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KOREA INSTITUTE of CONSTRUCTION TECHNOLOGY

3D Visualization of Volcanic Disaster with Spatial Information Open Platform in Korea

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1996: Yonsei University (BS)

1998: Yonsei University (MS)

(A Study on the Development of Digital Photogrammetry System Using CCD and GPS)

2006: Purdue University (Ph.D)

(Urban Area Road Extraction from Aerial Imagery and LIDAR)

2007-2012: SAMSUNG SDS

(Spatial Information Strategic Planning)

2012-current: Korea Institute of Civil Eng. & Building Technology

(ICT Convergence and Integration)

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Outline

I. Research Background
II. V-World
(Spatial Information Open Platform in Korea)
III. 3D Visualization of Volcanic Disaster
IV. Conclusions & Further Study

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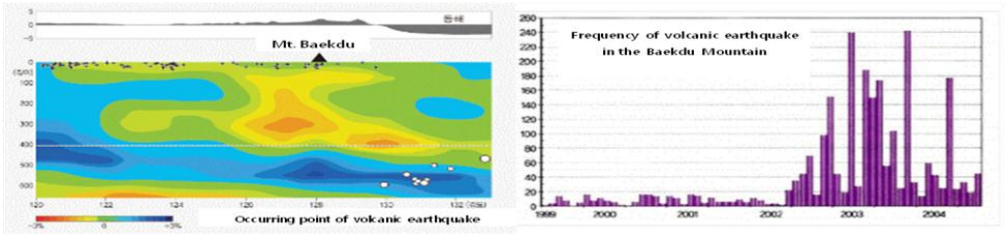
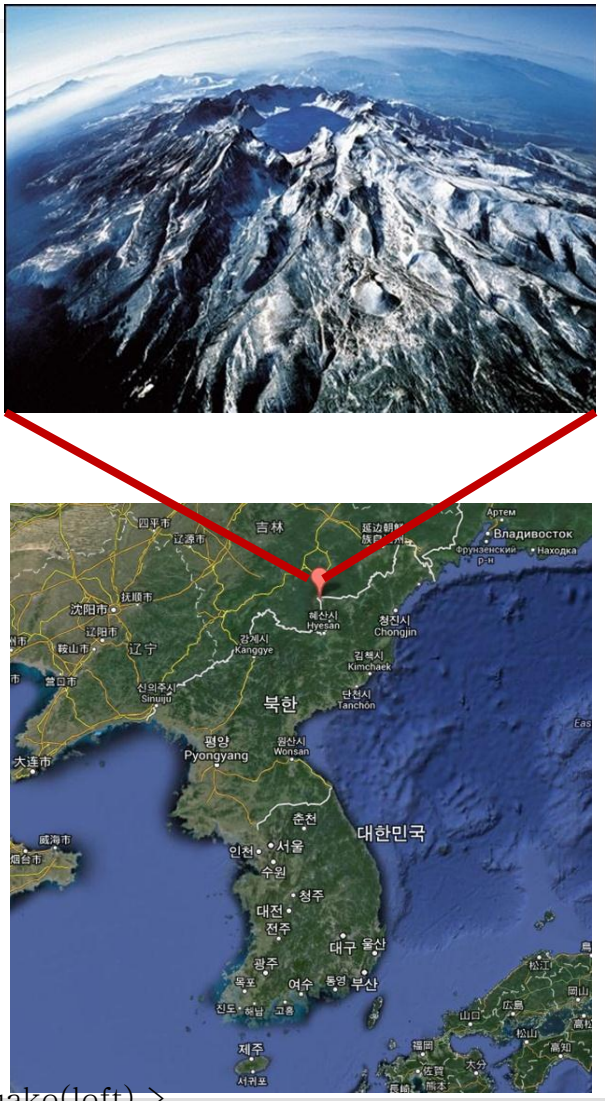
Issue

- Mt. Baekdu is The highest mountain(2,750m) in korea.
- **In 969**, **there was a large volcanic eruption(VEI 7.0)** that had a wide spread impact by 1,000km more than hokkaido in Japan.
- **Since 2002**, volcanic earthquakes have been observed **10** to **15 times** each month in Mt. Baekdu
- **Mt. Baekdu currently is a classified as 'a high-risk volcano'**(Fig 1)'
- Small-scale volcanic eruptions do not cause much damage. However, with **a large volcanic eruption in 969 happening a**gain, then we can encounter **lager political and economical impact** than before.



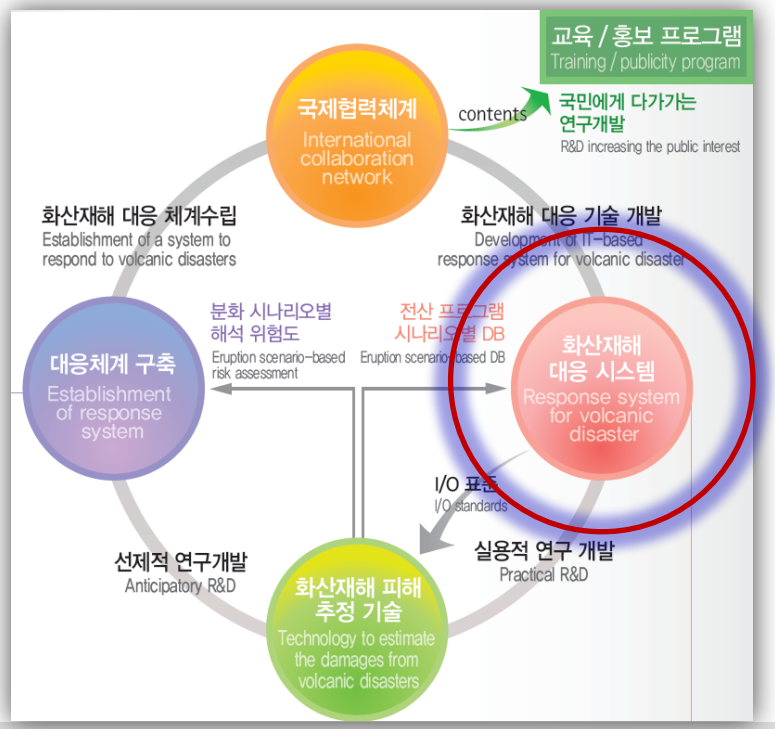


< Fig 1. Study area(right) and Location of magma/frequency of volcanic earthquake(left) >

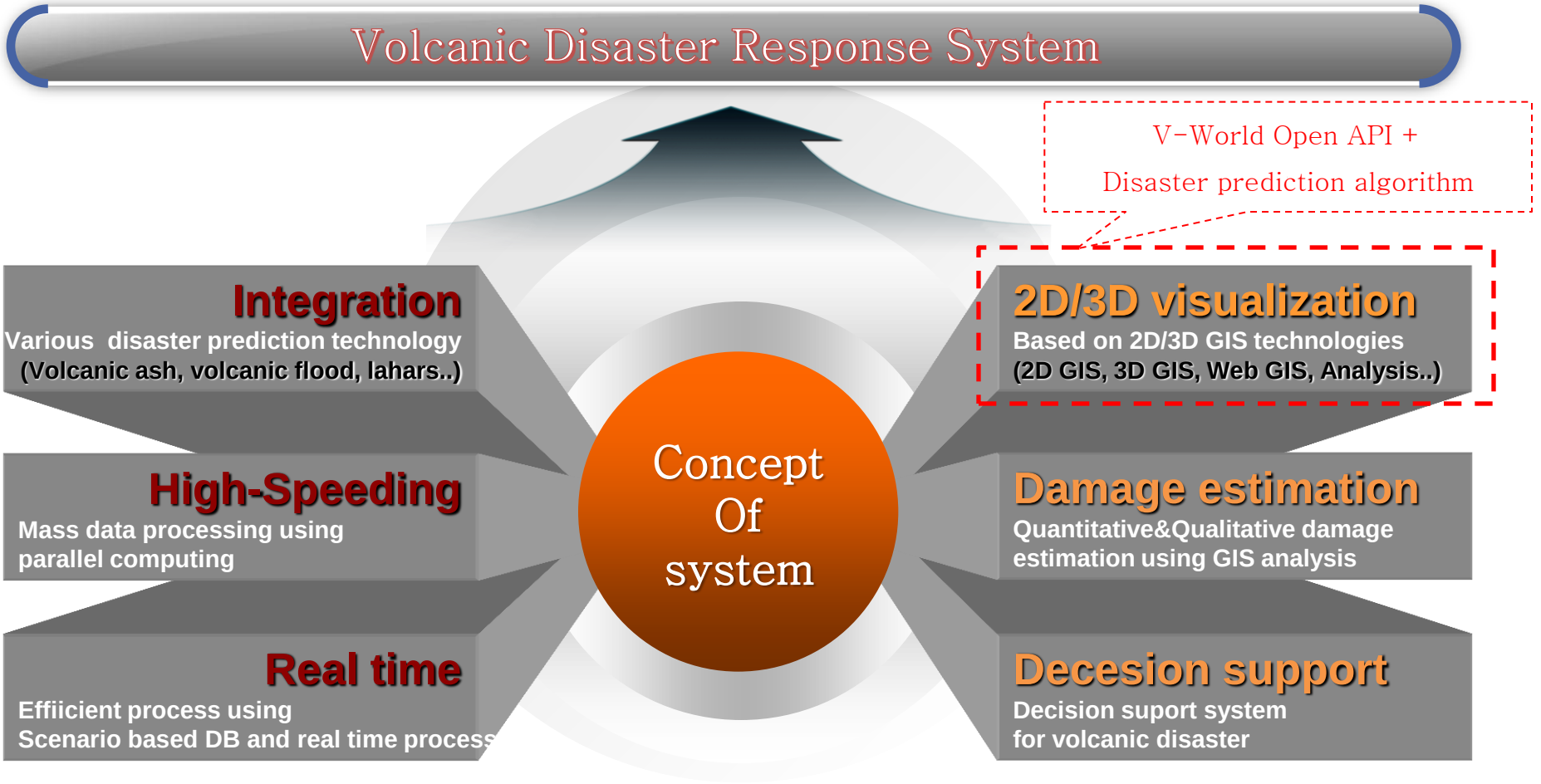
Volcanic Disaster Preparedness Research Center (2012-2015)

- Accordingly, Korea Ministry of Public Safety and Security (MPSS) and National Disaster Management Institute(NDMI) launched the "**Volcanic Disaster Preparedness Research Center**" to carry out R&D projects for disaster safety technologies.
- KICT consortium had executed **"Development of Volcanic Disaster Repose System"** project

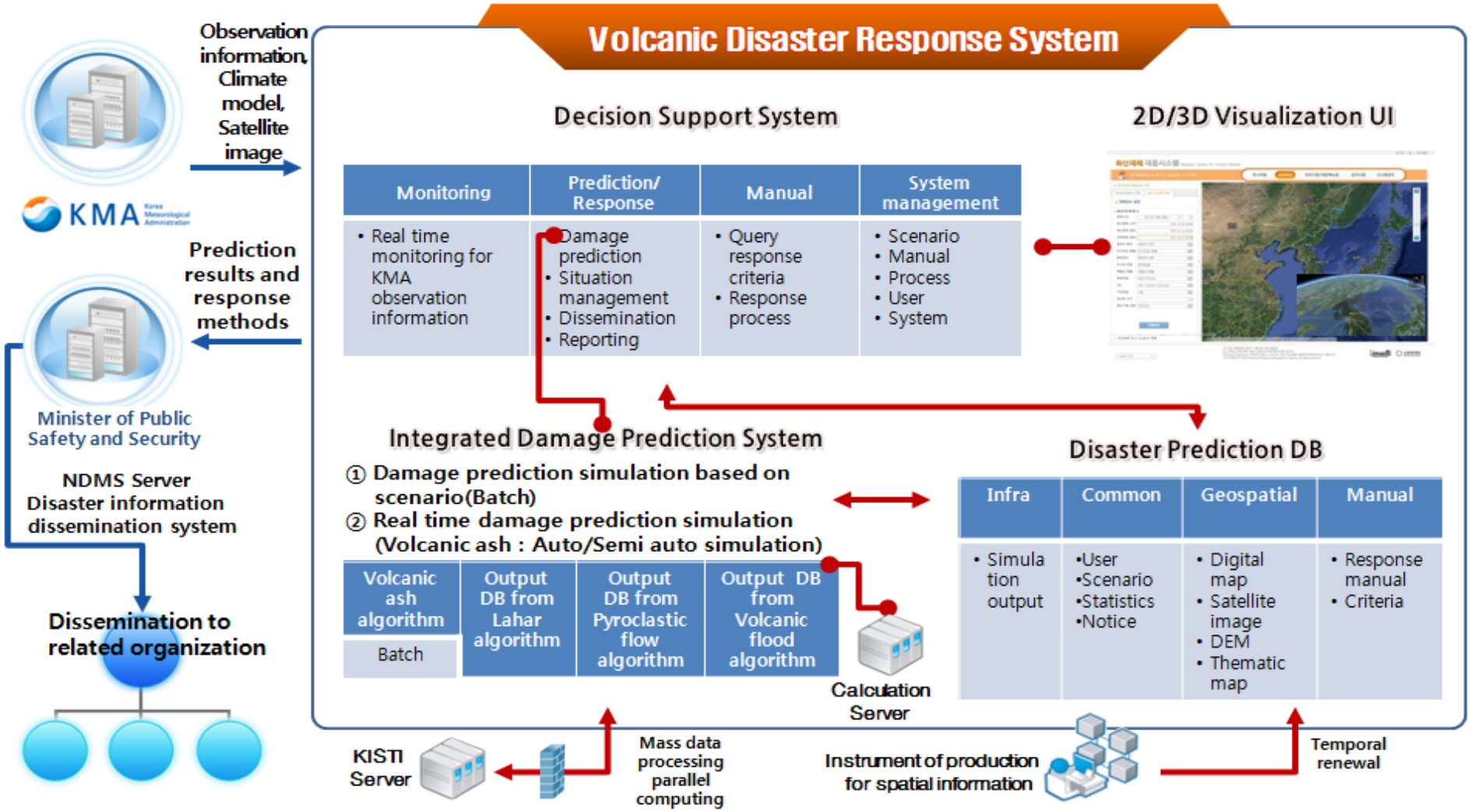
4 R&D Topics



Requirements & Objectives of the System



System Architecture



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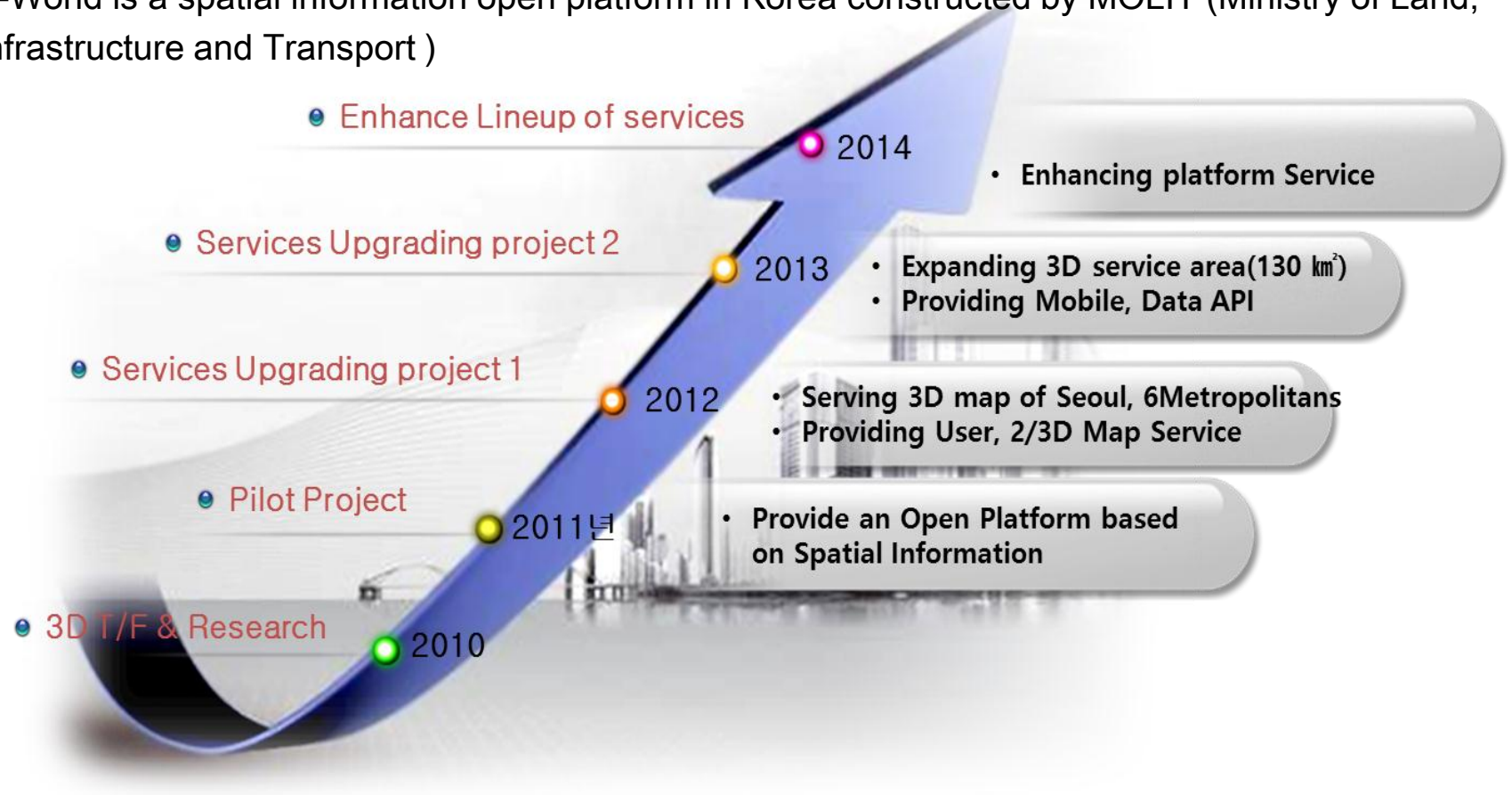
History

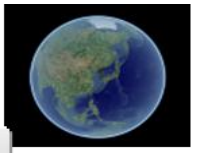
- V-World is a spatial information open platform in Korea constructed by MOLIT (Ministry of Land, Infrastructure and Transport)



< Source: SpaceN, 2015>

3D Information

World



World wide

Satellite Image → 15m
Sea Image → 500m
DEM data → 90m

Oversea Area

London, Sydney, Tokyo 3D Model


<London>


<Sydney>


<Tokyo>

North Korea

Satellite Image → 0.5~1m
Mt. Baekdu → 500m
DEM data → 90m

Nation

South Korea

Satellite Image → 25~50cm
DEM data → 5m

Precisonal Area

Seoul(part Dist.), 6 Metropolitans Yeosu, Chuncheon cities
Ortho image → 25cm
DEM data → 1m

High Precisional Area

Myeong-dong, Hong-dae, Insa-dong etc In Seoul


<Myeong-dong>


<Hong-dae>

< Source: SpaceN, 2015>

Services

Open API

Integration Control API | 2DmapAPI | 3DmapAPI

- 2D/3D/integration OpenAPI
- proper reference & common tools

Portal

- The core hub of V-World
- notifying Information, news about V-World service

2D/3D map

- 2D/3D map, integrated search service
- Searching and using high quality NSDI

Developer center

- apply & authorize Open API key
- support Open API developer

VWORLD
Spatial Open Platform
http://www.vworld.kr
ONE STOP SERVICE

3D Desktop service

- An application like Google Earth
- utilizing Various 3D practical service

Data center

- Spatial Info. Metadata and list
- data error declaration

Participation center

- sharing user content
- participating POI marking and uploading 3Dmodel, user content

< Source: SpaceN, 2015>

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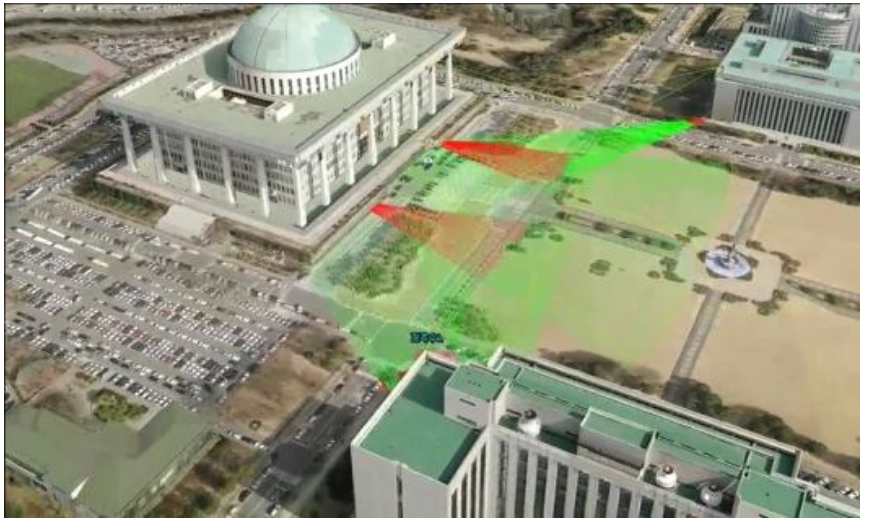
Successful Application : Public

- **Developed the new contents and better map service using the V-world.**

- provided various supporting service of international events

- Yeosu Expo
  - Providing cyber tour and event information service



- G20 Seoul Nuclear Security Summit
  - Supporting security service of G20 summit leaders
  - ex) Terror simulation

< Source: SpaceN, 2015>

Successful Application : Civilian

- **have developed better system and enhanced solutions**
  - **have utilized 2D/3D map of V-world as background map**
  - **ex) business marketing, location based service and etc**

biz-gis.com

- Utilize for gCRM and place marketing

GEOMEXSOFT

Road Tech

- Utilize Vworld as background map of its solution

< Source: SpaceN, 2015>

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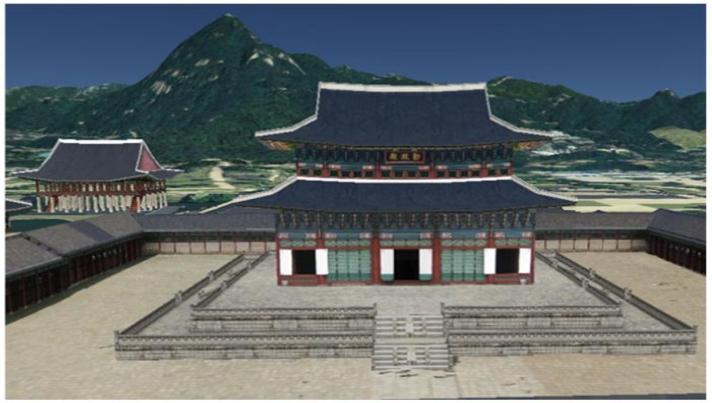
Galleries - Domestic

<Gangnam Station>

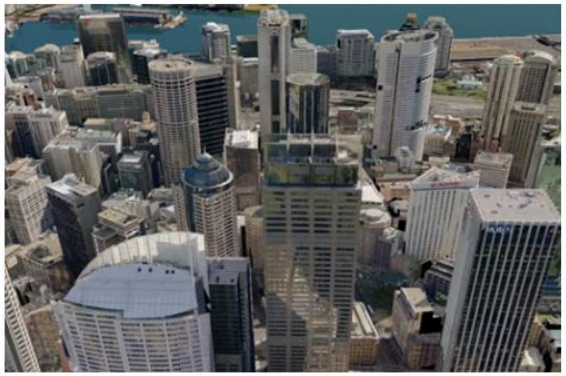
<National Assembly Building>



<Gyeongbok Palace>

<63 Building with Han River>

Galleries - Overseas



<London> <Sydney> <Tokyo>

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System Concept for Predicting Volcanic Ash Dispersion

Goal for predicting volcanic ash dispersion

- Our goal is predicting hourly base volcanic ash dispersion after volcano eruption for preparedness

Before eruption

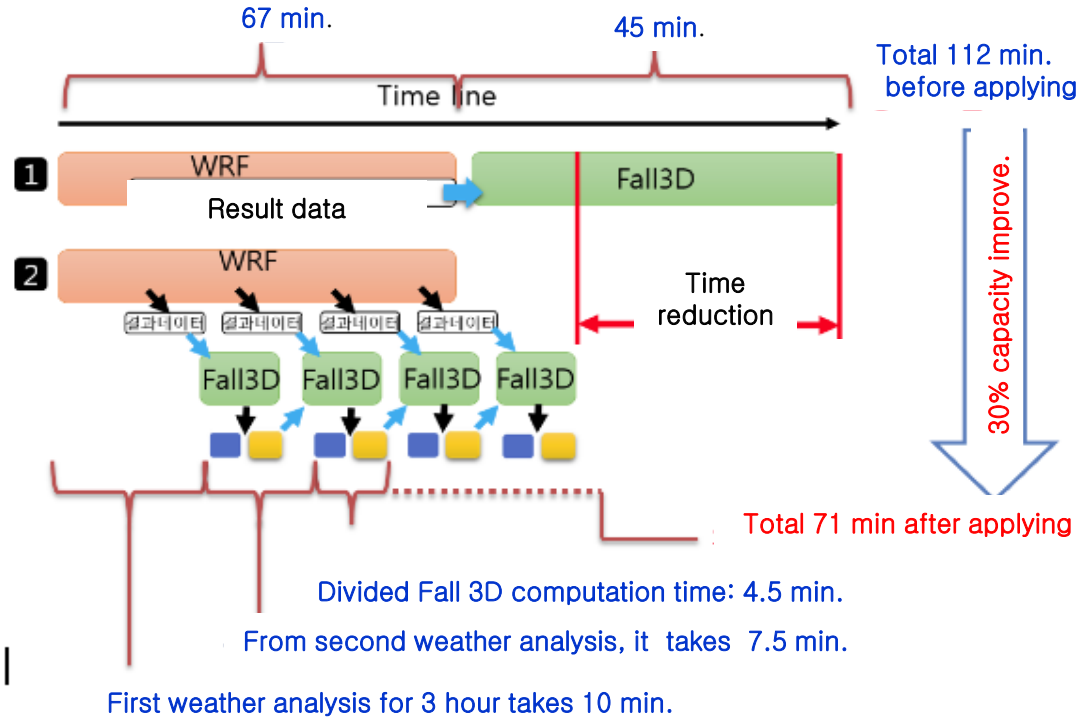
- So, we pre-calculated 1 year volcanic ash dispersion scenarios with various parameters and stored
- Pre-calculating uses historical average weather condition

After eruption

- When volcano erupting, the system choose most similar scenario at that time, and provides it
- However, weather condition would be different with historical average weather condition
- Therefore, the system continuously calculate the predicted volcanic ash dispersion reflecting the changed weather circumstances, and provides it

Calculating Volcanic Ash Position & Concentration

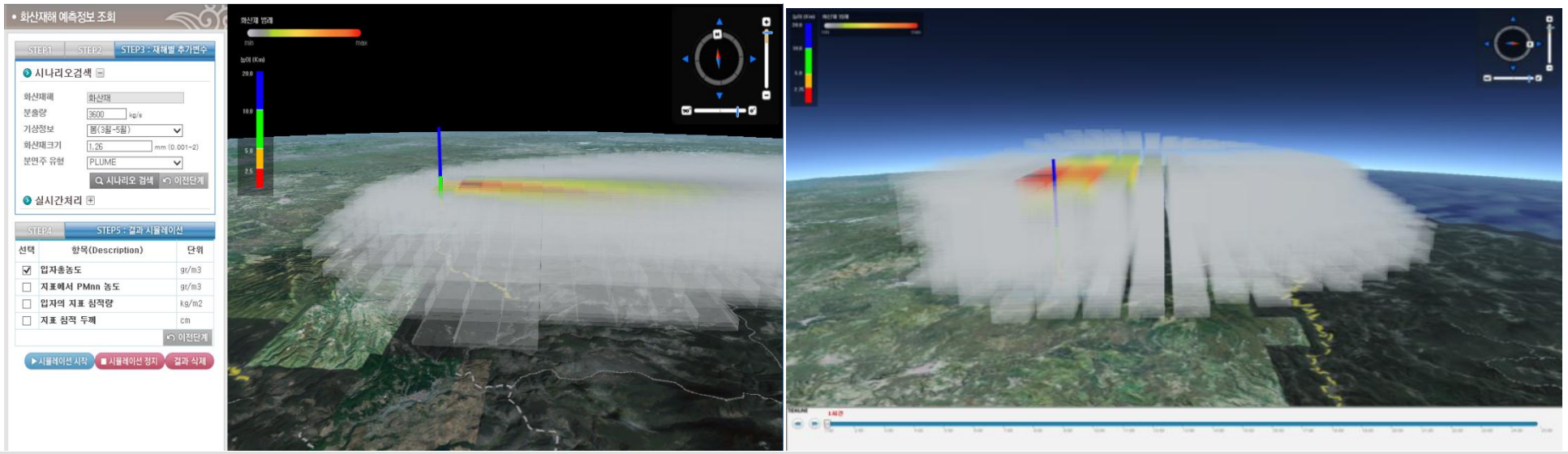
- WRF(Weather Research & Forecasting) model and modifiedFall3D algorithm are used
- Obtaining 3D position & concentration for volcanic ash takes massive computation time
- Therefore, high speed parallel processing modules by using super computer were developed



3D Visualization of Volcanic Ash

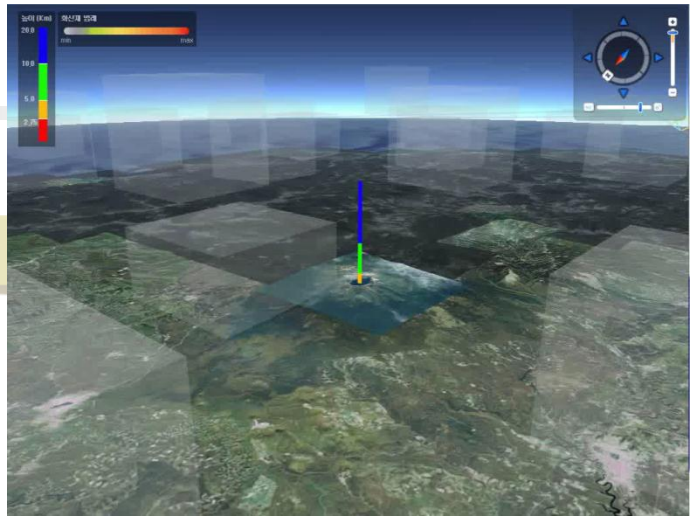
Applying 'Cube in the air' for particle concentration(gr/㎥)

- After calculating WRF model and Fall3D , grid type particle concentration file(NetCDF) is obtained
- Each cell for grid has concentration and height value
- Each cell is converted into cube, whose height is same with cell size, and is located at its coord.
- Color for cell presents particle concentration



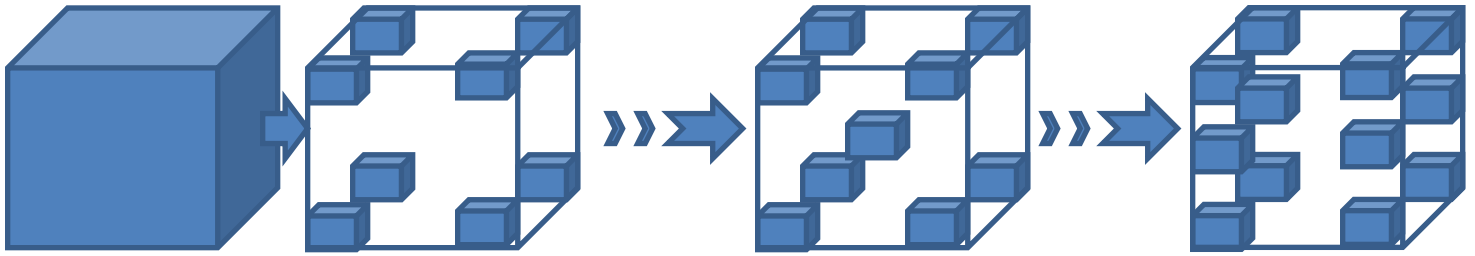
<Cube in the air (10km³)>

3D Visualization of Volcanic Ash



Applying 'Dividing cube' for particle concentration(gr/㎥)

- Big cubes is not realistic when it is zoomed
- We can calculate small cubes when applying Fall3D, but it takes so much time
- For realistic visualization and time efficiency, we divide the cube in proportion to concentration
- After obtaining 6km^3 cubes, divide the cube from a sixth(1/6) to a sixty fourth(1/64)
- Then, high-concentrating original cube has large number of small cubes



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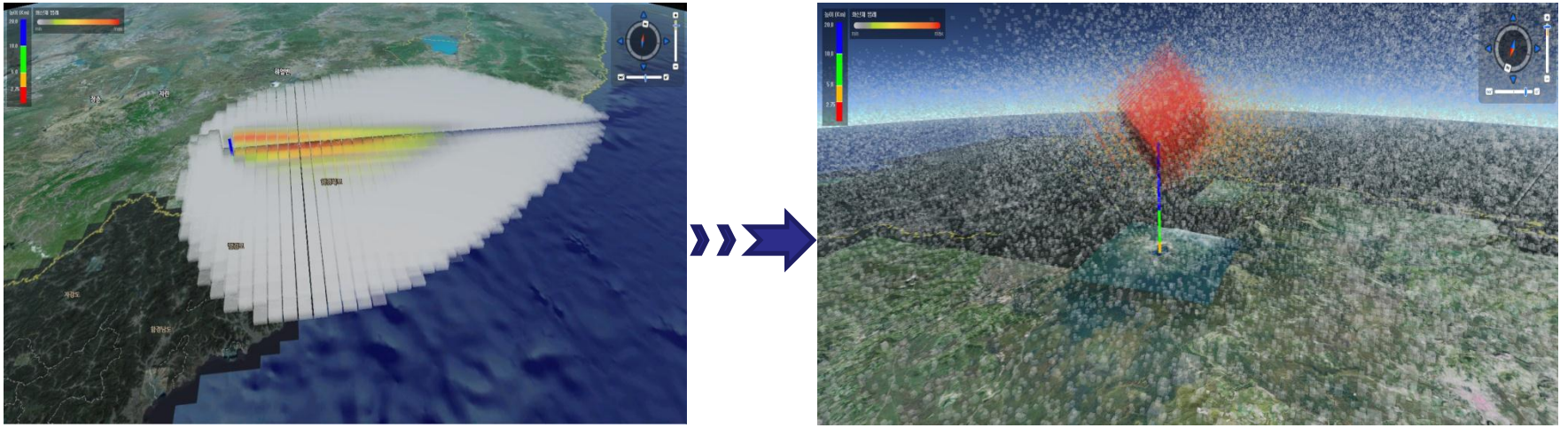
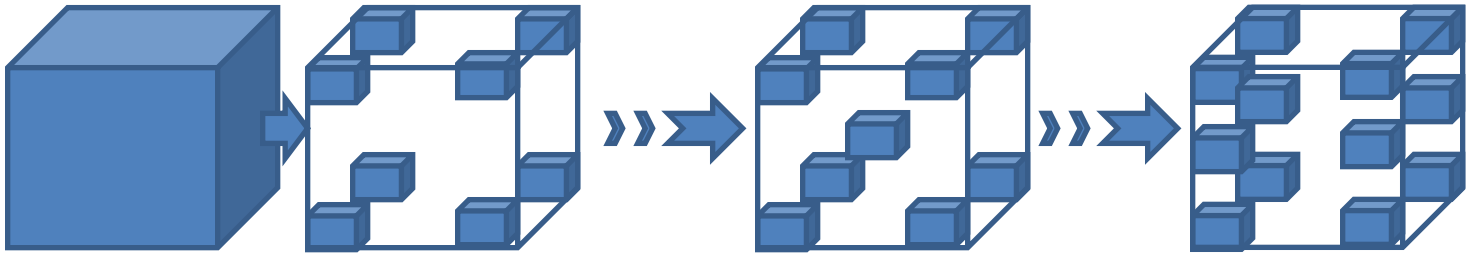
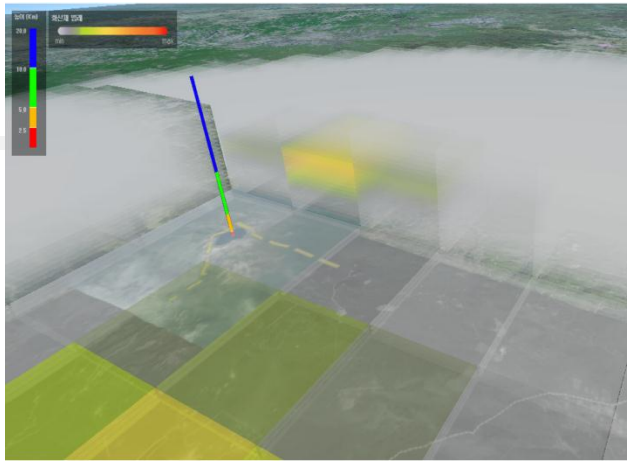


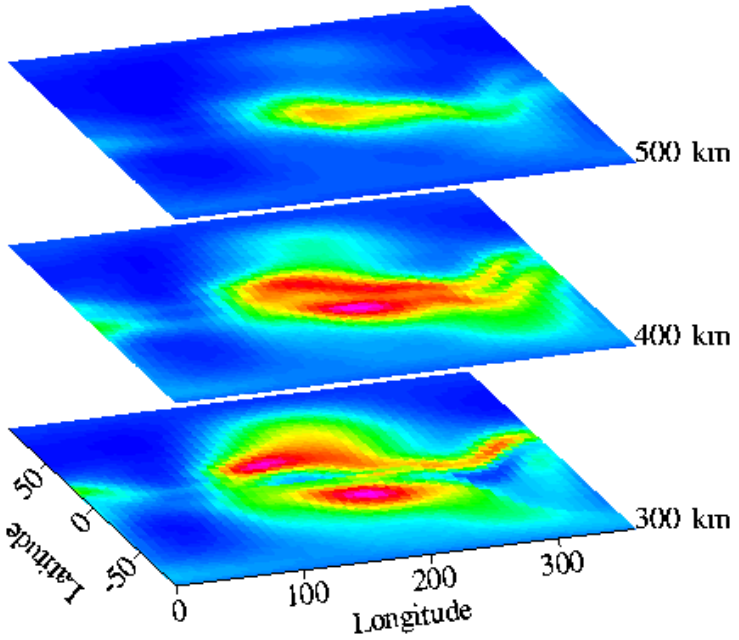


3D Visualization of Volcanic Ash



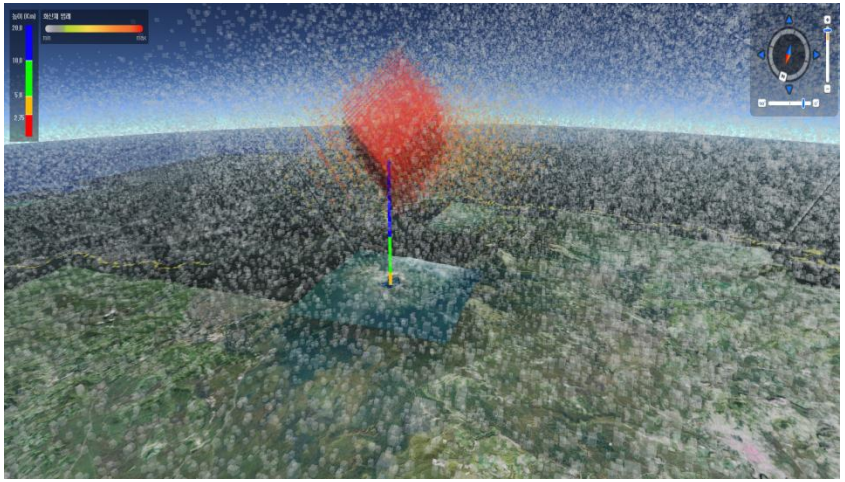
Applying 'Transparent plane' for particle concentration(gr/㎥)

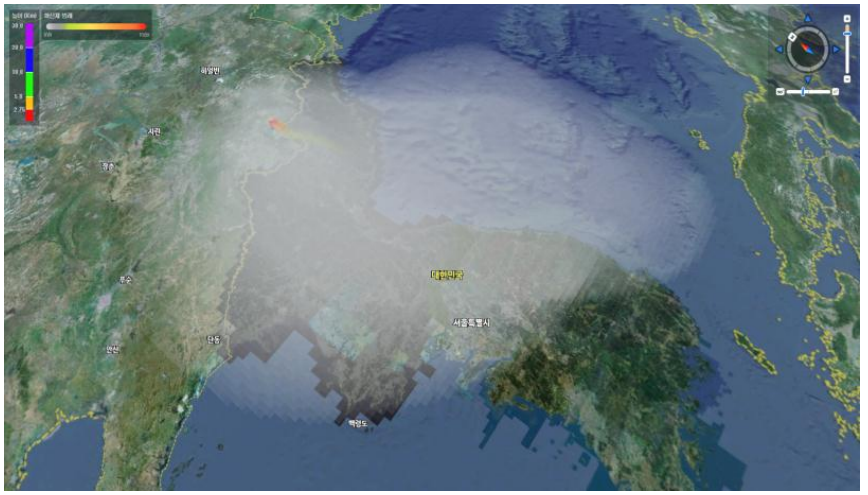
- Cube-expressed visualization has it's viviparous limitation. Nobody think ash as cube
- For visualizing volcanic ash as 'fog', we apply 'Transparent plane' method
- After calculating WRF model and Fall3D , grid type particle concentration file(NetCDF) is obtained
- Each file is converted into GIS layer, whose cell has its particle concentration
- Remotely viewing layer has low transparency, and close range layer has high transparency
- Each layer is located at its height



3D Visualization of Volcanic Ash

Applying ‘Transparent plane’ for particle concentration(gr/㎥)





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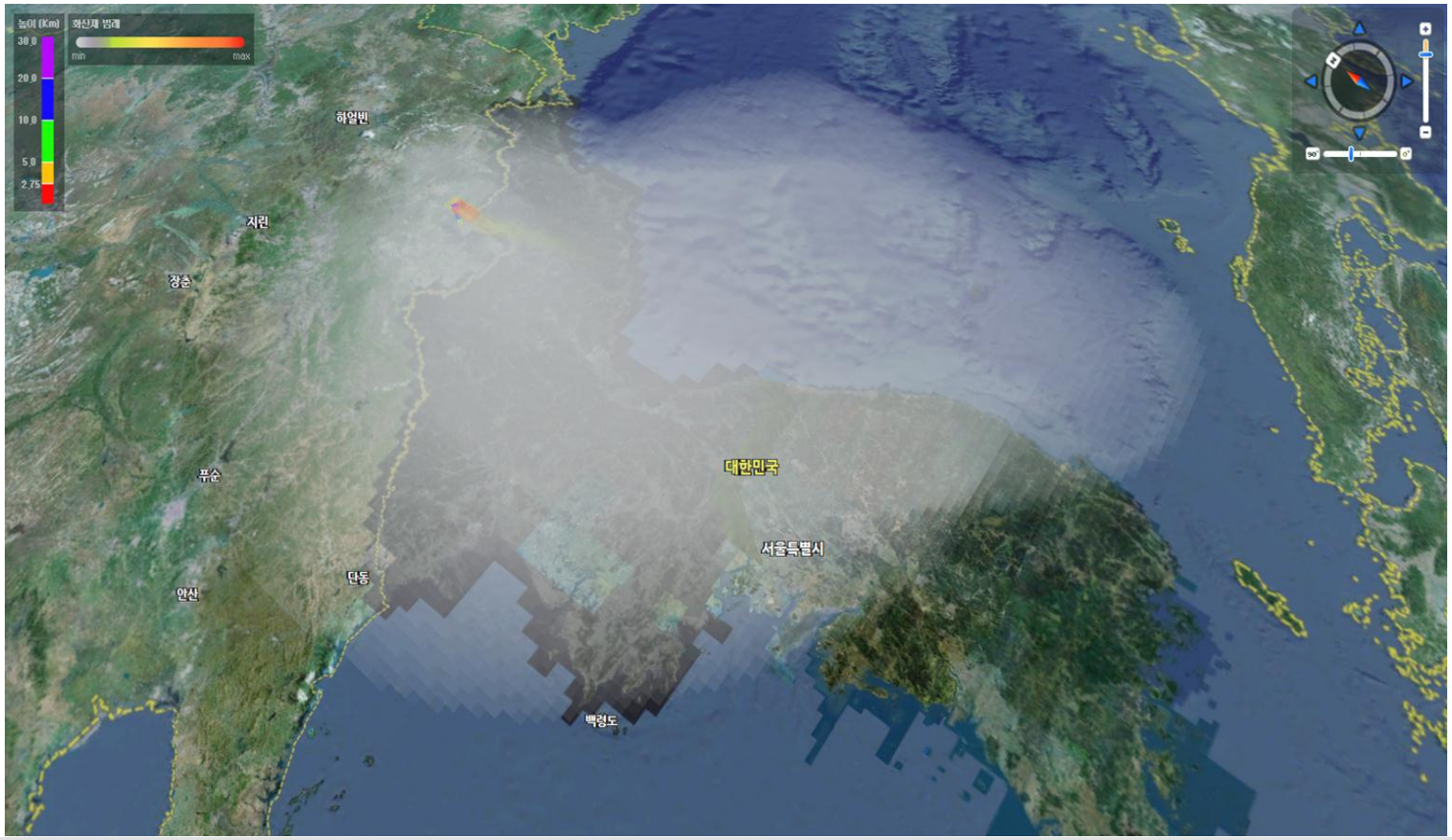
Applying ‘Transparent plane’ for particle concentration(gr/㎥)



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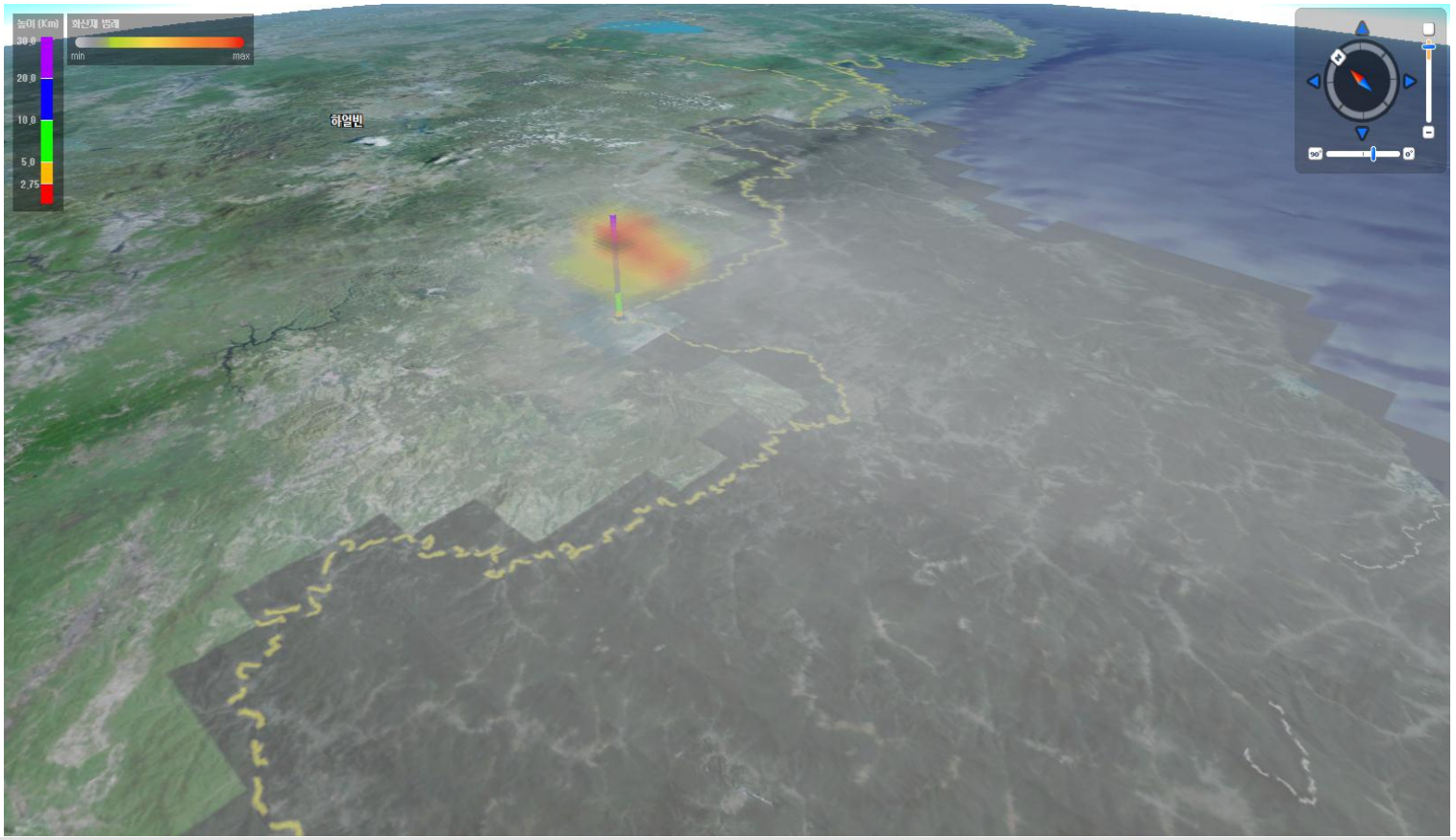


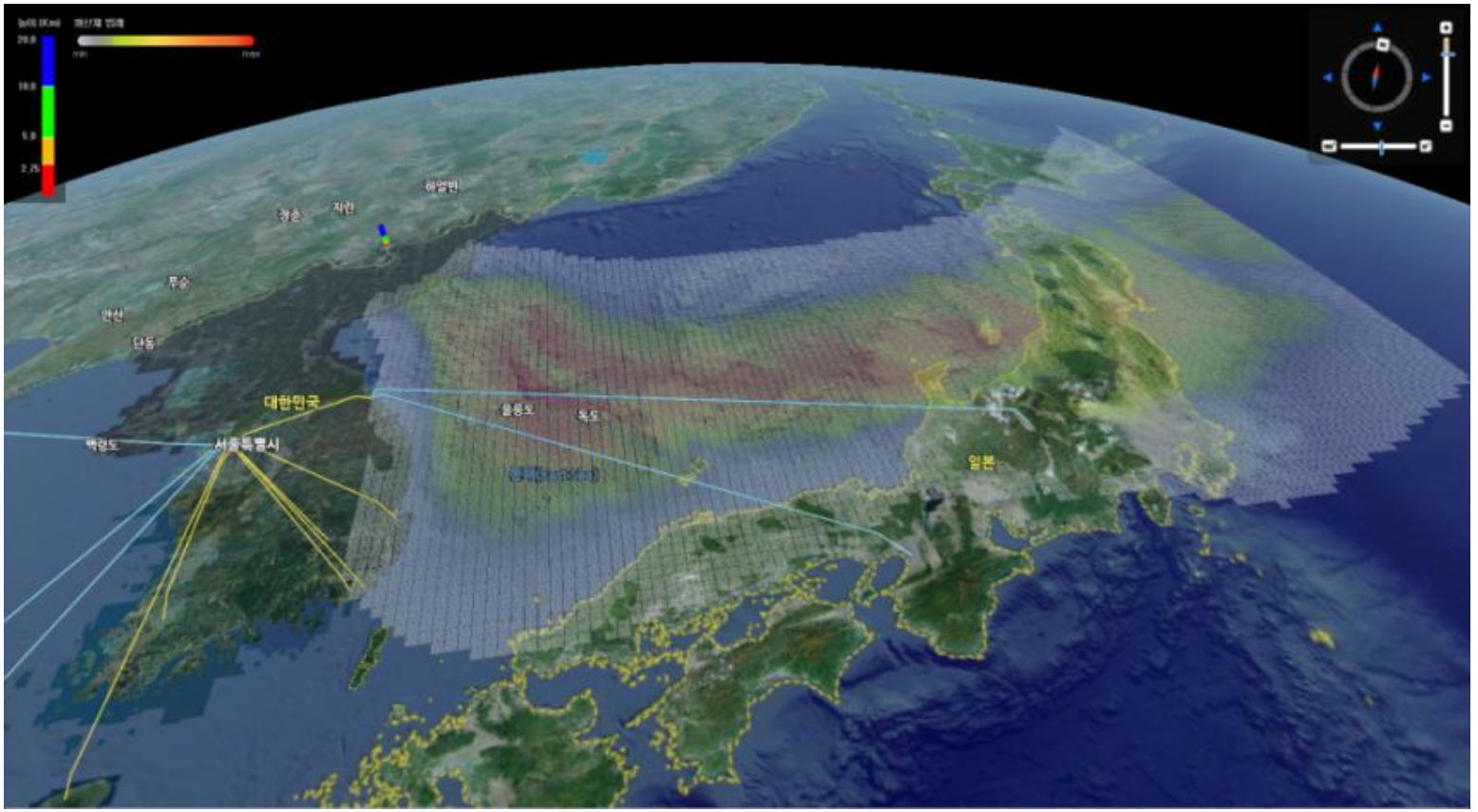
3D Visualization of Volcanic Ash

Overlaying airways in Korea

- Overlaying airway airways with volcanic ash in V-world, take-off and landing can be permitted or restricted

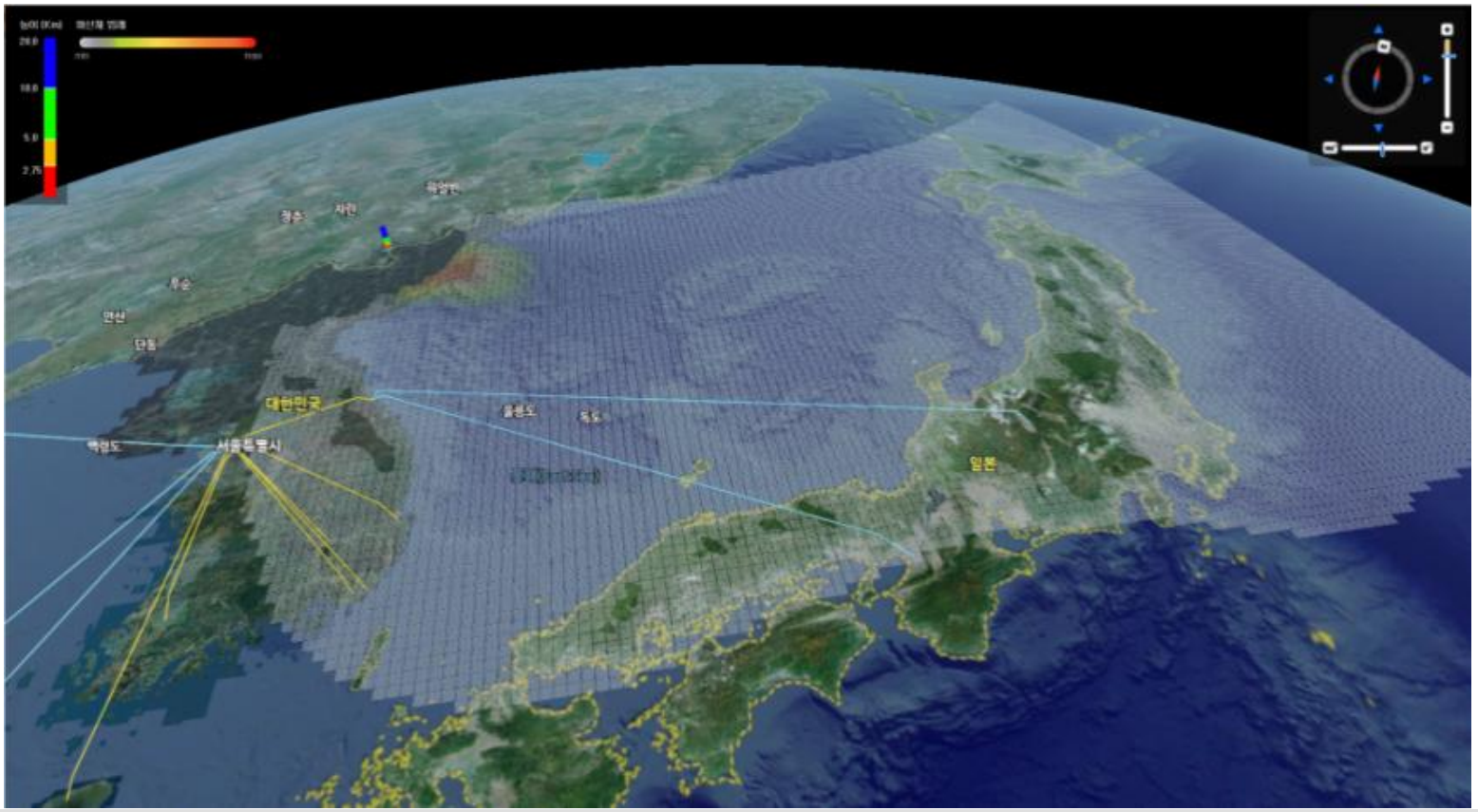
3D Visualization of Volcanic Ash

PM10 concentration at ground (gr/㎥)



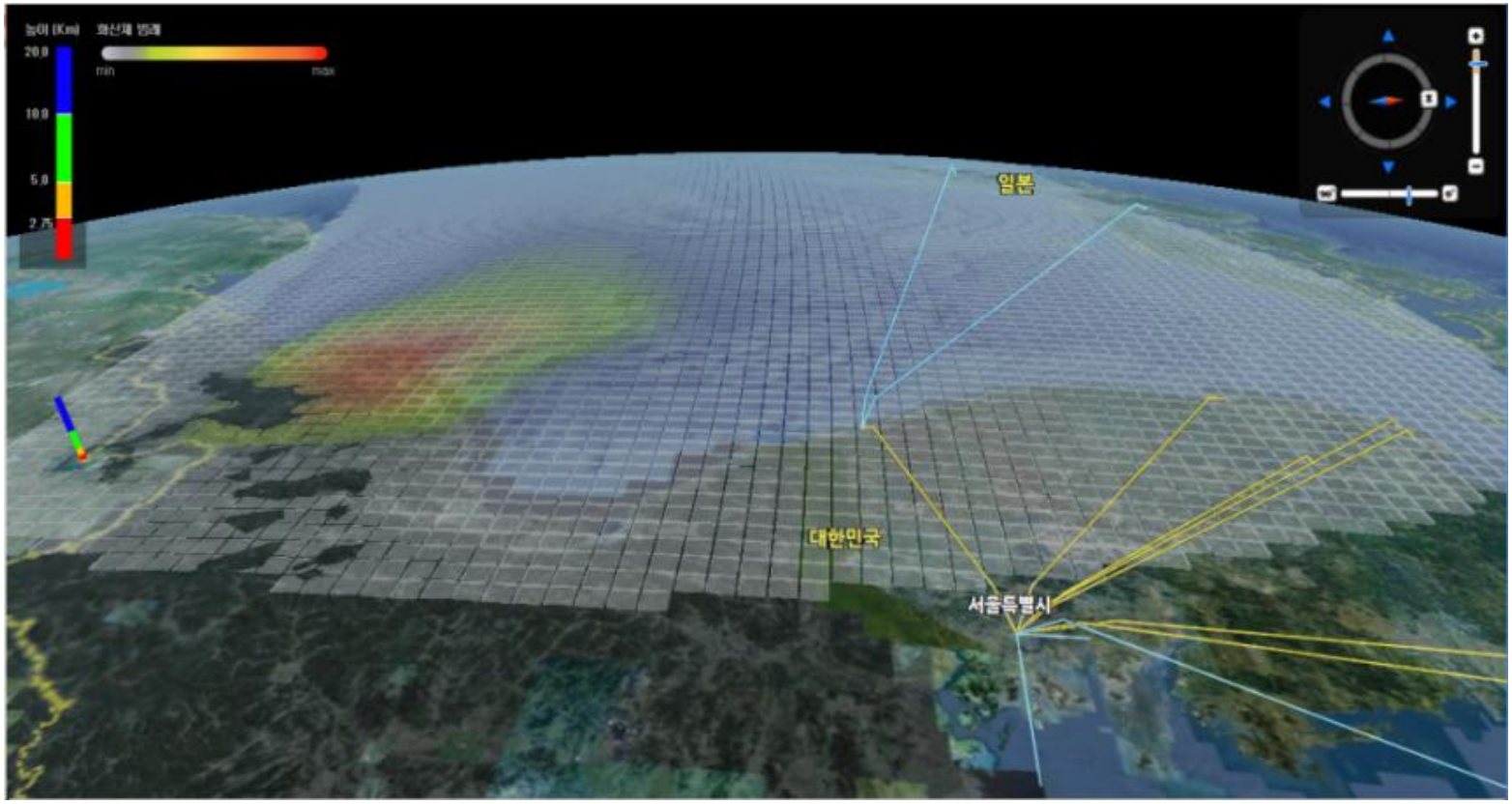
3D Visualization of Volcanic Ash

Particle ground deposit load (kg/m^3)



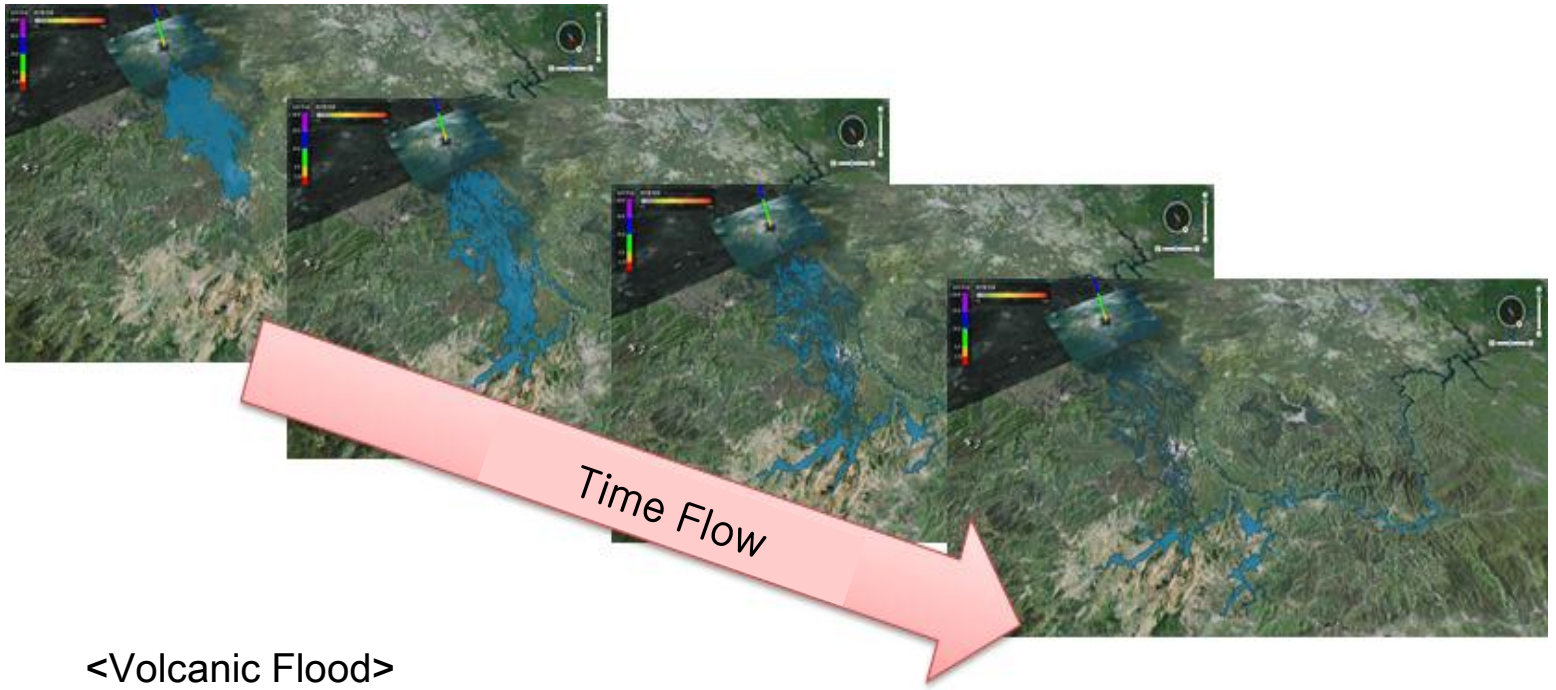
3D Visualization of Volcanic Ash

Particle ground deposit thickness (mm)



3D Visualization of Volcanic Flood

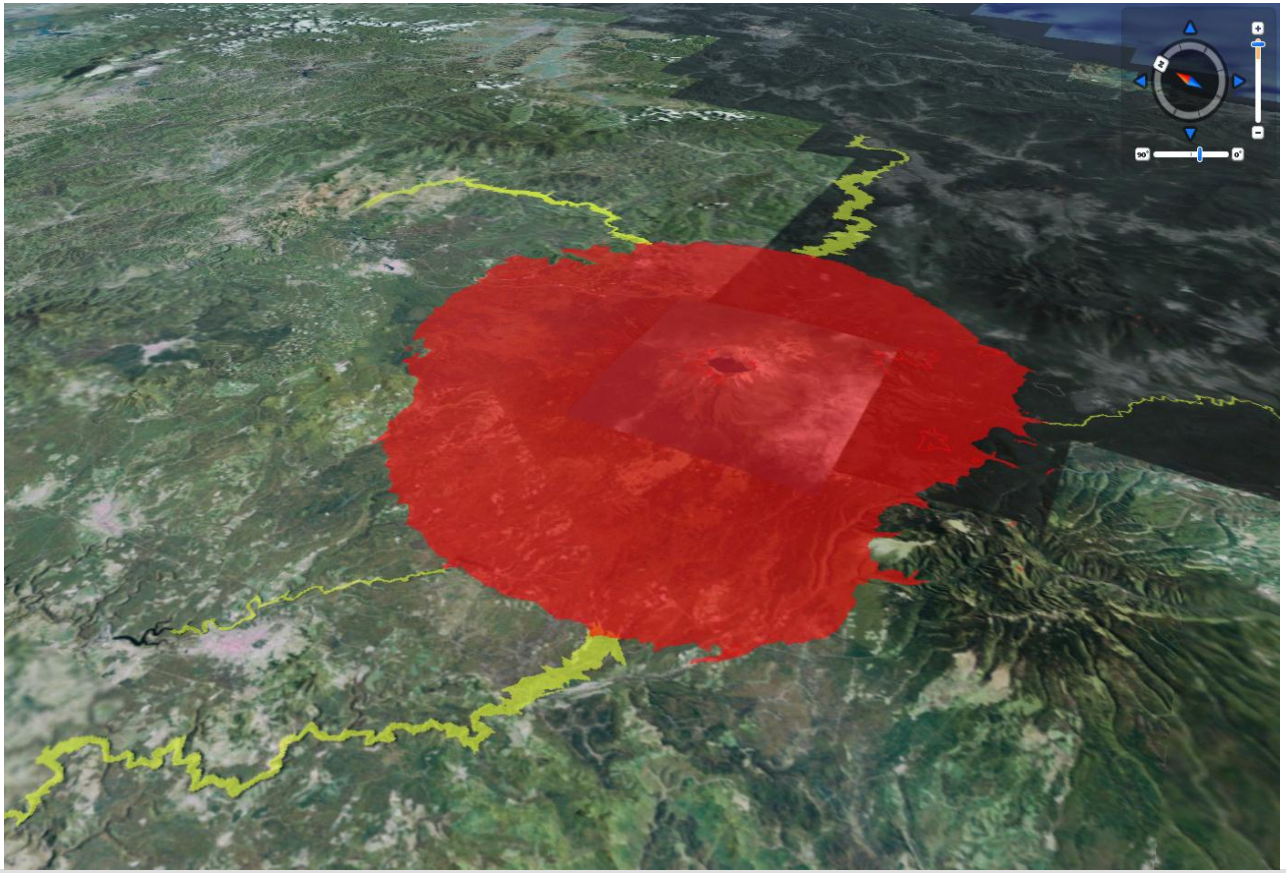
- For volcanic flood prediction, Flow2D algorith is used
- Volcanic flooding basin is calculated every 6 hours during total 240 hours about four conditions
- The results are converted into shape file and visualized



<Volcanic Flood>

3D Visualization of Larhrs

- For Lahrs prediction, LahrZ is used



<Lahrs>

System Demo

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- KICT consortium had executed and developed ‘Volcanic Disaster Response System’ (2012~2015) funded by Korea Ministry of Public Safety and Safety
- The objectives of the system are 2D/3D visualization of predicted volcanic disaster, damage estimation, and supporting decision making
- Korea Ministry of of Land, Infrastructure and Transport have developed V-world which is a spatial information open platform
- ‘Volcanic Disaster Response System’ visualizes various volcanic disaster by using V-World open API
- Various volcanic disaster (i.e volcanic ash, volcanic flood, Lahrs etc) prediction is 3D visualized at the system
- Now, MPSS have promoted “Volcanic Disaster Response System Ver. 2.0” since May 2015
- In this project, covered area will be expanded from Mt. Baekdu to 28 volcanoes located in far east asia area
- Also, various analysis models will be adopted for more accurate prediction

Thank You

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