th>
<th>Schematic Description</th>
<th>Major Improvements</th>
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*Weather radars* (1954) 
*Numerical Weather Prediction (NWP) models* (1959) 
24-hour Typhoon forecasts (1952) |
| **2nd Stage** 1965-1985 | Nation-wide automation and networking development stage | Nation-wide Observations, Telecommunication and Data-processing Systems (around 1970) 
*Automated Meteorological Data Acquisition System (AMeDAS)* (1974) 
*Geostationary Meteorological Satellite “Himawari”* (1977) |
Advancement of digitization, analysis, NWP models and forecast/warnings 
48 to 72-hour Typhoon forecasts (1989, 1997) |
| **4th Stage** 2005-present | Advanced networking stage with modern ICT to meet further challenges in the coming years | Emergency Warning (2013) 
Advanced networking, analysis, NWP models and forecast/warnings 
5-day Typhoon forecasts (2009-) |
General public weather services and Early warning and decision support services (JMA)

User-specific services and Early warning decision support services (JMA)

Integrated services

Public forecast, user-specific decision support services

Non-government services Private sector and others

Production and Services

Basic meteorological monitoring, forecast and warning services (by JMA as National Meteorological Service (NMS))

Mass Media
- NHK (Japan Broadcasting Cooperation)
- Private mass media

Central Government
- Cabinet Office
- Ministry of Land, Infrastructure and Transport and Tourism (MLIT)
- Ministries and Agencies: Police, and Fire and Disaster Management (FDMA); Agriculture; Forestry; Fishery; Environment; Health; Economy, Trade and Industry; Science and Technology; Education; etc.

Local Governments
- DRR, Environment, Health, Education; etc.

Research Institutes and Universities

Public, Central/Local Governments and Socio-economic/Industrial Sectors

Users and Collaboration/Cooperation Authorities/Stakeholders

Socio-economic/Industrial Activities
- Shipping and aviation, e.g., routings
- Public works and transport/distribution sector
- Merchandising
- Mass media (TV/radio programs)
- ICT media: Internet, mobile apps and SNS
- Power supply including renewable energy
- Manufacturing industry, leisure industry, etc.
Major Improvements
Long-term Efforts and Strategies

Warning Areas

Typhoon Forecast
- 24-hour: 1952
- 48-hour: 1989
- 72-hour: 1997
- 120-hour: 2009

- One: 1883
- Ten (region): 1935
- 90 (pref.): 1953
- 200 (sub-pref.): 1997
- 370 (sub-pref.): 2005
- 1800 (city): 2010

Evolution of JMA Warning Services through Revision of Warning Criteria
Based on the Latest Monitoring/Forecasting Techniques

- 1875: Initiation of weather and earthquake observations by Tokyo Meteorological Observatory
- 1883: First issuance of storm warning for the whole area of Japan
- 1935: Introduction of storm advisory in addition to storm warning

Establishment of a comprehensive framework of warning services for multi-hazards
- 1950-53:
  - Weather warnings: storm and rain, snow-storm, heavy rain and heavy snow
  - Weather advisories: gale and rain, gale and snow, gale, heavy rain, heavy snow, etc.
  - Warnings/advisories for flood, storm surge and high waves

- 1952: Establishment of the Meteorological Service Act

Introduction of short-range precipitation data for detecting potential impacts
- 1972: Introduction of one- and three-hour as well as 24-hour precipitation amounts for heavy rain warnings/advisories for each local meteorological office

- 1974: Operation of AMeDAS system

Introduction of precipitation indices for impact-based warning services
- 1994: Introduction of the Radar-Raingauge-Analyzed Precipitation data into the criteria
- 2000: Introduction of “soil-water index” for issuing “alerts on the highest potential of landslides for the past several years”
- 2008: Introduction of “soil-water index” and “runoff index” for heavy rain warnings and flood warnings, which provides forecasters with information on the potential impacts. Specific criteria are set up for each municipality (city/town).

- 2013: Introduction of emergency warnings for catastrophic events

Introduction of the latest monitoring/forecasting techniques led to:
- Improvement in accuracy of monitoring/forecast of heavy rains and potential impacts for issuing warning

* The term “landsides” here refers to debris flows and concentrated slope failures.
Major Improvements
Legal and Regulatory Frameworks

Met-Service Act
Enact: 1952

Major Amendments
Earthquake and volcanic eruptions: 1978 and 2007
Public-Private Partnership: 1993
Emergency Warning: 2013

Meteorological Services regulated in the Meteorological Service Act
(Numerals show Article Numbers in the Act)

International Cooperation

Observations
Establishment of observation networks (JMA)
3 to 5

WMO Convention

Support for private weather services
Information dissemination, etc.
24-28 to 33

Forecast, warning and information services
Establishment of forecast, warning and information networks (JMA)
Single authoritative voice for warnings (JMA)
17 to 22 and 24-2 to 27

License and standards for forecast services by other than JMA
3, 11, 13 to 16 and 23

Collaboration with stakeholders in Japan
shipping, aviation, governments, media and private sectors

Users
Public, governments and socio-economic sectors

Council of Meteorological Services 43-2
Major Improvements
Sound Observation Systems

Observation Systems

Weather radars: 1954
AMeDAS: 1974
Himawari: 1977

Online Data Exchange with Hydrological Services (MLIT) and Local Governments:

1990s

- JMA: 1,300
- MLIT (Ministry of Land, Infrastructure, Transport and Tourism): 3,400
- Local Governments: 5,700
Major Improvements
User-oriented, Risk-based and Seamless Early Warning Services

Schematic Flow of Real-time Information Issued by Local Meteorological Offices (LMOs) in the Seamless Early Warning System
Major Improvements
User Interface in Early Warning Services

**Briefing**

Briefing on Typhoon Forecast at Tokyo Metropolitan Government Office

**Lesson to School**

A Lesson to school by Local Meteorological Office (LMO) Staff

**Telephone Briefing**

Telephone Briefing on Weather Conditions for a Local Government

**Display of Internet Websites**

Display of Internet Websites dedicated to Local Governments

**Internet Websites**
Increases in resolution, accuracy and performance of Numerical Weather Prediction (NWP) Models, observation and monitoring systems, and forecasting systems

1952: Authorization of forecast service companies by JMA

1978: Distribution of AMeDAS-data, etc. to the private sector

1993: Institutional Enhancement of PPP (Met-Service Act)


1954: Operational weather radar

1974: AMeDAS

1977: GMS (Himawari)

1987: Establishment of 1st comprehensive forecasting system with NWPs for Global, Asia to Japan regions

Number of weather forecast service companies authorized by JMA from 1953 to 2014
Major Improvements
International Cooperation

World Meteorological Organization (WMO) Observation Networks

World Meteorological Organization (WMO) Information System (WIS)

Tokyo Climate Center (TCC)/JMA
Operation of Himawari-series Satellites

GMS (Himawari): 1978
MTSAT-1R: 2005, MTSAT-2: 2010

Himawari-8: 2015
Himawari-9: 2016 Launch

True-color Visible Imagery

Himawari-8 Imagery over the Asia-Pacific

Infrared Imagery
Modernization was initiated 140 years ago (1875)

What steps did Japan take from these beginning days to the today’s world-class services?

- “Long-term sustainable human resources development”, to foster highly educated experts capable of handling cutting-edge science and technology.

- “Long-term and step-by step developments/investments” based on the advanced science and technology with “verifications and improvements”.

Among these developments/investments, JMA has tackled many challenges to meet higher targets, such as “Weather radars (1954-)”, “Numerical Weather Prediction (NWP) models (1959-)”, “AMeDAS (1974-)” and “Himawari-series Satellites (1977-)”.
Knowledge, technology and expertise in the Japan Meteorological Agency (JMA) as the National Meteorological Service with International Centers, and in international cooperation projects with the Japan International Cooperation Agency (JICA) will contribute to the modernization of NMHSs in developing countries including systems, operations and human resources.

Lessons Learned from Japanese Experiences will be Summarized after the Presentation of Hydrological Services.

Thank you for your attention!