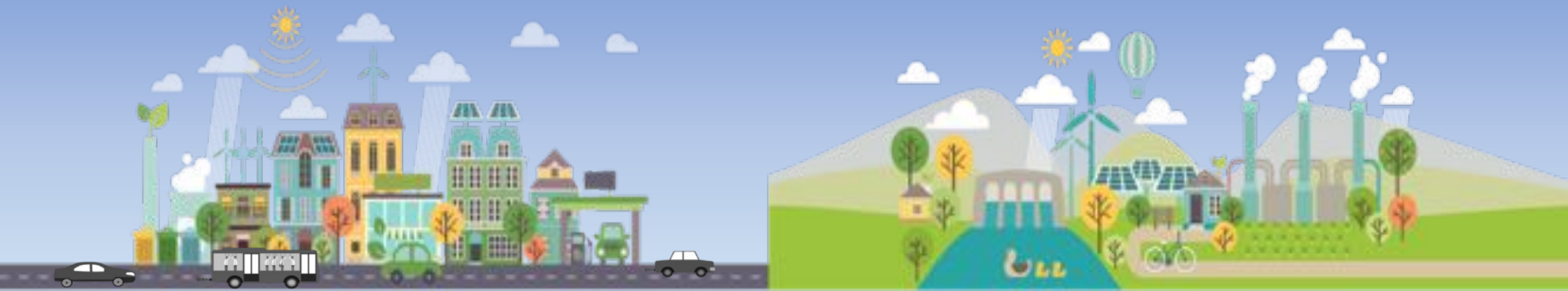
WISE program:
Observation, Modeling and Application for Urban Meteorology in Seoul

Seung On Hwang
(On behalf of Director Gangwoong Lee)
WISE / HUFS / KMA

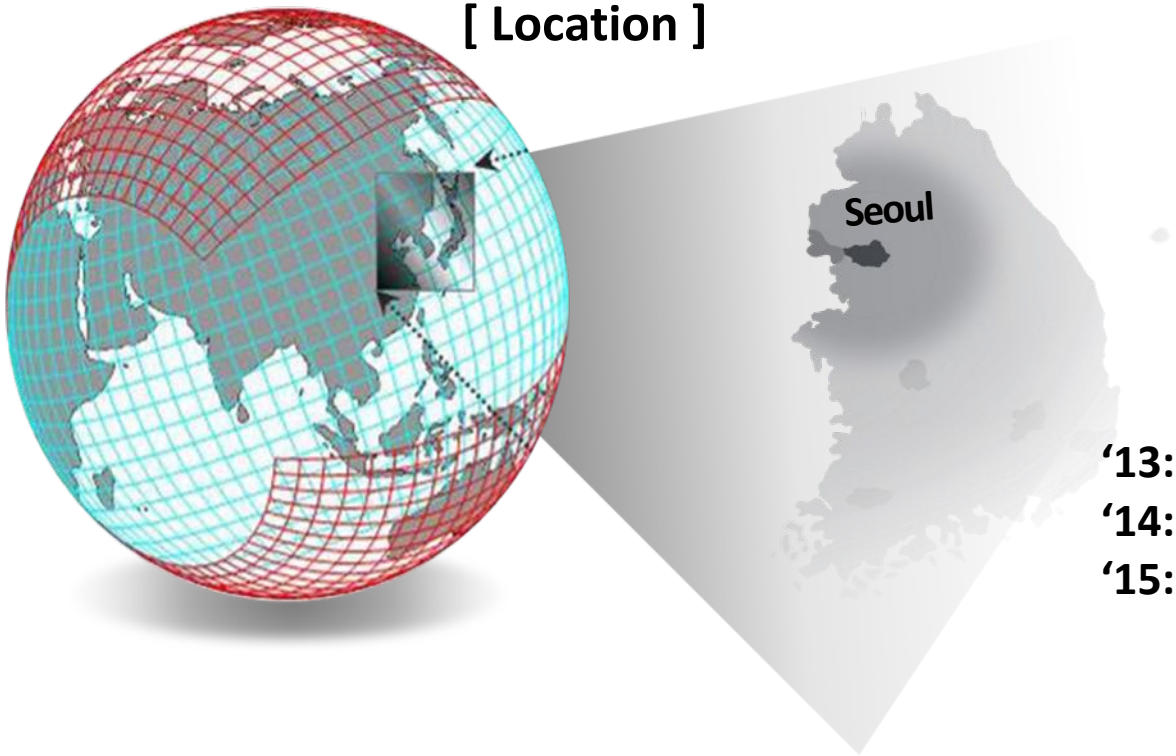
차세대도시농림융합기상사업단
(Weather Information Service Engine)



Unfortunately,

WISE has not been doing any research on Air Quality until now !

[Location]



History along with WMO

‘13: WISE submitted to 16th WMO CAS

‘14: Discussion with WMO GAW

‘15: with Dr. Alexander Baklanov

WISE program

❑ **Project period** : 2012~2019

❑ **Total budget** : US$85 million (Assessed every year)

-Actually received half of it from Gov. until now.

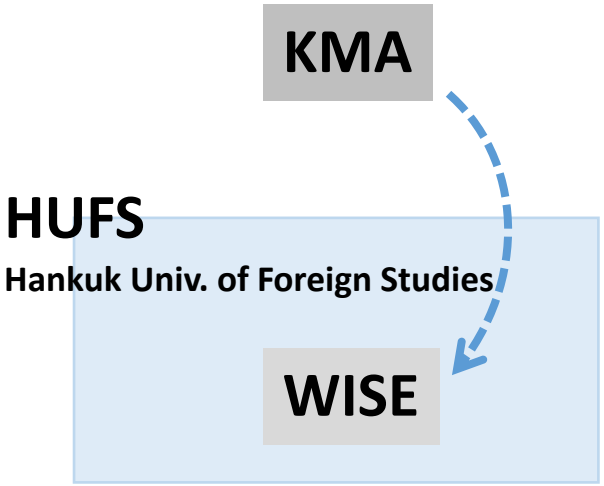
-'17 budget : US$5.5 million

❑ **Personnel** : Total 48 (43 researchers + 5 admin.)

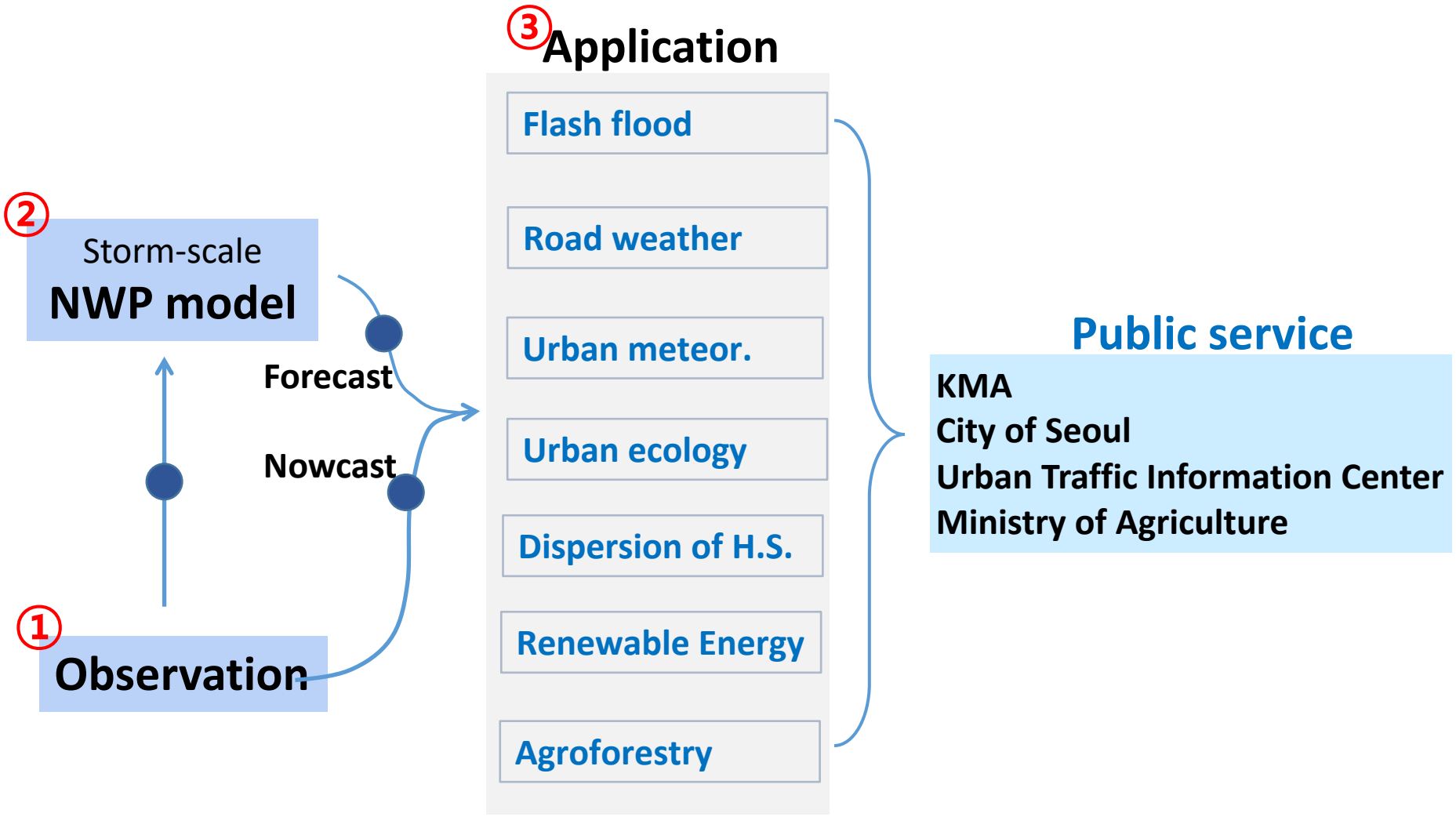
❑ **Organization**

3 Deps. of research + 1 Dep. of human resources

- Modeling & Computer
- Urban Observation
- Application
- Adm.



Program components

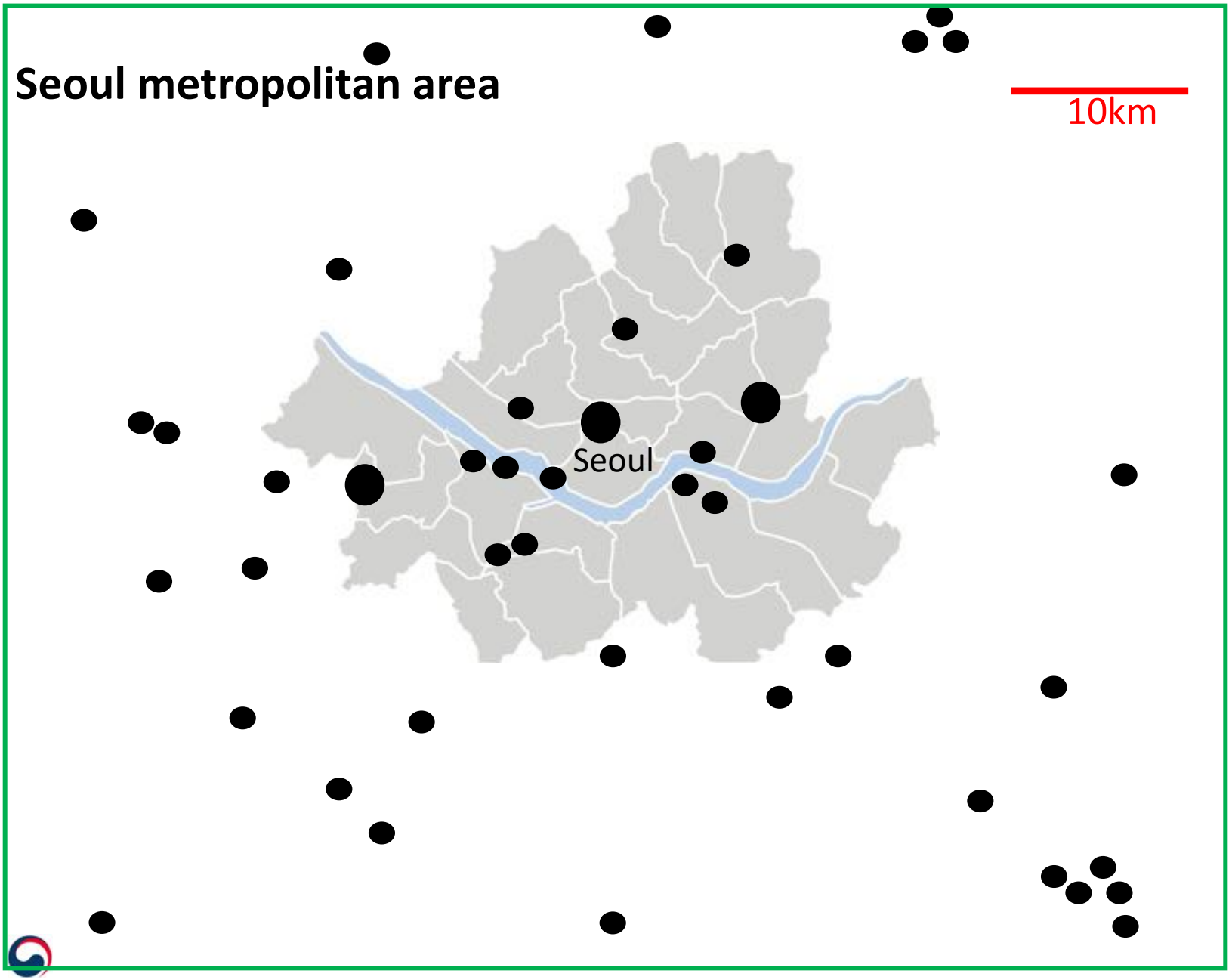


① Observation

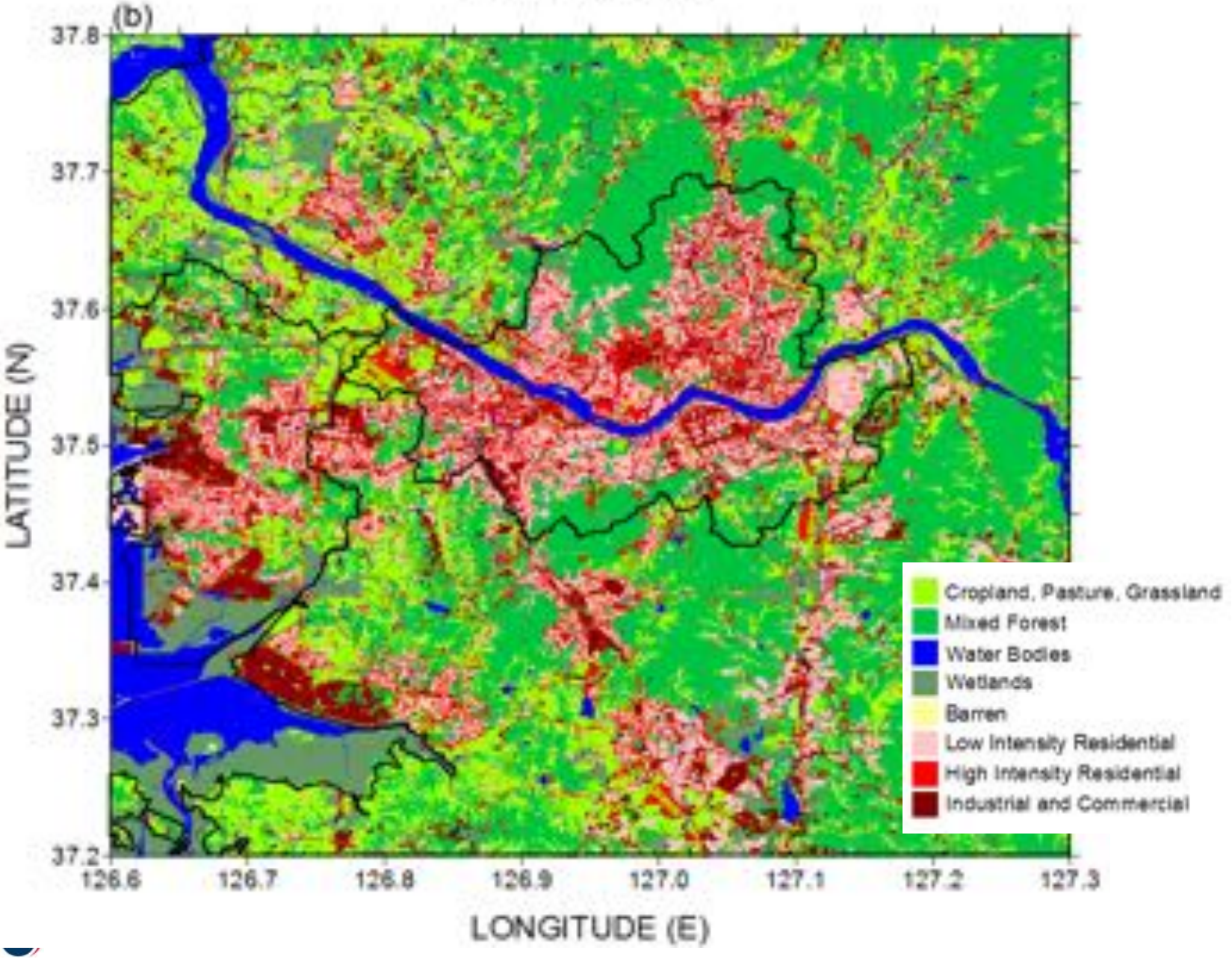
Finally, all observation sites have been installed late 2016.
are now running well !

Its total cost is approximately US$7 million.

Observation “Location”

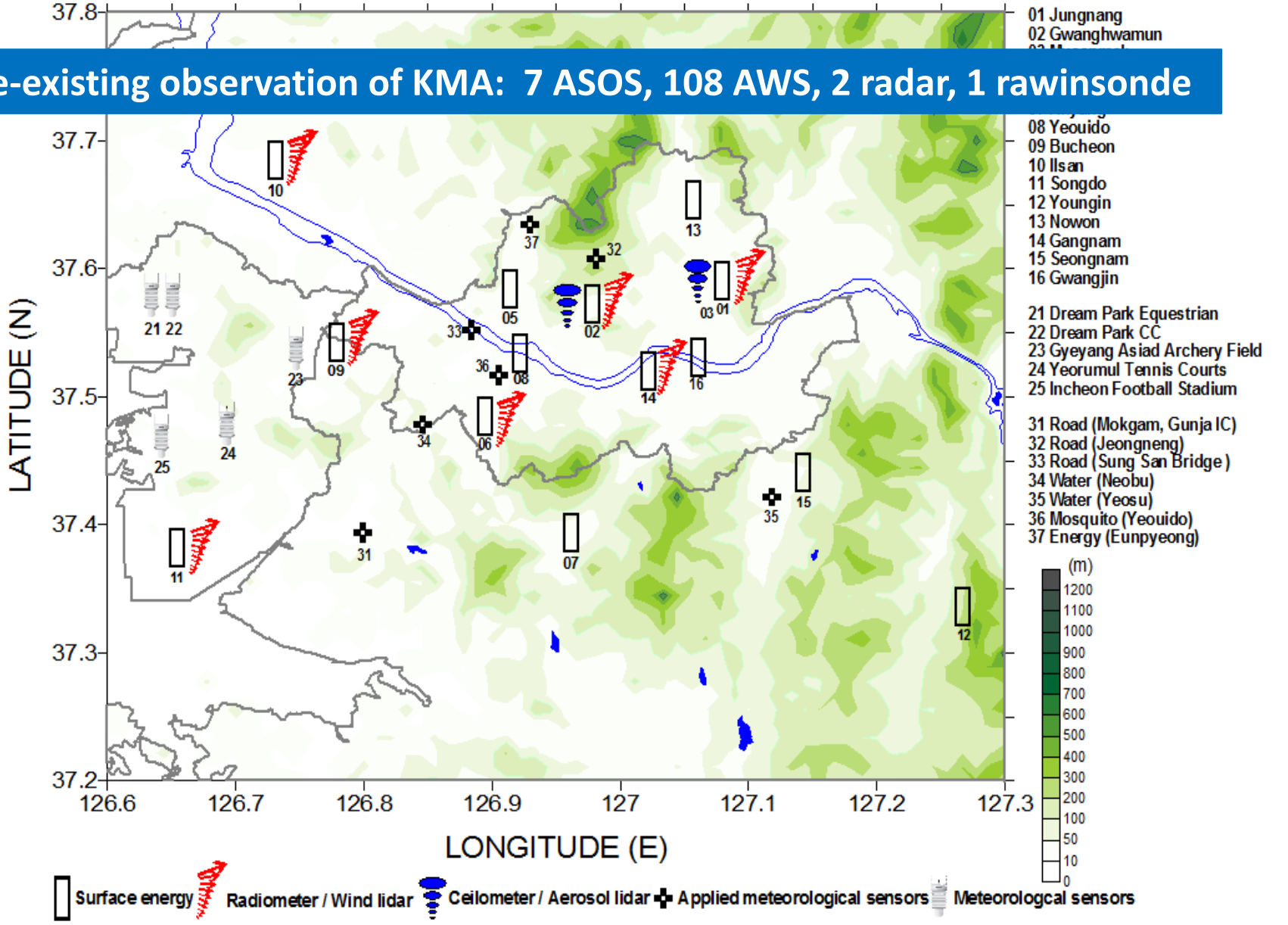


Land Cover


(b)
37.8
37.7
37.6
37.5
37.4
37.3
37.2
LATITUDE (N)
126.6
126.7
126.8
126.9
127.0
127.1
127.2
127.3
LONGITUDE (E)
Cropland, Pasture, Grassland
Mixed Forest
Water Bodies
Wetlands
Barren
Low Intensity Residential
High Intensity Residential
Industrial and Commercial

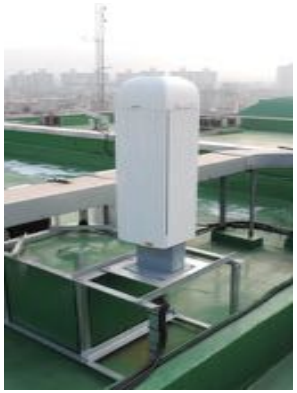
WISE Urban Meteorological Observation Network

Pre-existing observation of KMA: 7 ASOS, 108 AWS, 2 radar, 1 rawinsonde



Systems	Sensor or specification	
Surface energy balance obs. system (14 sites)	Sites	rural, residential, commercial, industrial, apartment, river (1.5~18.5m)
	Sensor	T, RH, Wind, ↑↓ short/longwave radiation, CO_2/H_2O IR gas analyzer, sonic anemometer, Tsfc, rain gauge, Twater(2), IR thermometry (6), Large Aperture Scintillometer(1 set). Tsfc monitoring system(2 sets)
Meteo. Obs. system for profile	Ceilometer (2)	Wavelength: 910 nm / Backscatter by aerosol (up to 15 km, 10 m vertical resolution, 1-min temporal resolution), cloud bottom heights (3 level)
	Aerosol lidar (2)	Wavelength: 532 nm (parallel, cross-polarized), 1064 nm / Backscatter by aerosol (up to 16 km, 3.75 m vertical resolution, 1-hr resolution), depolarization ratio, backscatter
	Radiometer (7)	Water vapor (22~31 GHz, 7 channels), T (51~58 GHz, 7 channels) T_B for each channel, vertical profile of T, RH, liquid water content
	Wind lidar (6)	Wavelength: 1532 nm, Wind speed and direction (up to 6,000 m, 100 m vertical resolution, 10-min interval)
Applied meteo. Obs. system	Road (6)	Wind, T, RH, Precip., Precip. detection, insolation, net radiometer, road temperature and status, salinity, water depth
	Water quality (2)	T_{water}, pH, conductivity, dissolved oxygen, salinity, turbidity, chlorophyll-a, water depth
	Mosquito (3)	Mosquito collector
	Greenhouse gas (1)	CH_4 concentration, total radiation, diffuse radiation
	Agrometeo.(4)	Shortwave/longwave radiation, T and RH, albedo, leaf wetness, soil moisture content, wind speed and direction, precipitation, Tsoil

1) For Vertical Profiles



Ceilometer

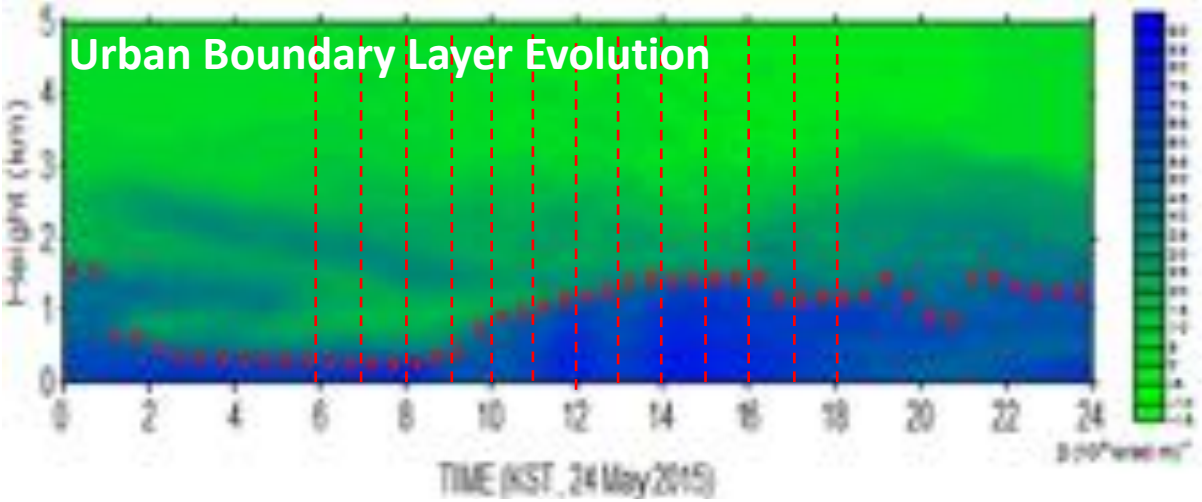
Aerosol Lidar

Wind Lidar

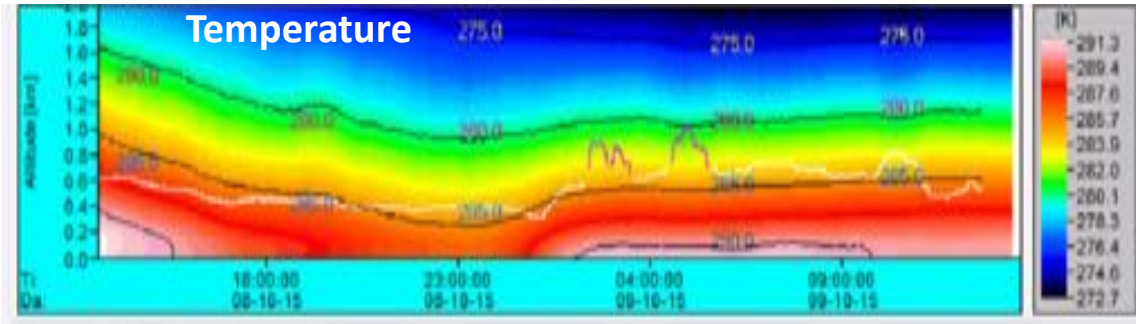
Microwave Radiometer

Vertical Profiles

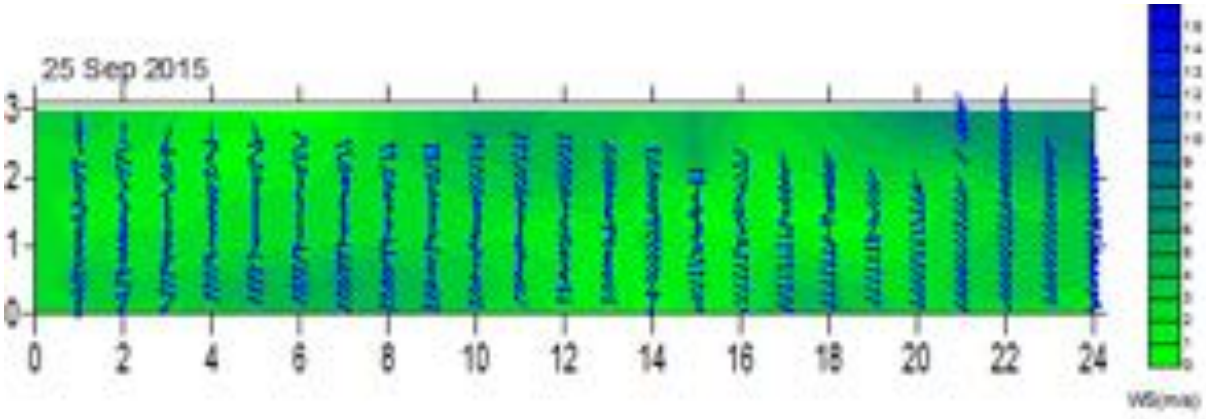
(Ceilometer/Aerosol Lidar)



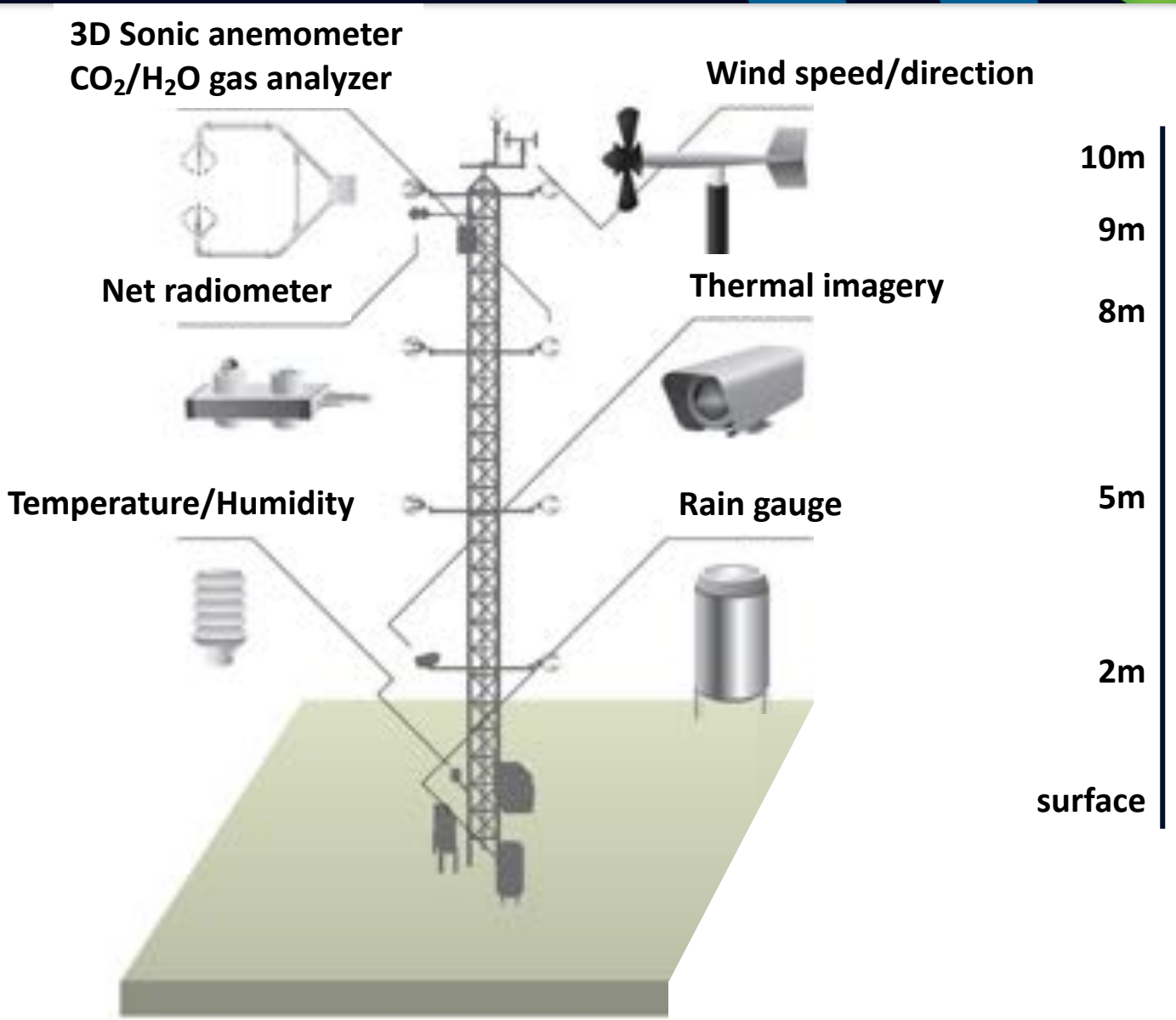
(Microwave Radiometer)



(Wind Lidar)



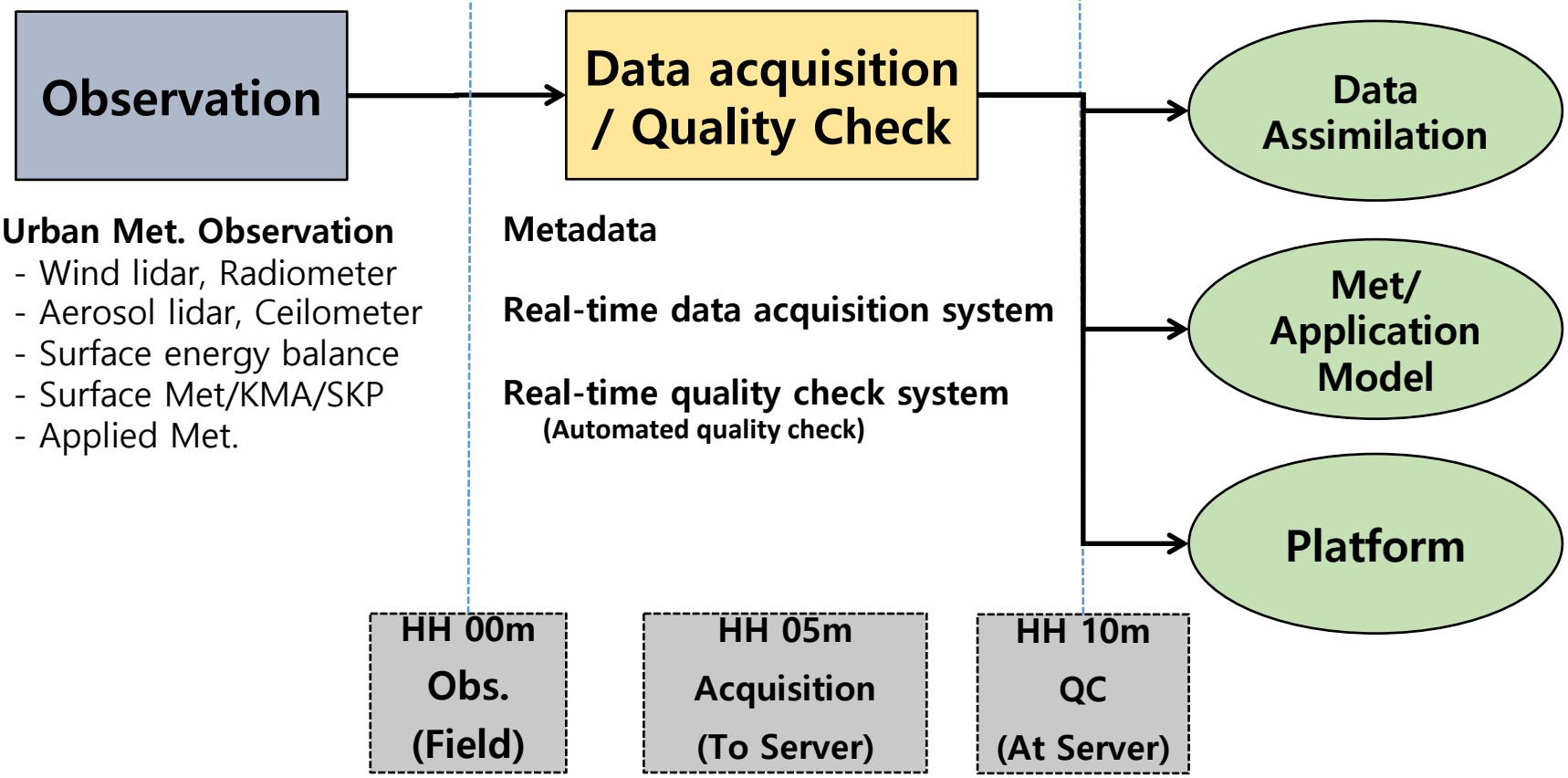
2) AWS + Surface energy balance system



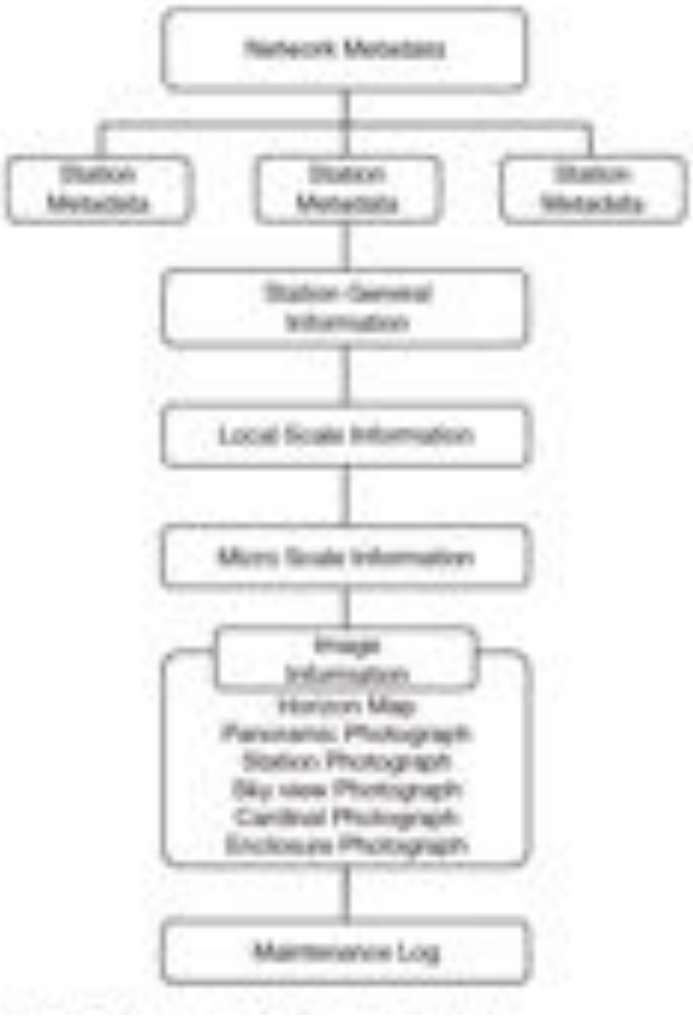
3) Mobile Road & Urban Meteo. Obs. System

WISE Meteorological Observation Data Process

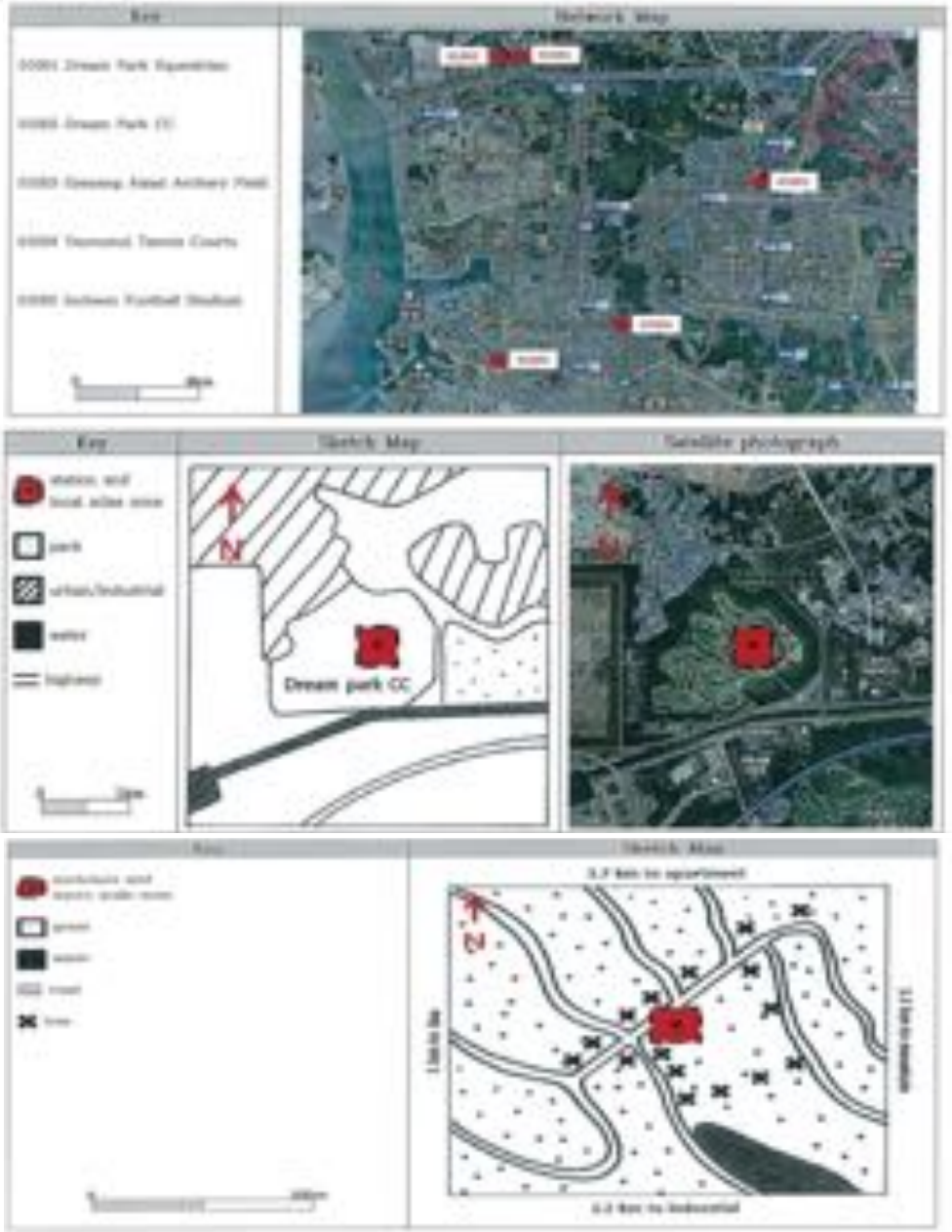
WISE is providing observation data to KORUS-AQ



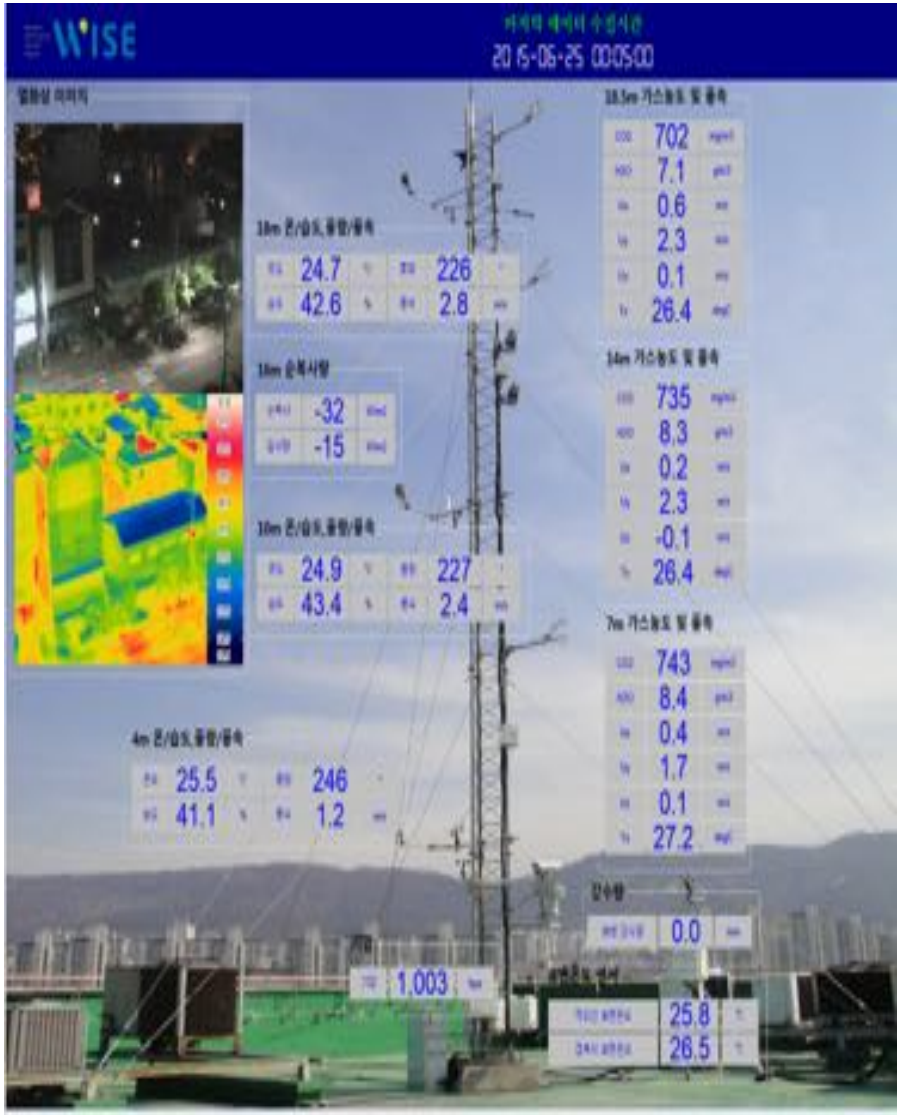
Station Metadata

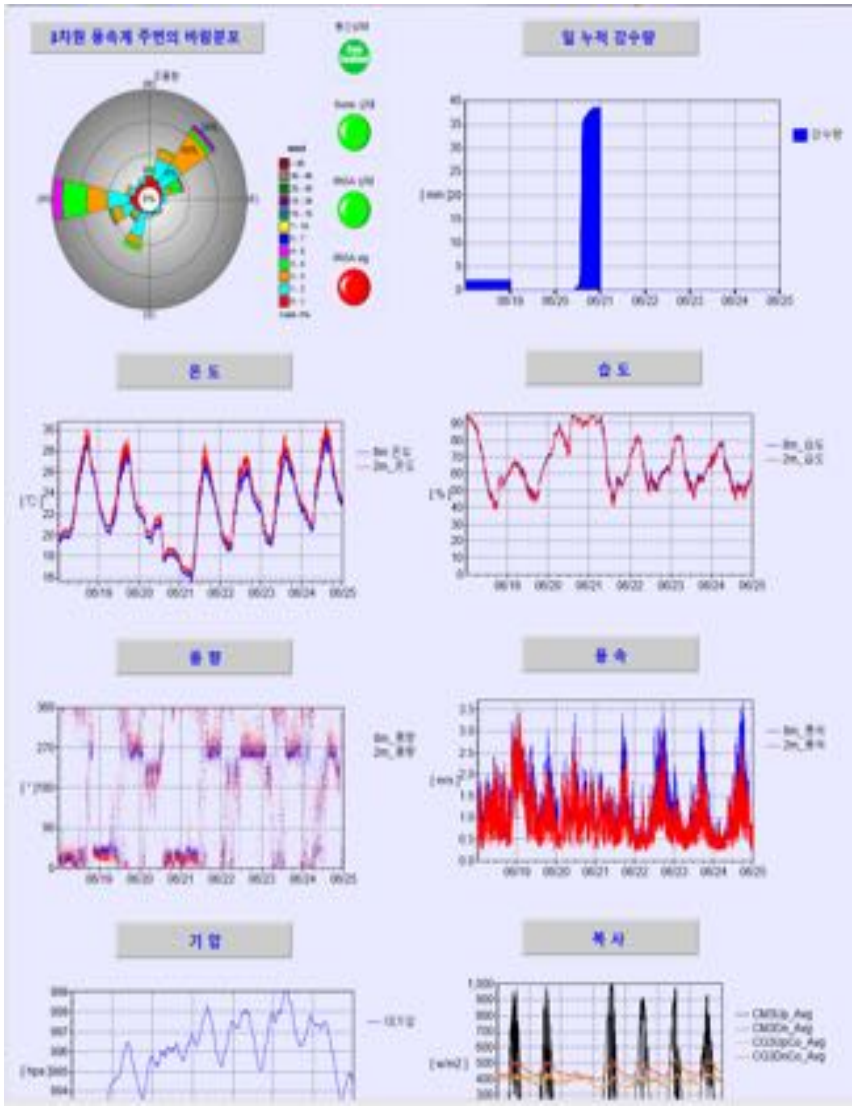


(Muller et al., 2013; Song et al., 2014)



Real-Time Data Display and Check





② Storm-scale

NWP model

Advanced Storm-Scale Analysis and Prediction Sys.

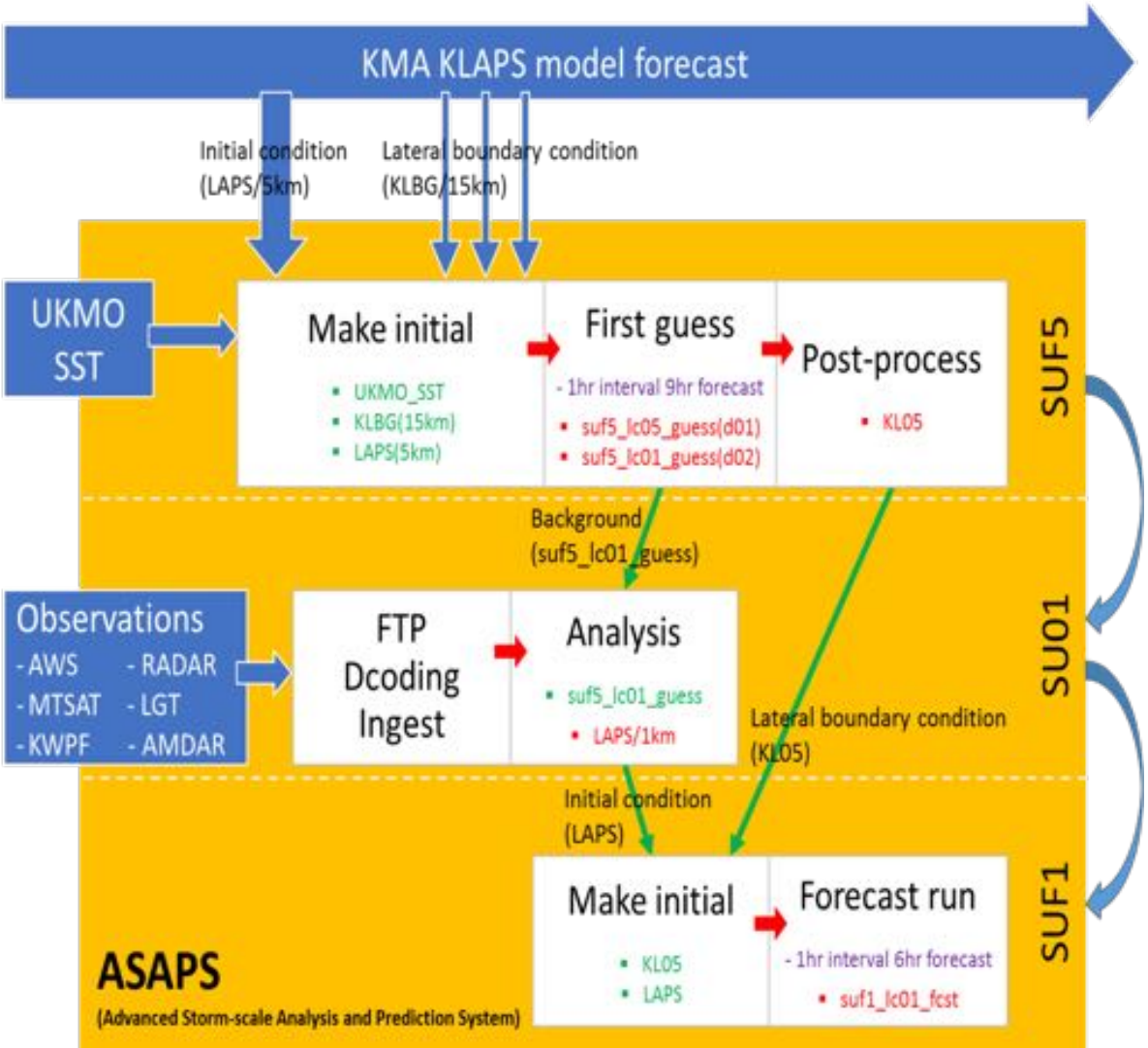
(ASAPS)

1-km resolution, up to 6-hr forecast, every hour

Predicting severe weather on Seoul and metropolitan area
to support meteorological prediction information to application models

LAPS (from NOAA)

WRF (from NCAR)



Operational on KMA Cray supercomputer

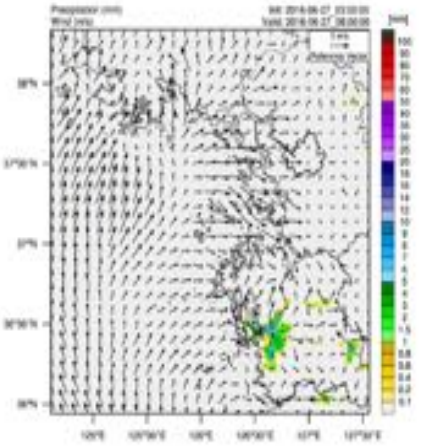
HomePage | About | Administration

ASAPS V1.0

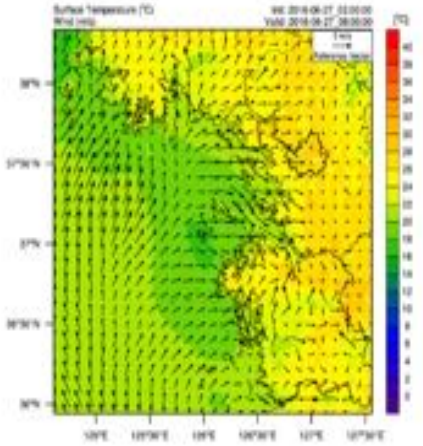
Mon Jun 27 2016 13:55:08 GMT+0900 (대한민국 표준시)

Main ASPAS V1.0 | Main ASAPS V2.0 | ASAPS V1.0 | ASAPS V2.0 | QPE | Wind | SST | Road

강수



온도



Surface Temperature

2016.06.27.03:00 | 2016.06.27.02:00 | 2016.06.27.01:00 | 2016.06.27.00:00

2016.06.26.23:00 | 2016.06.26.22:00 | 2016.06.26.21:00 | 2016.06.26.20:00

2016.06.26.19:00 | 2016.06.26.18:00 | 2016.06.26.17:00 | 2016.06.26.16:00

Precipitation

2016.06.27.03:00 | 2016.06.27.02:00 | 2016.06.27.01:00 | 2016.06.27.00:00

2016.06.26.23:00 | 2016.06.26.22:00 | 2016.06.26.21:00 | 2016.06.26.20:00

③ Application

for **Public Service**

- **Flash flood**
- **Road weather**
- **Urban meteor.**
- **Urban ecology**

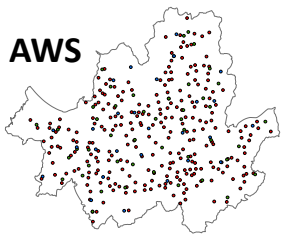
Not Serviced yet !

1. Flash flood

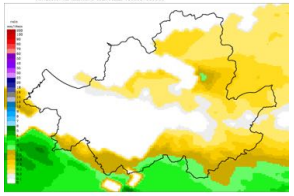
Urban flash flood (only for the city of Seoul)

Observation & NWP forecast

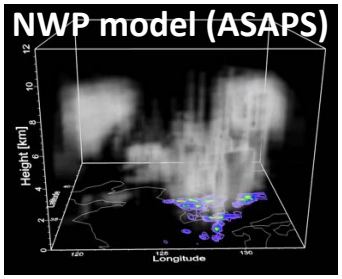
AWS



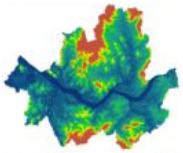
QPE/QPF from Radar



NWP model (ASAPS)

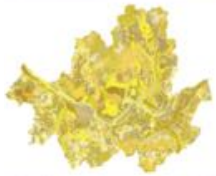


Land / Hydraulic structure

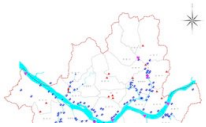


Digital map (2m)

Land Cover



Soil map



Pumping / Undercurrent

Pipe linenet

Manhole

Run-off and flooding Forecast model

83 drainage areas in Seoul

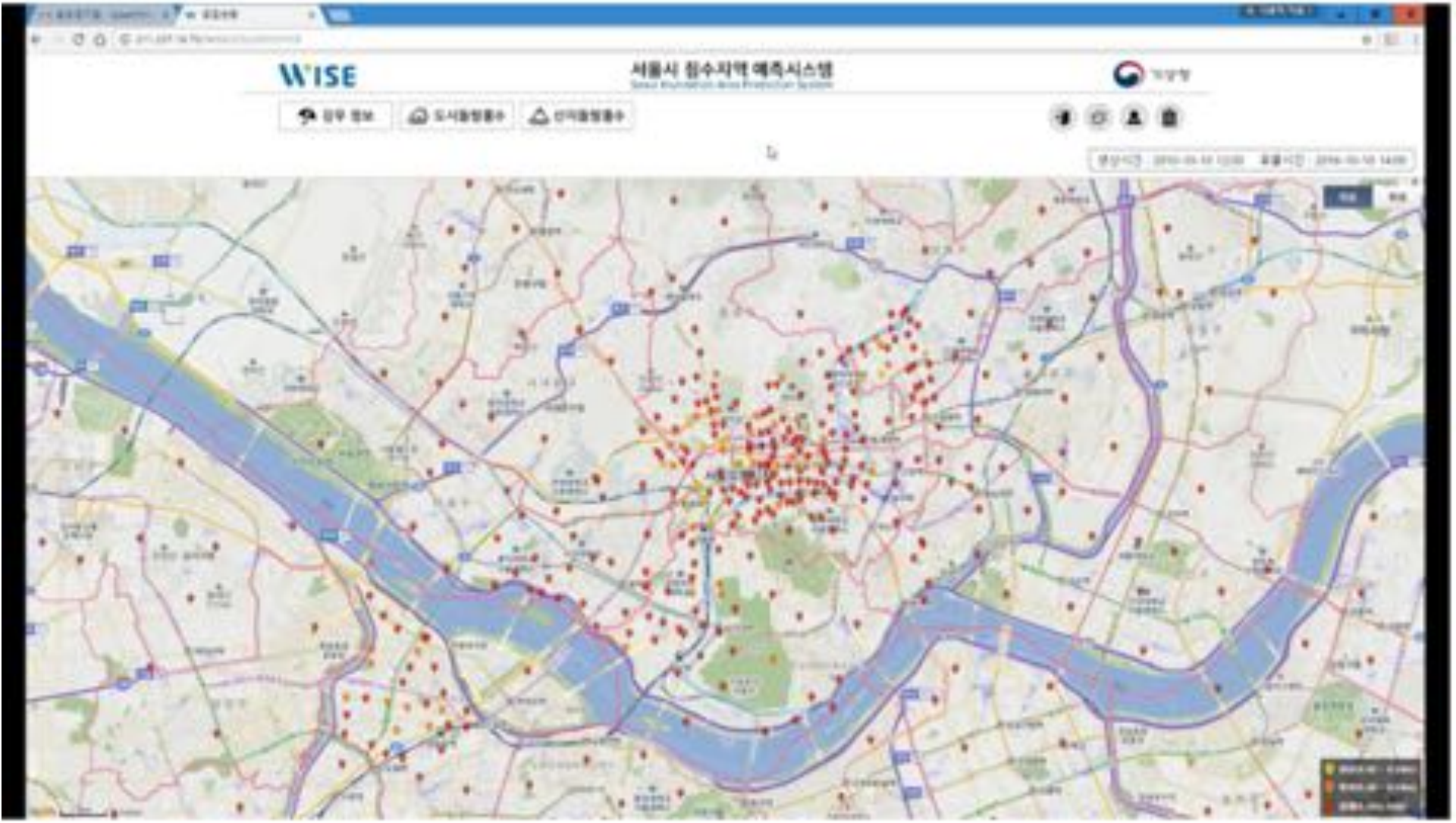
Risk matrix (tentative proposal)

For the impact-based forecast

Likelihood						
	≥ 60%	High		2	7	10
	≥ 40%	Medium		1	6	9
	≥ 20%	Low			4	8
	≥ 1%	Very Low			3	5
			Very Low	Low	Medium	High
Area (km^2) that depth of flooding is higher than 0.5m			< 0.01	0.01 - 0.1	0.1 - 0.2	0.2 <

Level	Take action	Be prepared	Be aware	Not severe

Prediction system for Inundation Area in Seoul



2. Road Weather

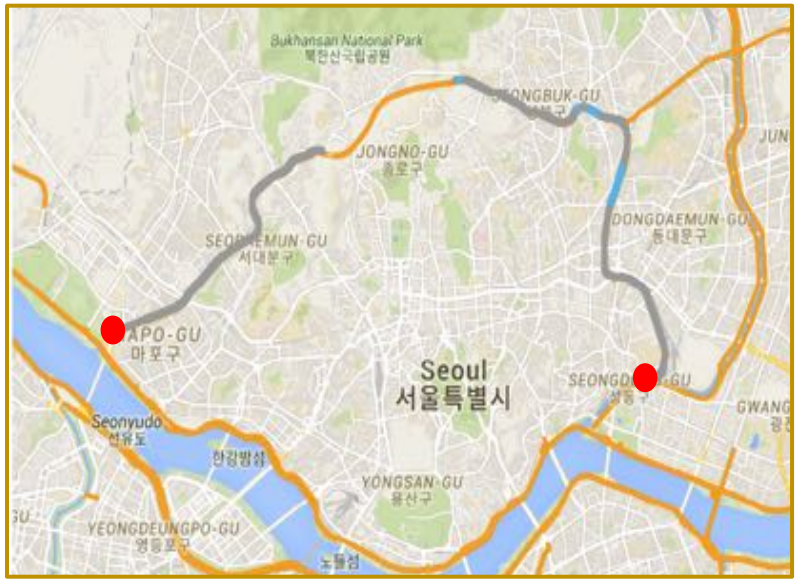
1) Road Condition

Observation & NWP forecast → **Road T.** → **Road condition (wet, dry, ice, snow)** → **Service map** forecast

Heat balance model for road Temp.

- Guess Sensible & Latent heat
- Geothermal heat
- Net radiation
- Radiation from cars
- Friction heat of tires
- Sensible heat of cars
- Estimation of T on road

Water balance model / Machine running

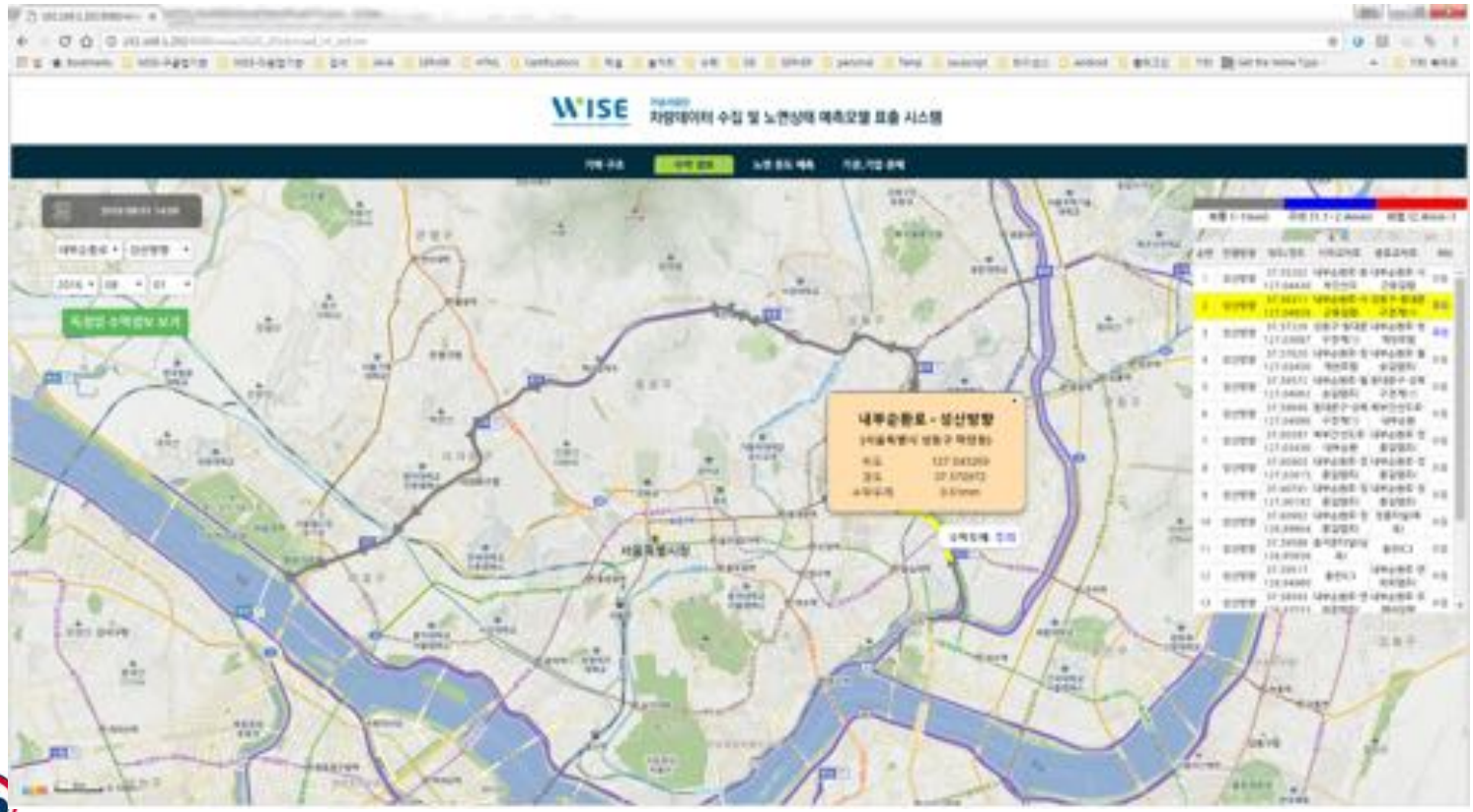


2) Road Hydroplaning (water film thickness)

Observation (AWS) → **interpolation** → **Estimation of precipitation on roads** → **Hydroplaning zone**

Precipitation

Road geometry
(wide, # of lanes, height,
cross-fall, vertical grade etc)



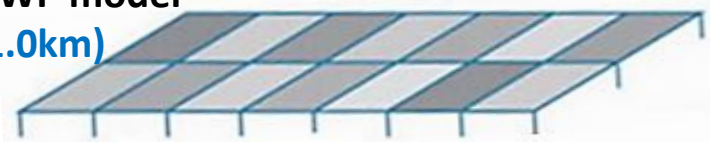
OBD (Future work)

- To collect Temp. and Pres. in real-time basis from **OBD (On-Board Diagnostics)** installed in moving cars.
- It can be used to provide real-time Temp. in urban area, and to evaluate the estimated Temp. on roads

3. Urban Micormeteo.

WISE Urban Microclimate Information

NWP model
(1.0km)



Meteo. Surface property

Climate Analysis Seoul (CAS)

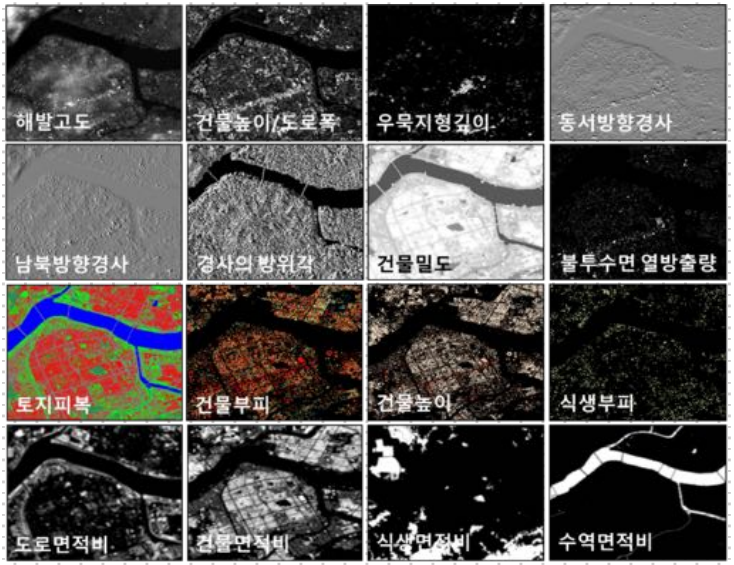
Urban microclimate analysis model

(10m-resolution)

which is able to analyze urban spatial characteristics in detail.

Surface structure (**GIS**)

Slope, dx/dz, dy/dz, Hollow depth,
Aspect Ratio, Building(Vegetation) Height,
Volume, Density,
Complete Surface Area Ratio,
Fractional Coverage of Land cover



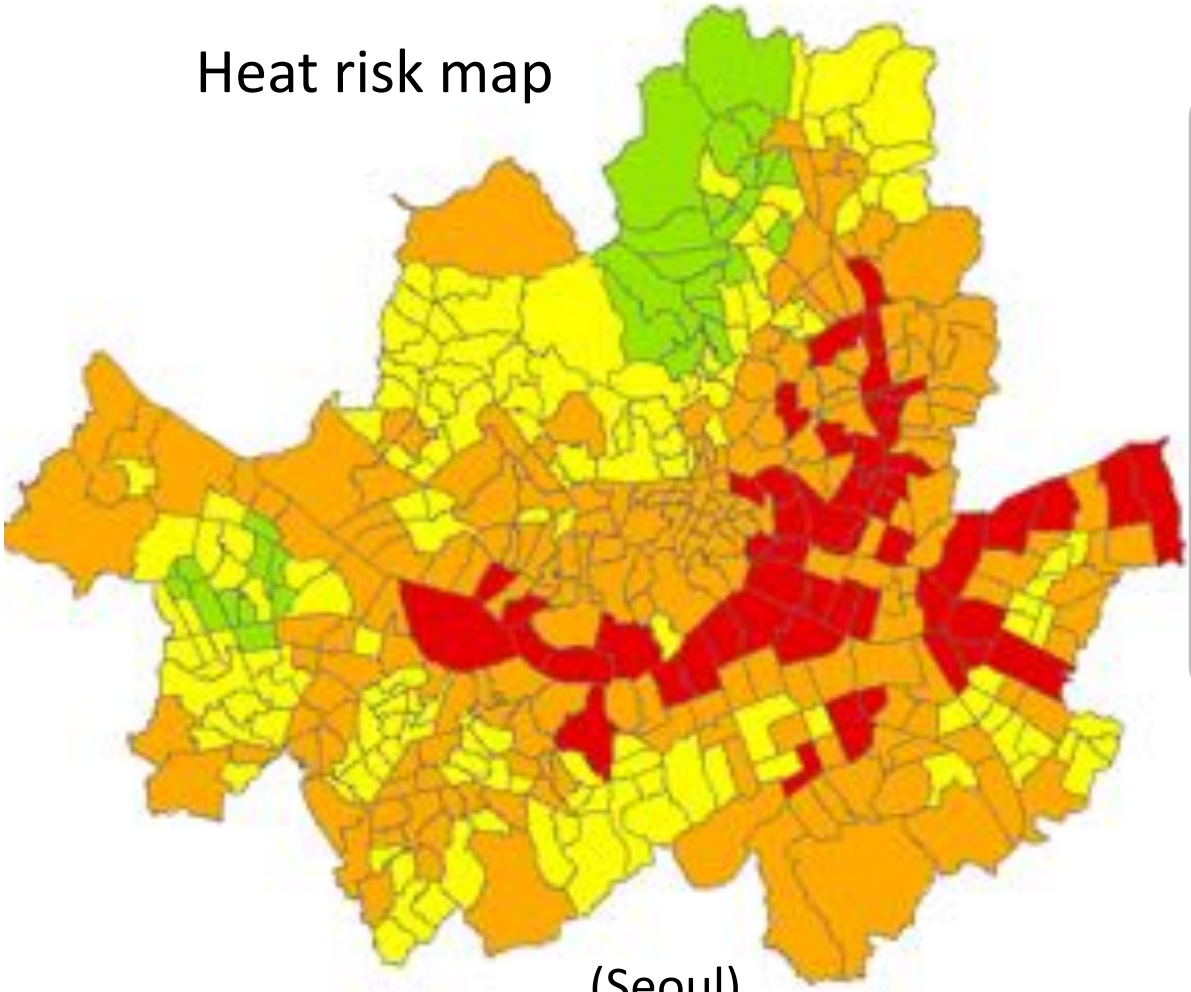
CAS: by National Institute of Meteo. Science (NIMS) and Technical University of Berlin

WISE

Ex 1) Urban Heat Wave

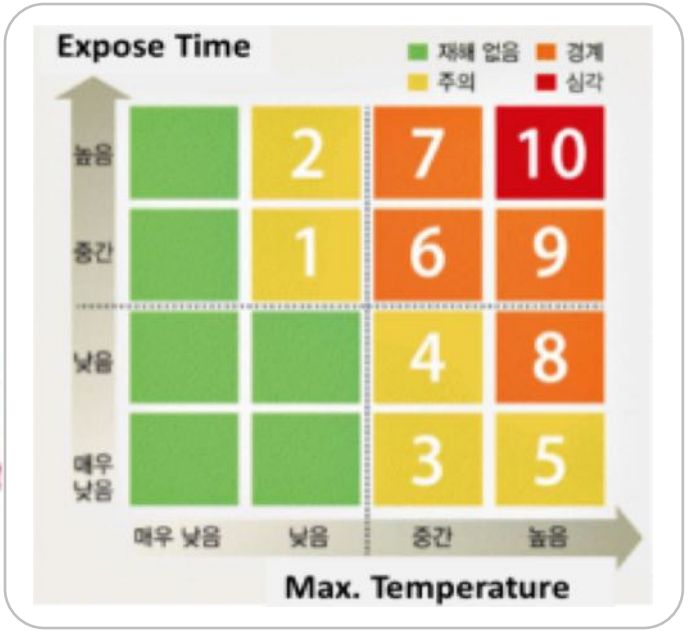
- **Building-Resolving air Temperature (BRT) forecast**

Heat risk map

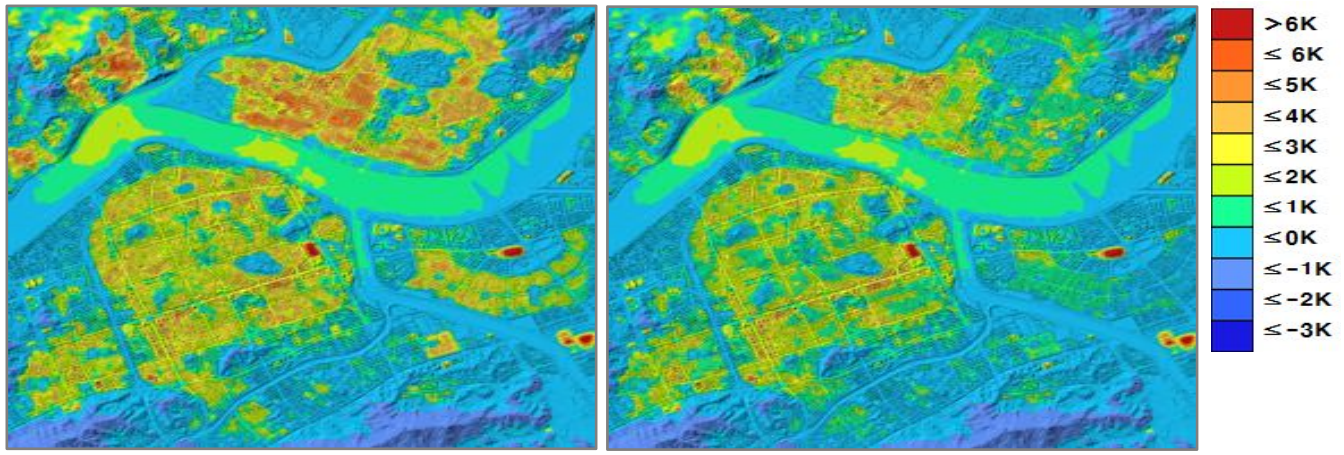


(Seoul)

Risk Matrix



Ex 2) Cool roof



Production of Surface Microclimatological / Micrometeorological Data
(Wind, Humidity, Air/Radiation Temp., etc)

- Weather Impact forecasts
- Urban policy support
- Public service

4. Urban Ecology

MAPS (Mosquito Activity Prediction System)

Forecast using meteorological observation/prediction data and ecological environment

- **Mosquito collector : 50 by City of Seoul, and 3 by WISE**
- **Method: Random forest (Machine Learning)**
- Category:
  - -Comfortable
  - -Concerned
  - -Beware
  - -uncomfortable

Thank you for listening!