Current Status and Future Plan of the implementation of Impact-based Forecasting at KMA

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Characteristics of climate and weather in Korea

- A small territory, but with a variety of severe weather
- Geographical environment and complex topography
  → Distinct seasons and big regional differences in weather
- 2-3 typhoons a year directly affect the peninsula
- Relatively big change in climate

Heavy Rainfall & Landslide

Heavy Snow

Typhoon

Drought

Heat Wave

Cold Wave

Asian Dust

Wild Fire (dry season)

Strong Wind ......

China

Korea

Japan

Accurate and effective early weather warning system is necessary to prevent social and economic damages.

2

Current warning system at KMA

Threshold-based Weather advisory/warning Service

	Advisory	Warning
Strong wind	Wind speed exceeding 14m/s or wind speed of moment exceeding 20m/s are expected on land. But, wind speed exceeding 17m/s or wind speed of moment exceeding 25m/s are expected in mountain areas.	Wind speed exceeding 21m/s or wind speed of moment exceeding 26m/s are expected on land. But, wind speed exceeding 24m/s or wind speed of moment exceeding 30m/s are expected in mountain areas.
Wind wave	Wind of 14m/s or more sustains for over 3 hours at sea or significant wave height is expected to be over 3m.	Wind of 21m/s or more sustains for over 3 hours at sea or significant wave height is expected to be over 5m.
Heavy rain	The precipitation for 6 hours is expected to be more than 70mm or the precipitation for 12 hours to be over 110mm.	The precipitation for 6 hours is expected to be more than 110mm or the precipitation for 12 hours to be over 180mm.
Heavy snow	Snowfall is expected to be more than 5cm in 24 hours.	Snowfall is expected to be more than 20cm in 24 hours. In mountain areas, however, the snowfall is expected to be more than 30cm in 24 hours.
Dry air	Effective humidity of 35% or less is expected for at least 2 days.	Effective humidity of 25% or less is expected for at least 2 days.
Storm surge	Sea level is expected to rise locally due to complex factors, such as astronomical tides, typhoons, storms and low pressures, and to surpass the standard point to issue the advisory. ref) the standard point is set by regions.	Sea level is expected to rise locally due to complex factors, such as astronomical tides, typhoons, storms and low pressures, and to surpass the standard point to issue the advisory. ref) the standard point is set by regions.
Cold wave	When any of the following is expected between October and April: ① Morning minimum temperature is predicted to drop by more than 10℃ than the previous day to below 3℃ and to lower by 3℃ compared to the climatological normal year; ② Morning minimum temperature of −12℃ or less is expected for more than 2 days; ③ Serious damage is expected due to rapid temperature drop.	When any of the following is expected between October and April: ① Morning minimum temperature is predicted to drop by more than 15℃ than the previous day to below 3℃ and to lower by 3℃ compared to the climatological normal year; ② Morning minimum temperature of −15℃ or less is expected for more than 2 days; ③ Serious damage is expected over a wide range of areas due to rapid temperature drop.
Typhoon	Strong wind, wind wave, heavy rain and storm surge are expected to reach advisory levels due to typhoon.	When any of the following is expected to fall under due to typhoon: ① Strong wind(or Wind wave) is expected to reach warning levels; ② The total precipitation is expected to be more than 200mm; ③ Storm surge is expected to reach warning levels.
Asian dust (HWANGSA)	Hourly average dust(PM) concentration is expected to exceed 400 for over 2 hours due to Asian dust.	Hourly average dust(PM) concentration is expected to exceed 800 for over 2 hours due to Asian dust.
Heat wave	Between June and September, the daily maximum temperature of more than 33℃ is expected for over 2 days.	Between June and September, the daily maximum temperature of more than 35℃ is expected for over 2 days.

Observation Monitoring

Model Analysis

Forecast Production

Delivery Application

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+ wave height (→ in a total, we are issuing warning for 11 elements)
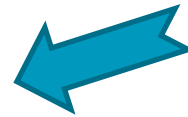
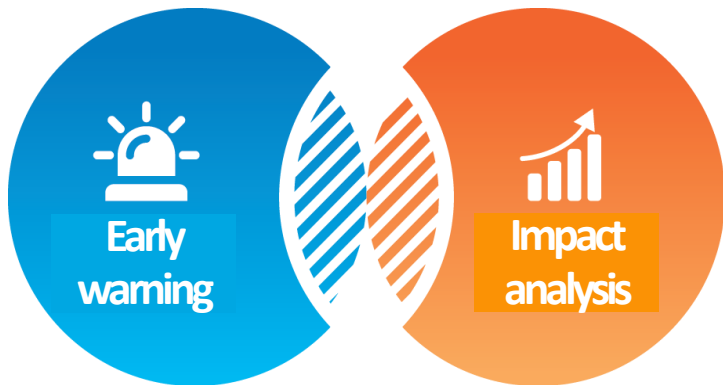# Case Study (Severe snow) Jeju International Airport (Jan. 23~25th, 2016)

Current severe weather warning system in KMA

	Mid-term forecast	Short-term forecast	Short-term forecast
Jan. 23.	forecast snowfall	Preliminary Warning on snow, wind, wind wave	Advisory on snow, wind, wind wave
	- 7 days	- 1~2 days	D - day

Jeju International airport
Massive flight cancelation
90,000 passengers were stranded after Jeju airport closed

Need for Impact forecasts

Early warning

Impact analysis

- **The "weather impacts" can vary depending on time and place**
- **New forecast system should take into a consideration the expected social and economic impacts due to weather changes**

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Five Prerequisites for Successful IBFWS

OBS
develop agreements and standards for generating necessary impact data

Observations & Monitoring

RMP
Harness science capabilities and results to meet the needs of IBFWS

UIP
provide ways for IBFWS users and providers to interact and improve the effectiveness of the Framework and its services

User Interface Platform

Impact -Based Forecasting and Warning Services (IBFWS)

Research, Modeling and Prediction

SIS
produce and distribute impact data and information according to the needs of users and to agreed standards

CB
support the systematic development of the institutions, infrastructure and human resources needed for effective IBFWS

Capacity Building

Service Information System

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OBS: based on new Technologies related to 4th Industrial Revolution

Impact Database

- National Disaster Reports (Traditional approach)
- Drone, CCTV
- Crowdsourcing Data Acquisition System (SNS)
- Citizen's participation using **emoticon (or infographics)**

Interactive warning and data acquisition w/ graphics

| Be aware | Be prepared | Take action | Rain | Wind | Snow | Ice | Fog |

OBS: People activity detection / tracking / understanding (Demo)

- Ex. of weather impact data acquisition system we are developing

- Multi-Person Tracking System using CCTV and AI

- Plan to use the system to build DB of how weather affects people's activities

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Courtesy of Korea University (Prof. Han-Seok KO)
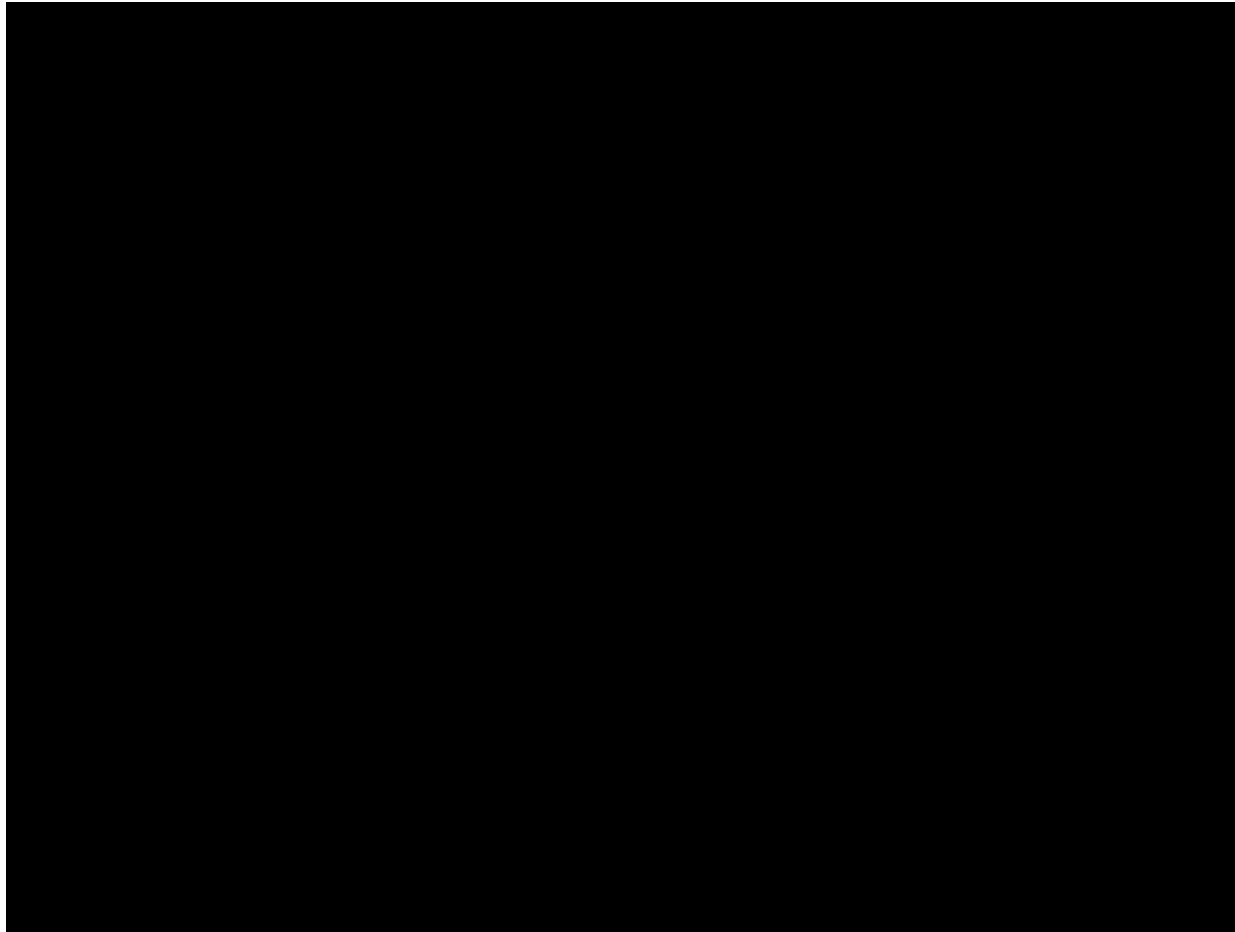
Road Map for the implementation of IBFWS at KMA

2016-2018

Step 1

Early warning on High-Impact Wather

Based on the "'Risk Matrix" approach

Impact Forecasts based on Risk Matrix

Risk = Hazard x Vulnerability x Exposure

2018-2019

Step 2

Development of Hazard Impact Model

To link meteorological model with disaster model

(flood, heat wave etc.)

2020~

Step 3

Operational Impact Forecasts Services

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RMP: Empirical Risk Thresholds for severe weather phenomena

- In order to determine the impact or the level of risk for each area in Korea, we utilized experiences and expertise of retired KMA forecasters and former disaster-prevention officers.
- Using the information they have provided, we have calculated the regional risk thresholds we currently use as shown here for strong wind and heavy rain.


관심	주의	경계	심각
5m/s	8m/s	12m/s	16m/s
7m/s	10m/s	15m/s	20m/s
8m/s	12m/s	16m/s	24m/s
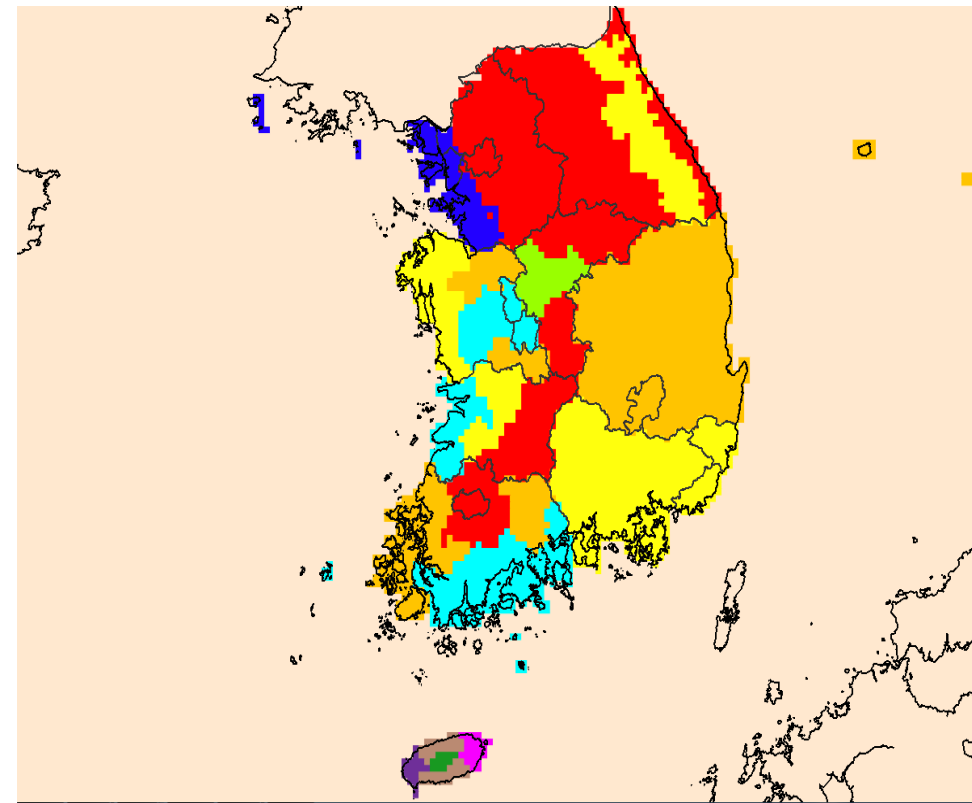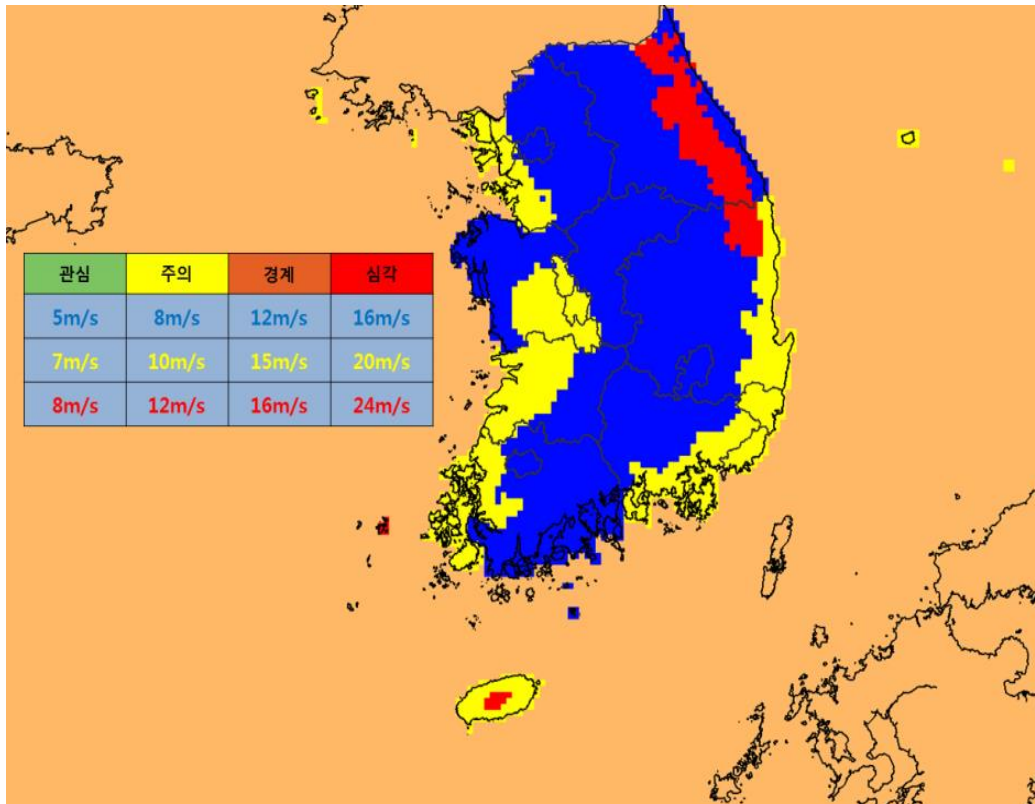
Regional Risk Threshold : (a) strong wind, (b) heavy rain

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RMP: Ensemble Outputs → Probabilistic Forecasting

- **Probabilistic forecasting by calibrating the results from ECMWF Global Ensemble and UM Global and Local Ensemble**
- **To improve the precision of forecasting the likelihood of severe weather.**

Calibration of ECMWF ENS Outputs
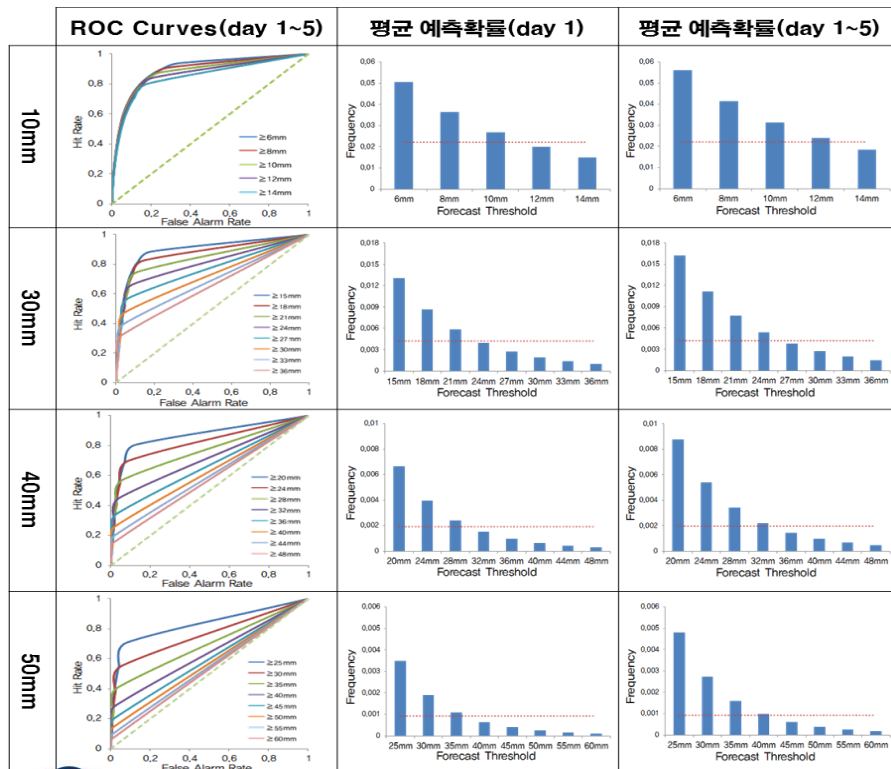
	+1 day prediction	+1~5 day prediction
10mm/6hr	12mm	12mm
20mm/6hr	18mm	20mm
30mm/6hr	24mm	27mm
40mm/6hr	28mm	32mm
50mm/6hr	35mm	40mm

Calibrated Precipitation thresholds of ECMWF ENS during the summer of 2013 through 2015 over South Korea

Heat Wave Impact Model
that incorporate with demographic and GIS information

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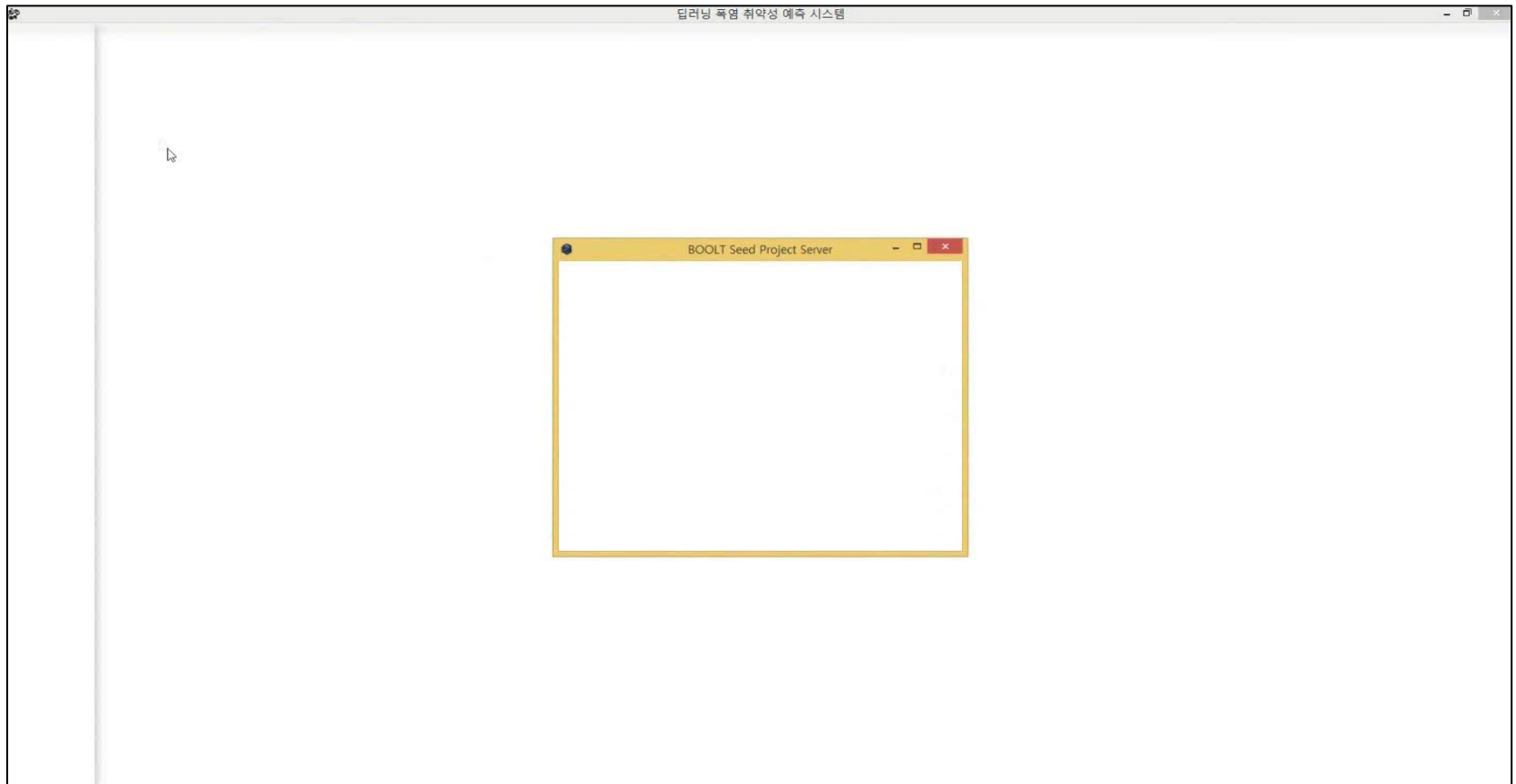
Storm Surge Flood Model
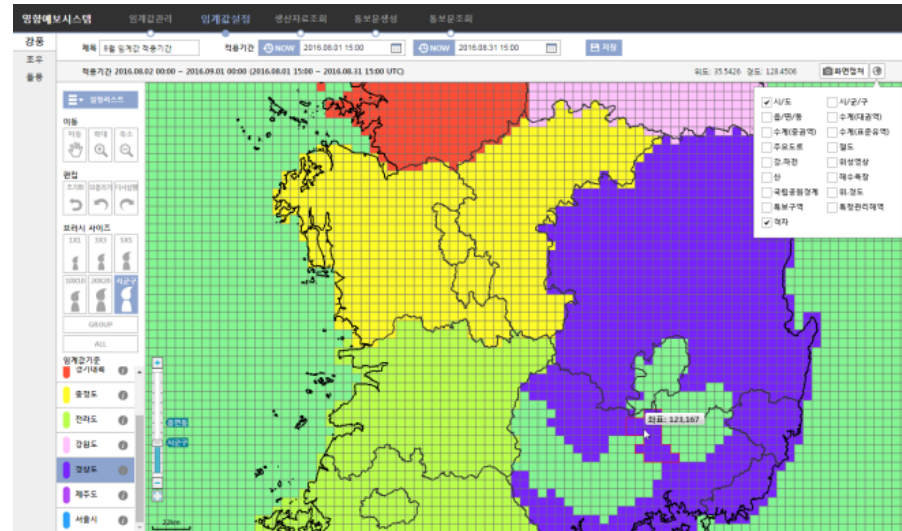
that estimates property damages

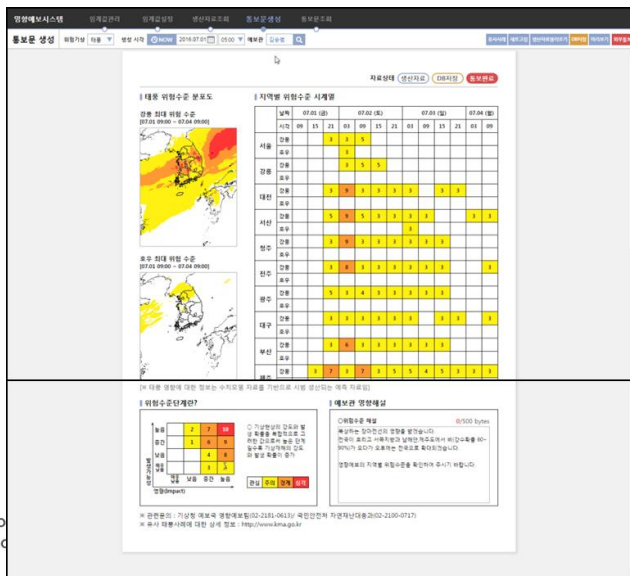# SIS: Web-based Supporting System for forecasters and users

Intro
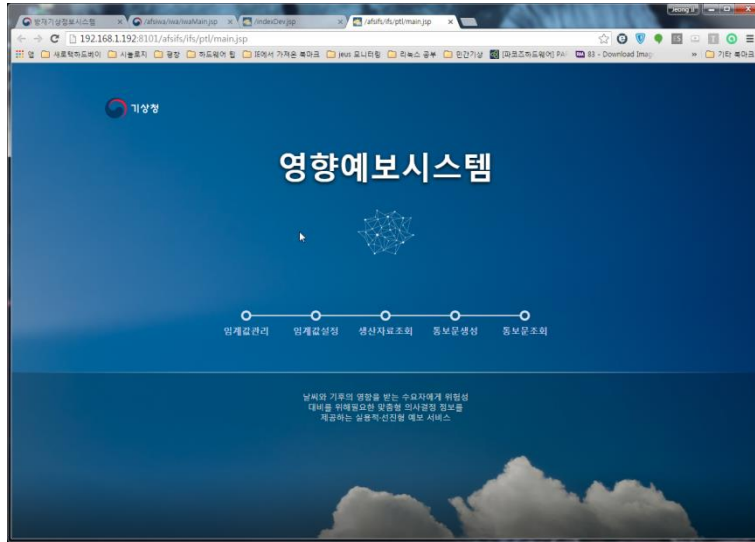
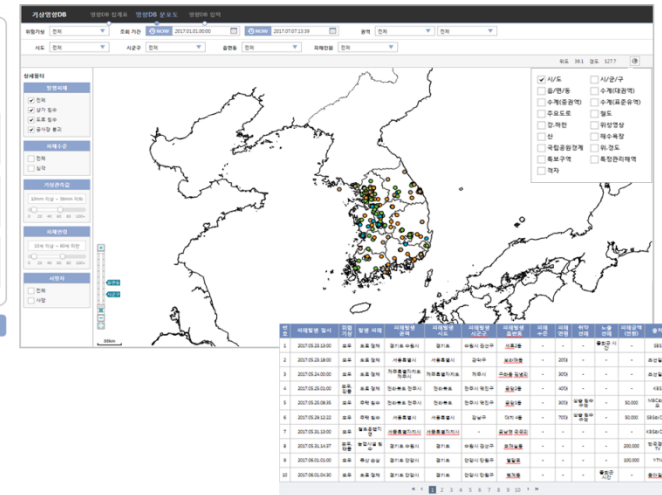**Setting Impact Thresholds for each region in Korea**
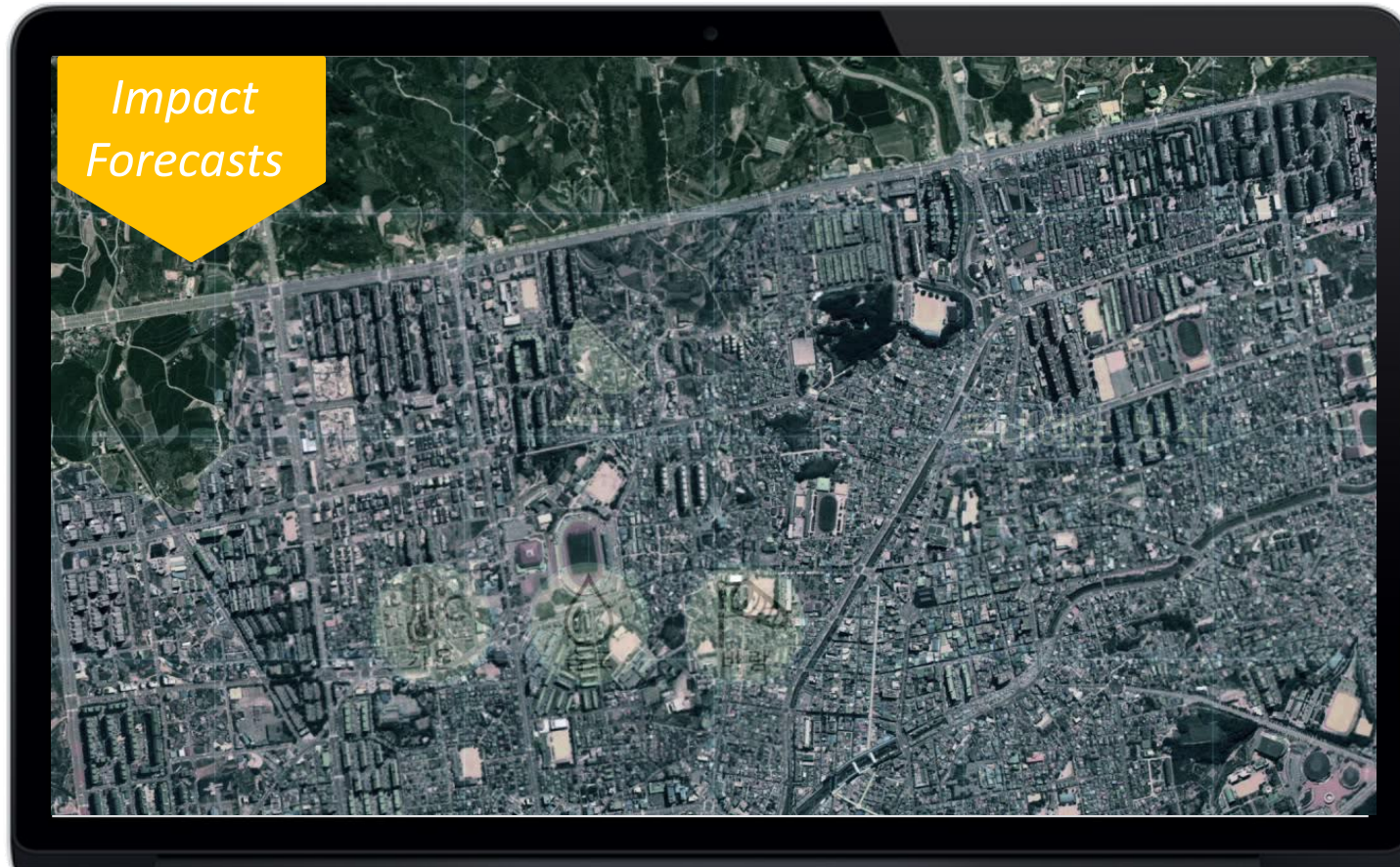

Impact-based Warning Statement

Impact DB(Library)

Cooperation with decision makers in local governments

Pilot Project on IBFWS in Asia : "International Workshop"

- **(Purpose)** to promote the concept of multi-hazard impact-based forecasts including the role of future forecasters to identify associated training needs in the Region.

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- Through KMA's experiences, we realized that risk-matrix approach can potentially be used for user-specific applications and decision making - **but it needs the more accurate ensemble outputs and suitable thresholds.**

- **Building partnership with stakeholders** is also the main key for the success. It is absolutely necessary to collaborate with social scientists and staffs involved in the partnership. The results should be shared.

- **Hazard Impact Modelling** is challenging but ultimately it can prove to be impactful in decision making

- We need to focus on the collection of impact DB. For this, **studies that enhance the usability of new technologies such as IoT(CCTV, Drone etc), Big Data, AI should be actively pursed in the future**

- **In order for the IBFWS to succeed, collaboration between academia and government is very important** at National level

- At Regional and Global Level,

"Let's work Together!!!"

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GAM SA HAM NI DA!
(Thank you very much!)

Thank you for your attention!
Any Questions and Comments?

kmaskim@korea.kr

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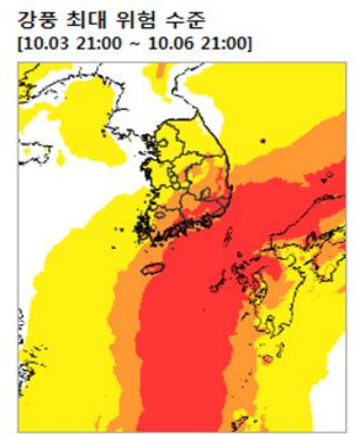
Impact forecast & Disaster distribution

Impact-based Typhoon warning

강풍 최대 위험 수준
[10.03 21:00 ~ 10.06 21:00]

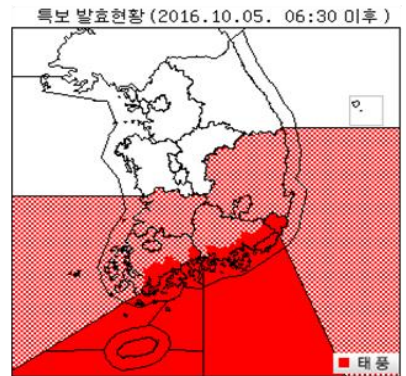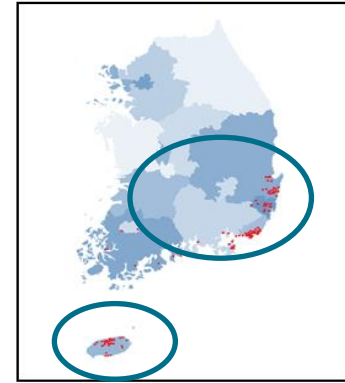(a) Impact-based warning for strong wind
(-2day)

호우 초
[10.03 2

Storm Surge,
Strong wind,
Flooding..
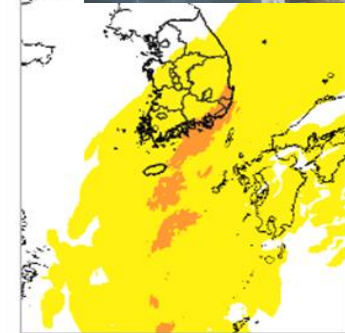
(b) Impact-based warning for heavy rain
(-2day)

Typhoon warning in current KMA's forecasting System based on Observations

특보 발효현황(2016.10.05. 06:30 이후)

■ 태풍

(c) KMA's typhoon warning issued on the D-day

(d) Areas damaged by Typhoon CHABA in korea

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Impact Forecasts based on Risk Matrix

High

Medium

Low

Very Low

Assign a color to the warning which is a combination of potential impact and likelihood (source : Met Office)

Likelihood

Potential impacts

Very Low   Low   Medium   High

No severe weather

Be aware

Be prepared

Take action
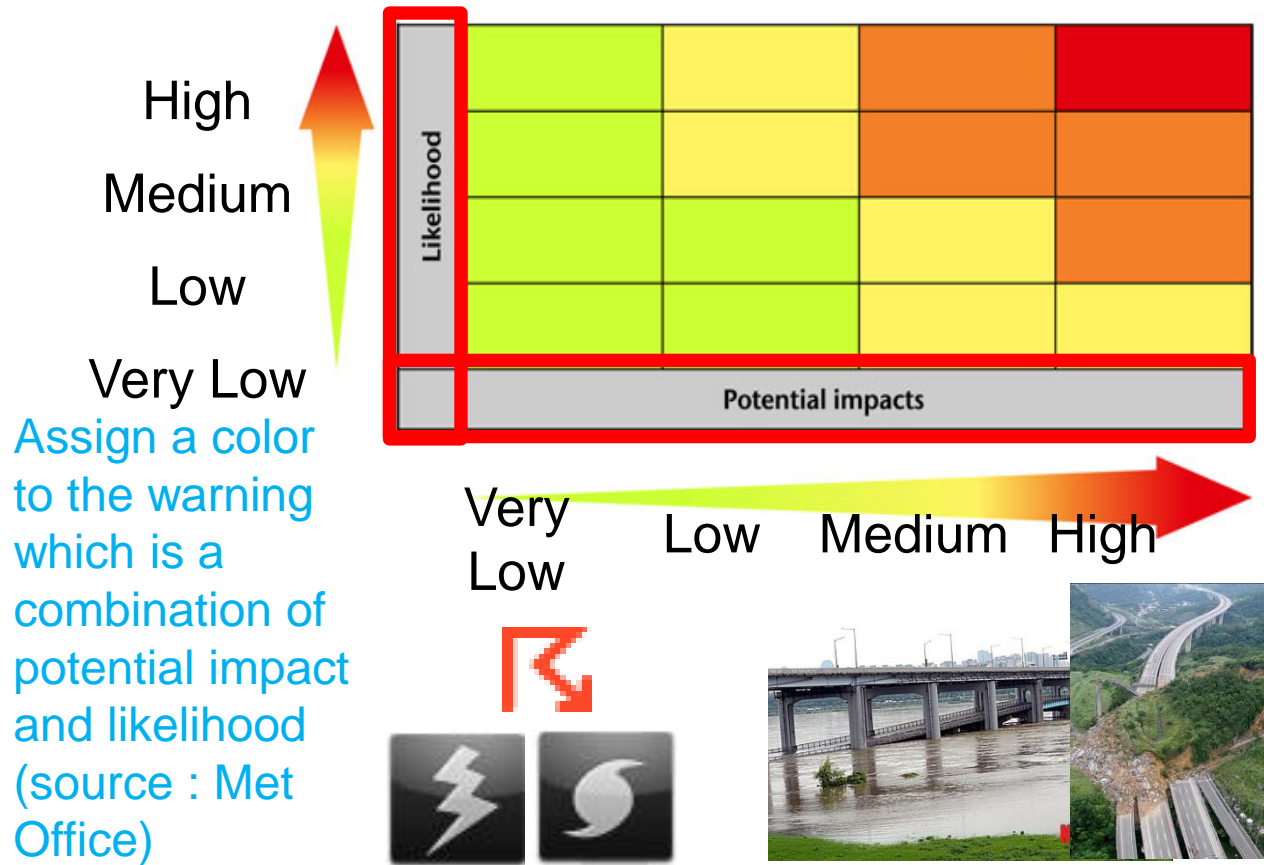
Illustrated by WMO report

Risk = Hazard x Vulnerability x Exposure

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