The Space and Time Evaluation of Forest Fire Occurrence Hazards Using Climate Data of Ten-day Intervals 30 Years in Spring, Korea

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- 2. Forest Fire & Climate
- 3. Forest Fire Occurrence
- 4. Forest fire & Geo-spatial Management
- 5. Forest Fire and Fuel

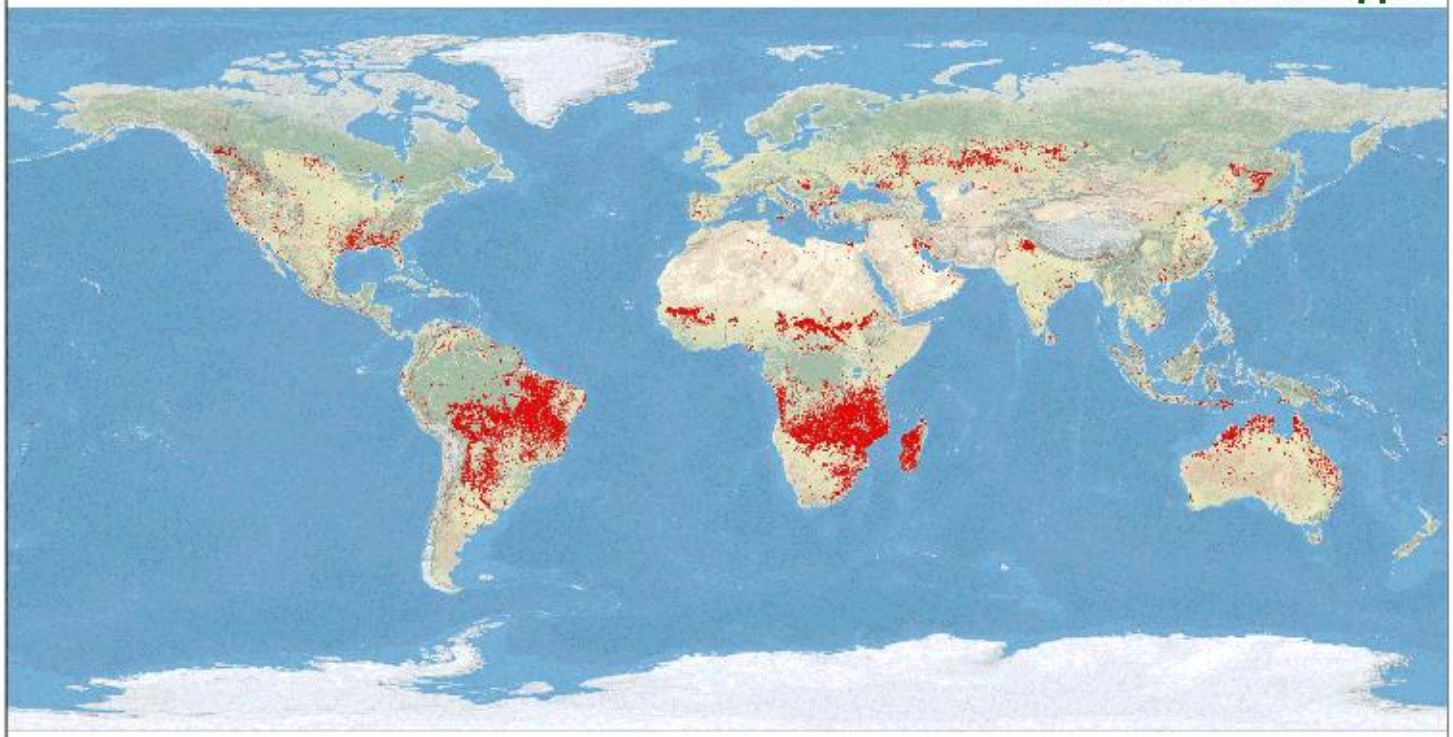
Introduction

- **High Temp., Dryness on Climate impact recently**
  - ➲ High Temperature and continuous drought phenomenon in winter
    → Increase forest fire in Fall/Winter
  - ➲ Increase forest fire occurrence potential by early agricultural activities
- **Climate Change on Global worming**
  - ➲ Increase possibilities of large-sized forest disaster such as forest fire, landslide and forest disease/insect. etc.
  - ➲ Needs to develop social disaster prediction techniques

Introduction

MODIS Rapid Response Active Fire Detections for 2008

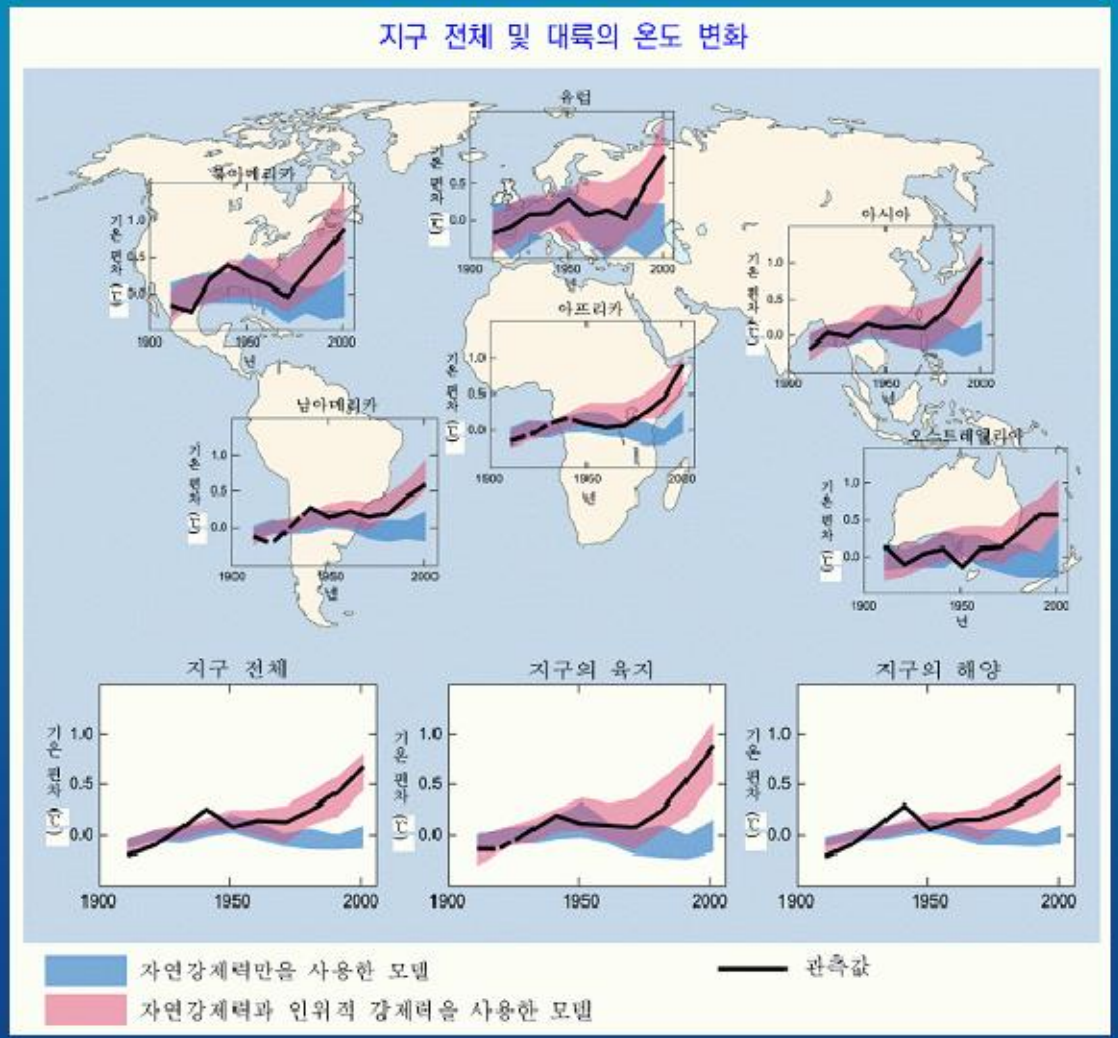
From : Web Fire Mapper



January February March April May June July August September October November December

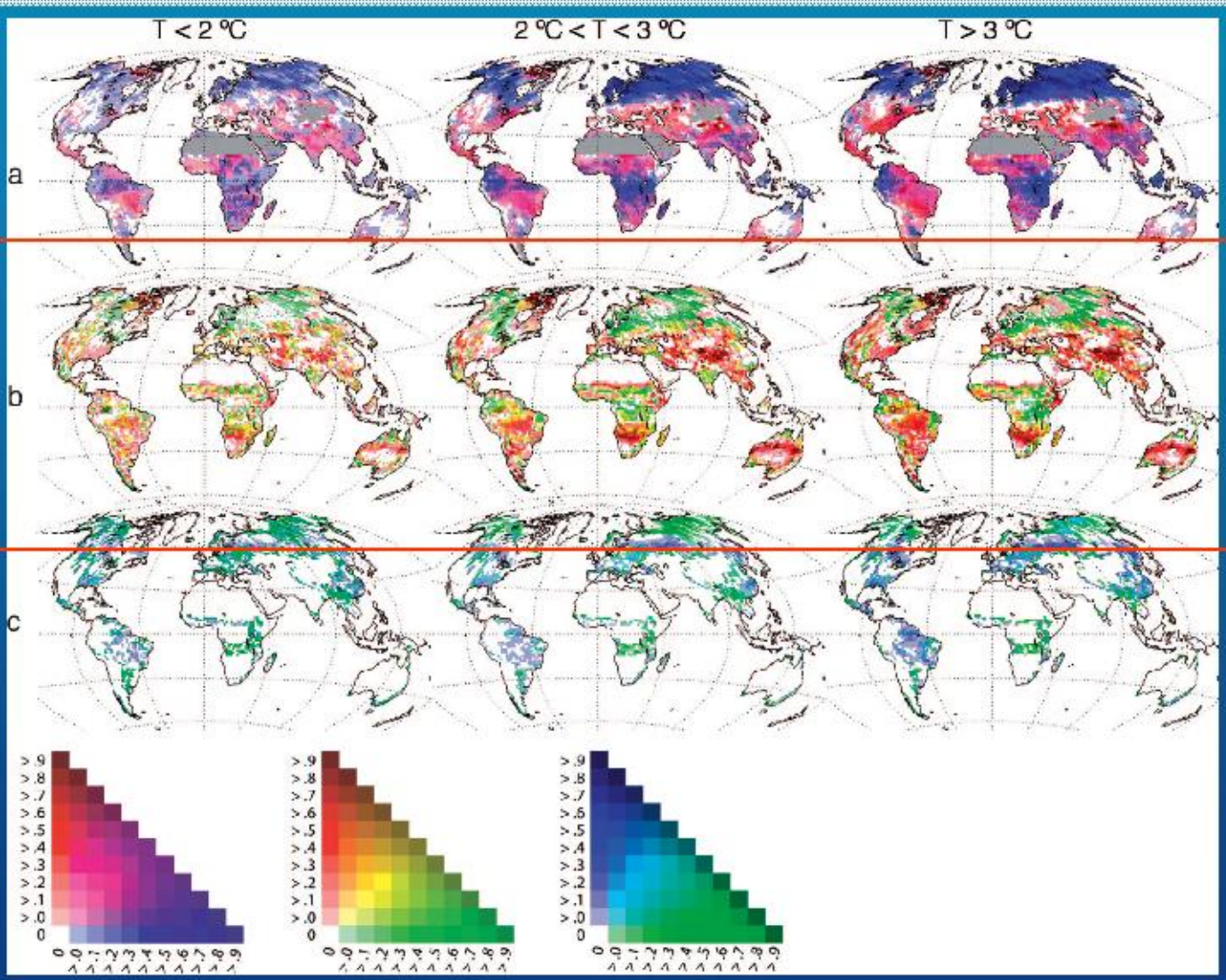
Active fires, shown in red, are detected using MODIS data from the Terra Satellite
Source: MODIS Rapid Response http://rapidfire.sci.gsfc.nasa.gov/
Fire Information for Resource Management System (FIRMS)
http://maps.geog.umd.edu

Introduction



(IPCC 2007, KMA)

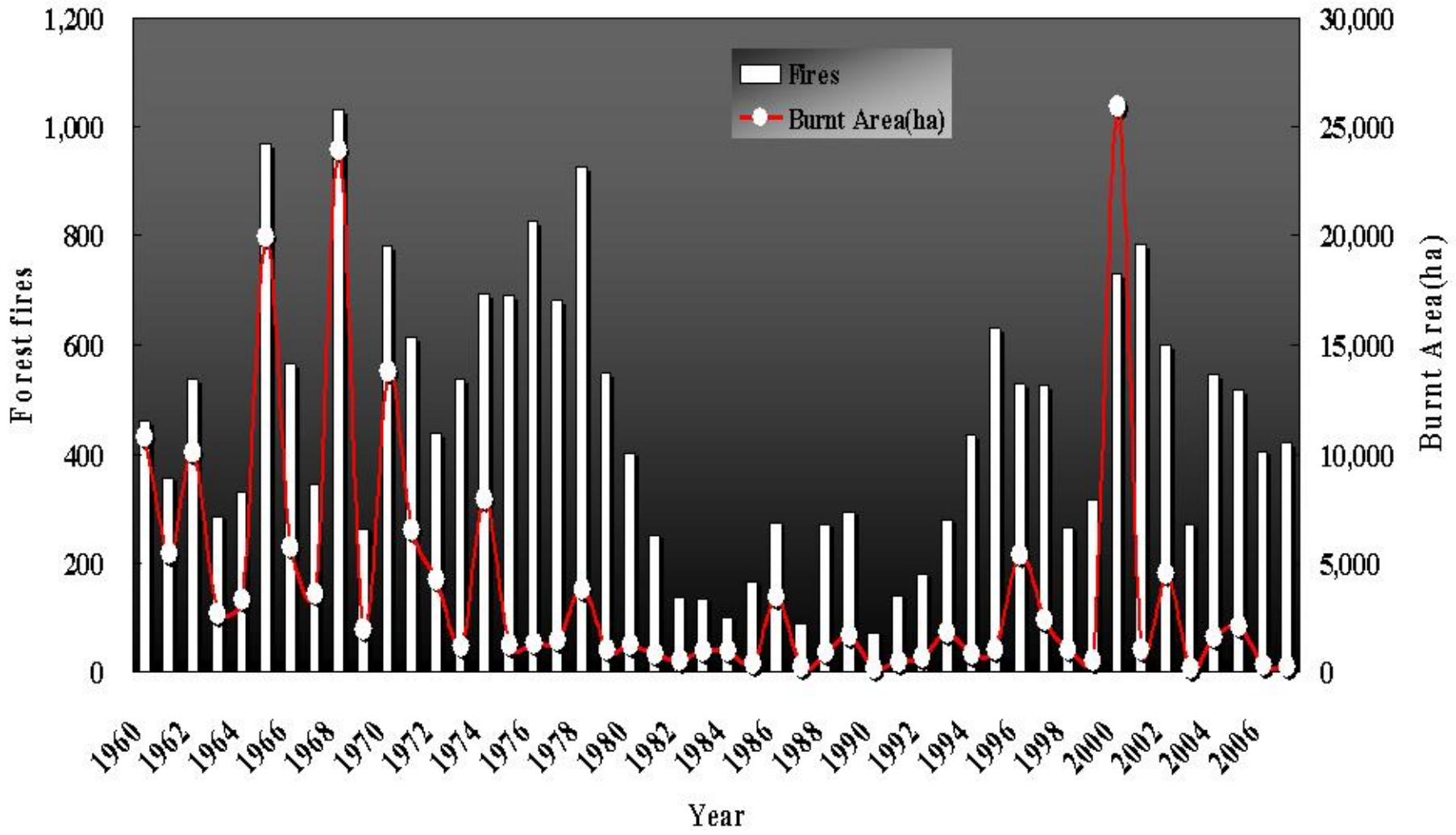
Introduction



- Report for fire effects and terrestrial forest ecosystems(Southampton, 2006)

Introduction

Fire Status, Korea

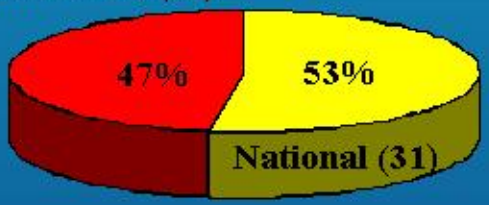


Introduction

Large fire distribution(30ha over)

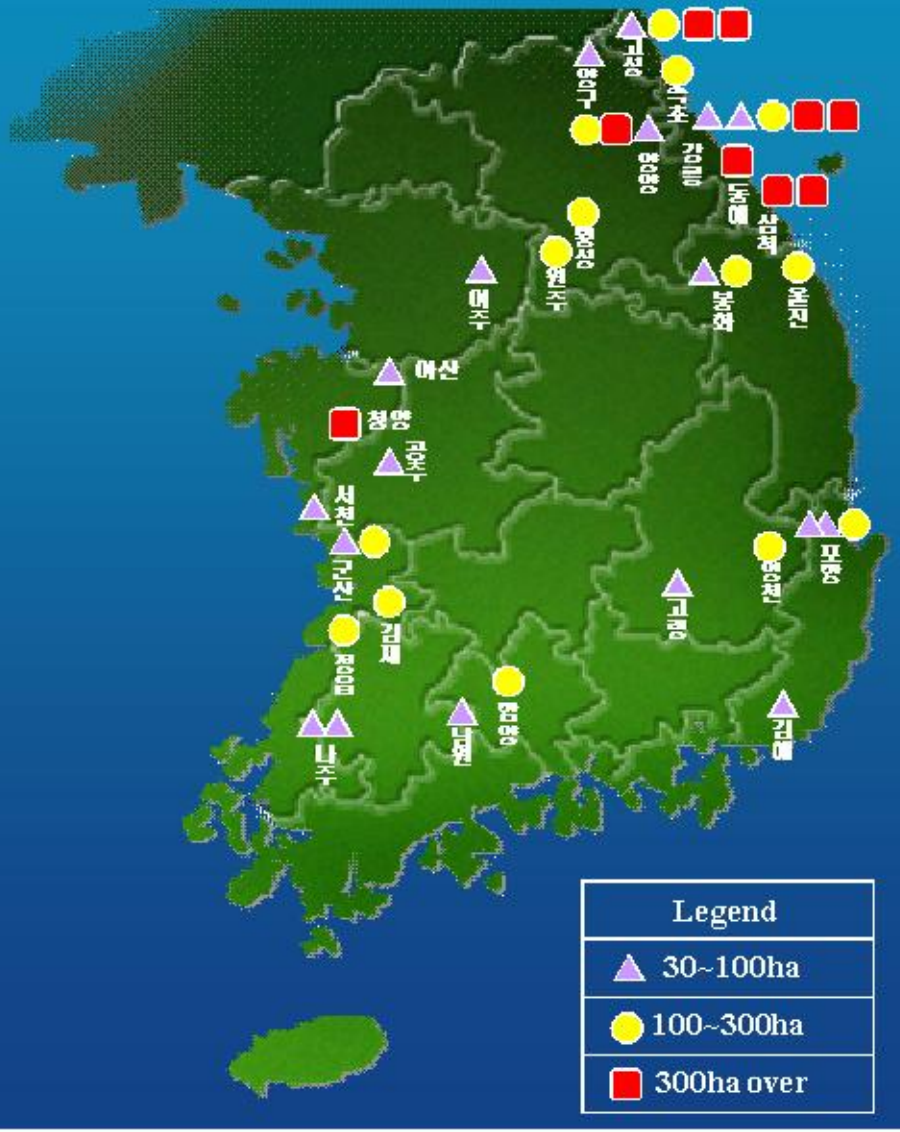
Fire Number

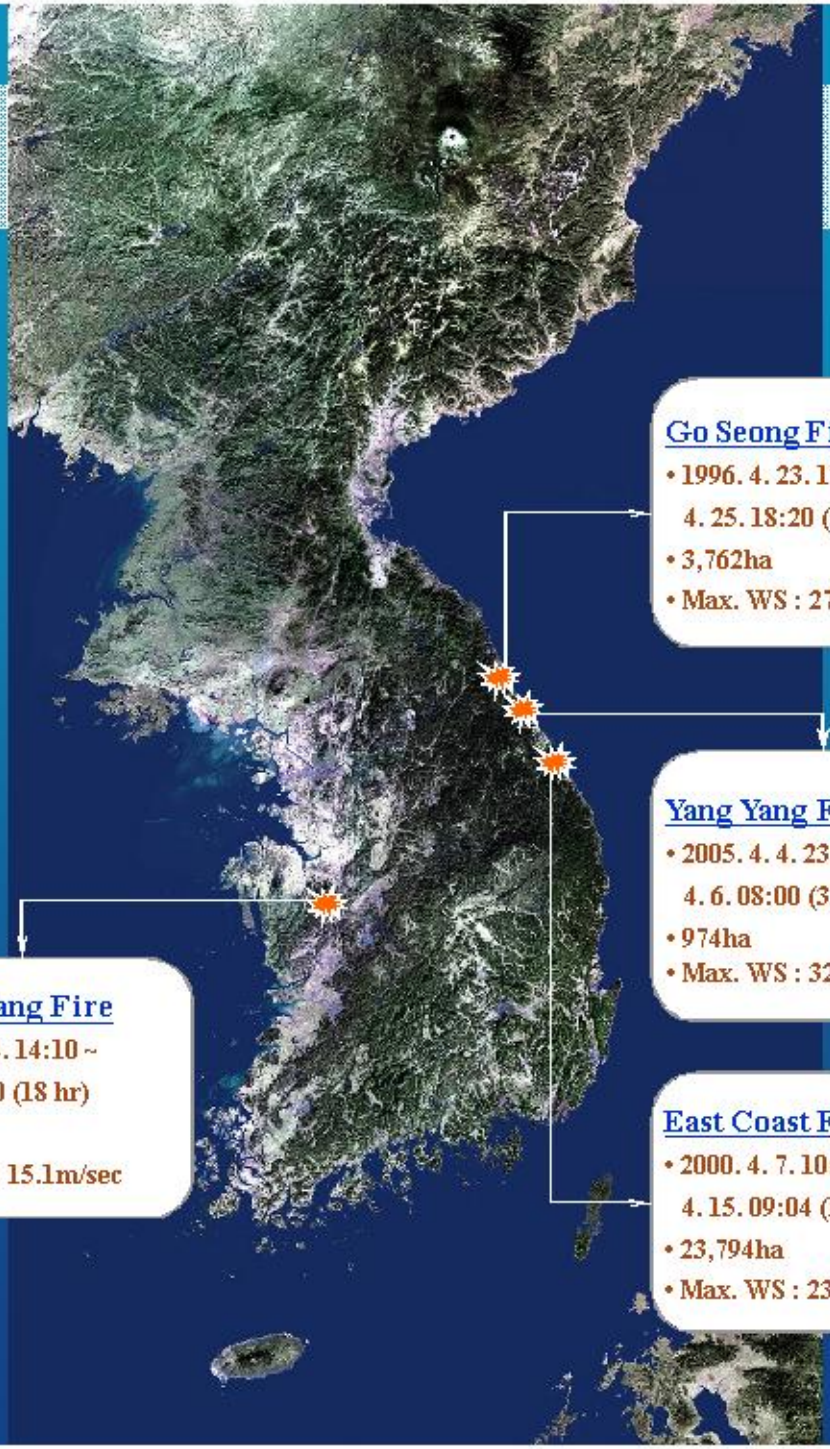
East Coast (28)



Burned Area

National(36,918ha)





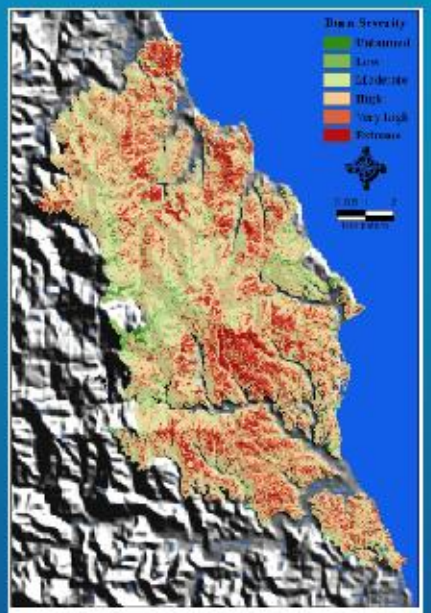
Go Seong Fire
- 1996. 4. 23. 12:20 ~ 4. 25. 18:20 (54 hr)
- 3,762ha
- Max. WS : 27m/sec

Yang Yang Fire
- 2005. 4. 4. 23:53 ~ 4. 6. 08:00 (32 hr)
- 974ha
- Max. WS : 32m/sec

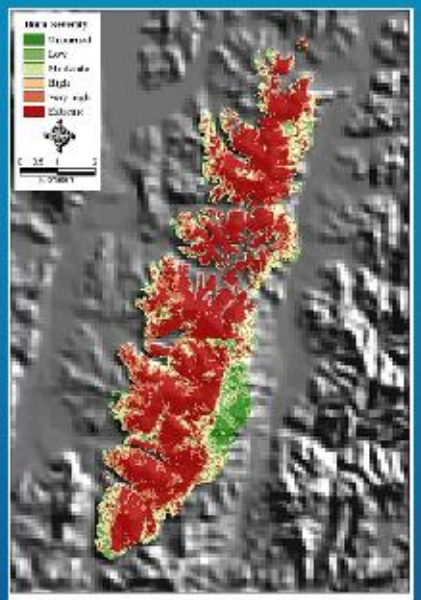
Cheong Yang Fire
- 2002. 4. 14. 14:10 ~ 4. 15 08:00 (18 hr)
- 3,095ha
- Max. WS : 15.1m/sec

East Coast Fire
- 2000. 4. 7. 10:04 ~ 4. 15. 09:04 (191 hr)
- 23,794ha
- Max. WS : 23.7m/sec

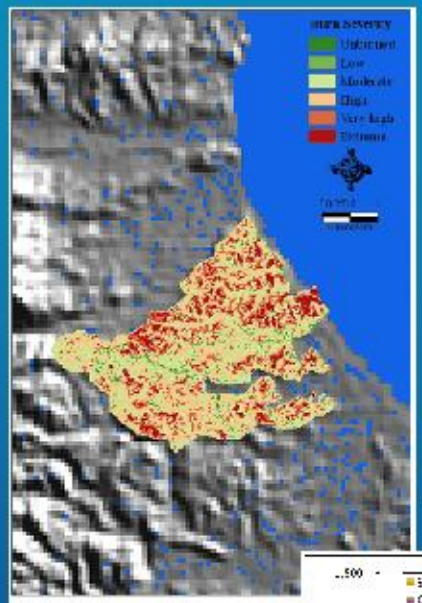
Introduction Damaged area/Burn severity(NBR)



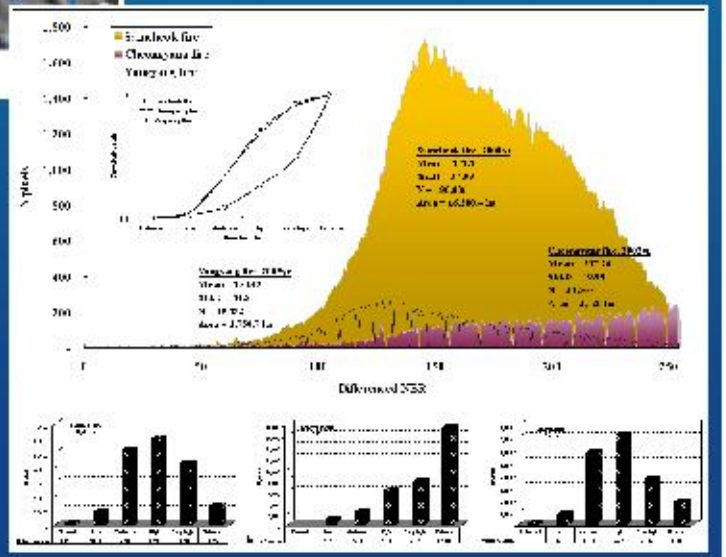
$\Delta NBR_{1999\text{-}2000}$



$NBR_{2000\text{-}2002}$



$NBR_{2004\text{-}2005}$



❖ **NBR & *ΔNBR***

☞ Key and Benson 2002, 2006 (USFS RMRS)

- NBR=(R4-R7)/(R4+R7)
- *ΔNBR* (Differenced Normalized Burn Ratio)

✓ $\Delta NBR = NBR_{prefire} - NBR_{postfire}$

Introduction *Non-CO_2 Emissions from Biomass burning*

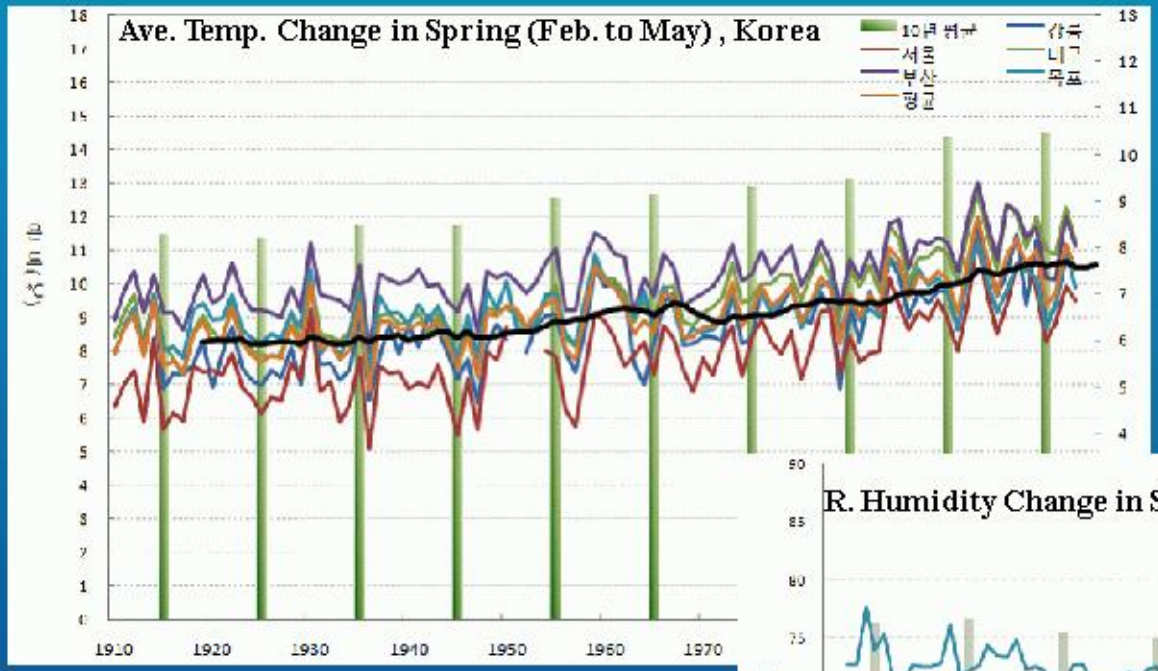
(Unit : Gg·yr^{-1})

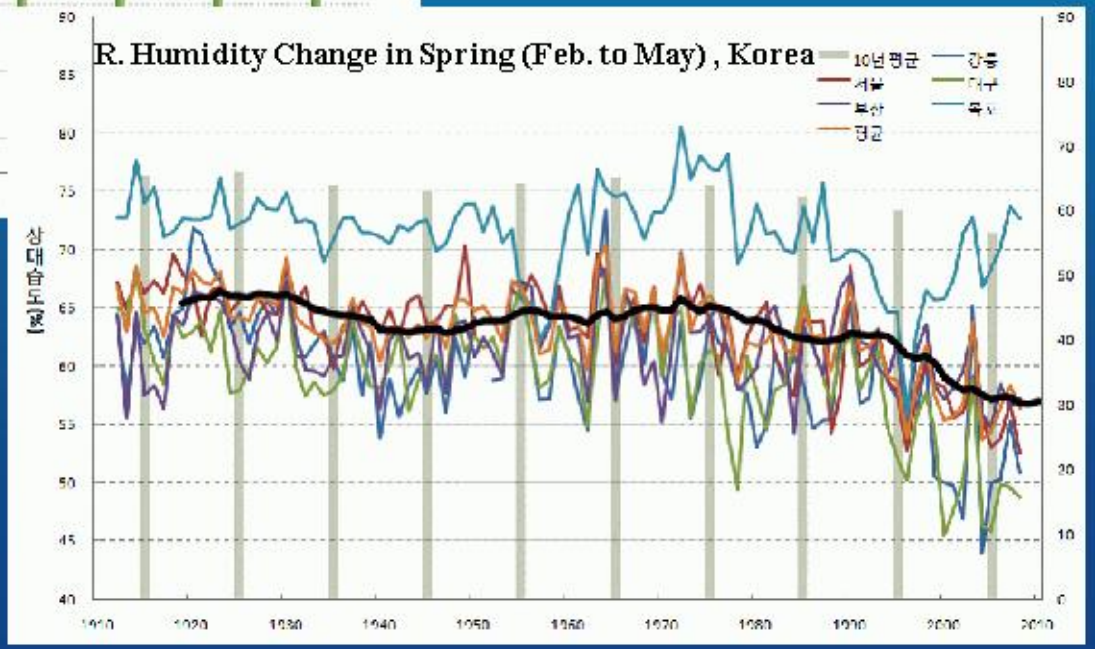
Classes	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
CH_4	1.11	0.52	0.26	14.85	0.58	2.82	0.09	1.09	1.47	0.19
CO	16.04	7.45	3.72	214.56	8.38	40.80	1.26	15.78	21.24	2.71
N_2O	0.01	0.01	0.00	0.18	0.01	0.03	0.00	0.01	0.02	0.00
NO_x	0.09	0.04	0.02	1.16	0.05	0.22	0.01	0.08	0.11	0.01
Total	17.25	8.01	4.00	230.75	9.02	43.88	1.36	16.97	22.84	2.91

The results of applying IPCC Guidelines(2003 GPG, 2006 GL) equation to estimate non-CO_2 greenhouse gases emissions from biomass burning in South Korea is released 93% of CO, 6.4% of CH_4, 0.5% of NO_x, and 0.5% of N_2O in order.

Fire & Climate

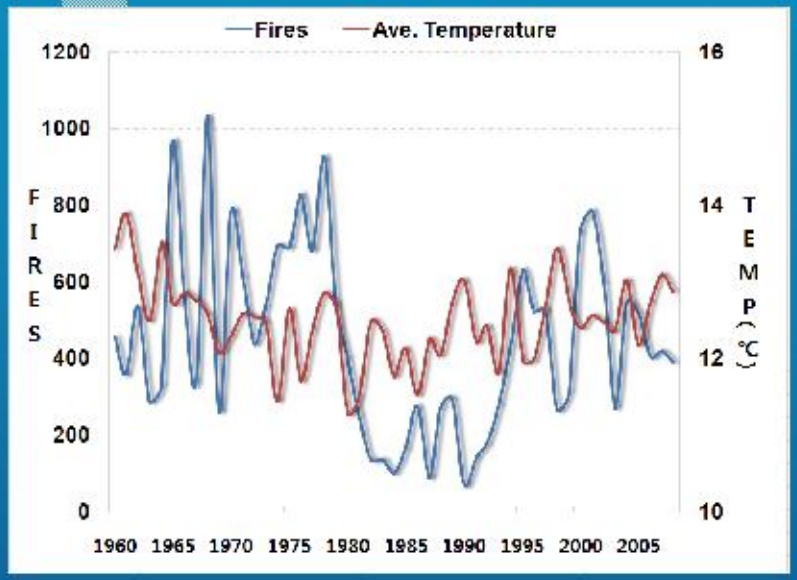
Climate change in Spring, Korea

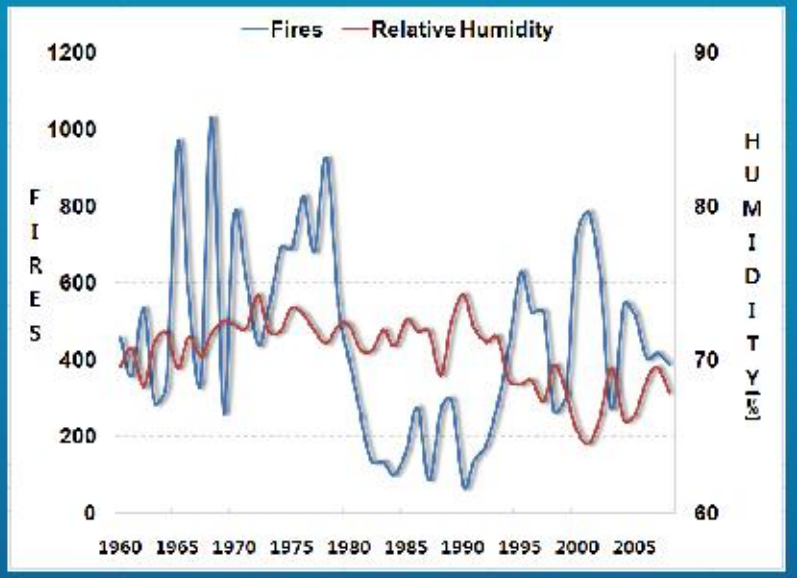


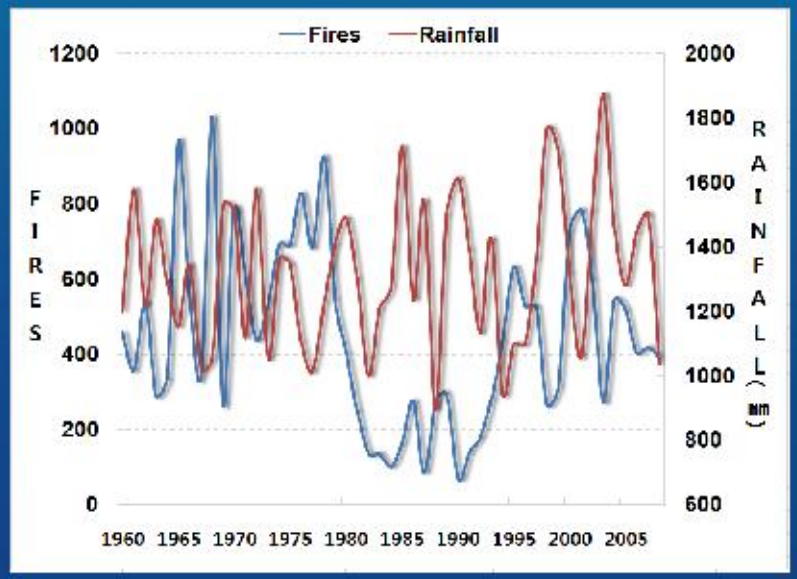


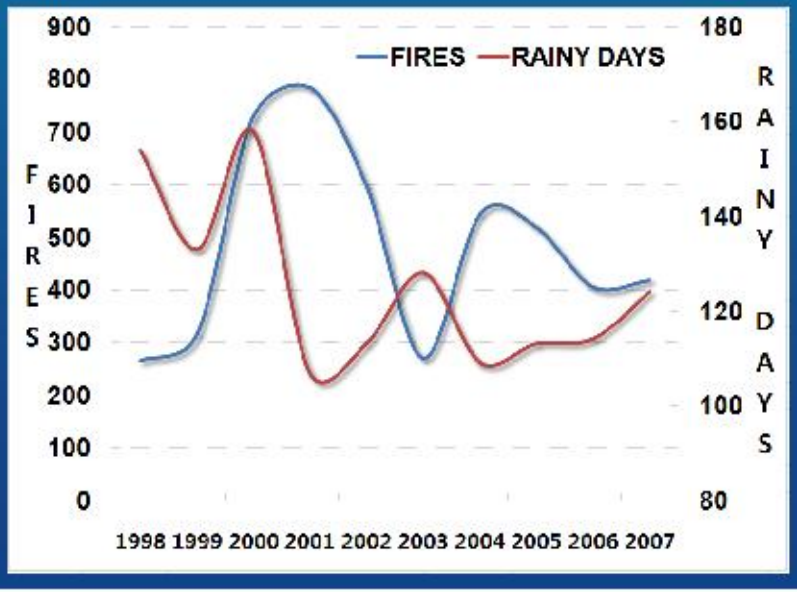
Fire & Climate

Fire frequency on Climate change

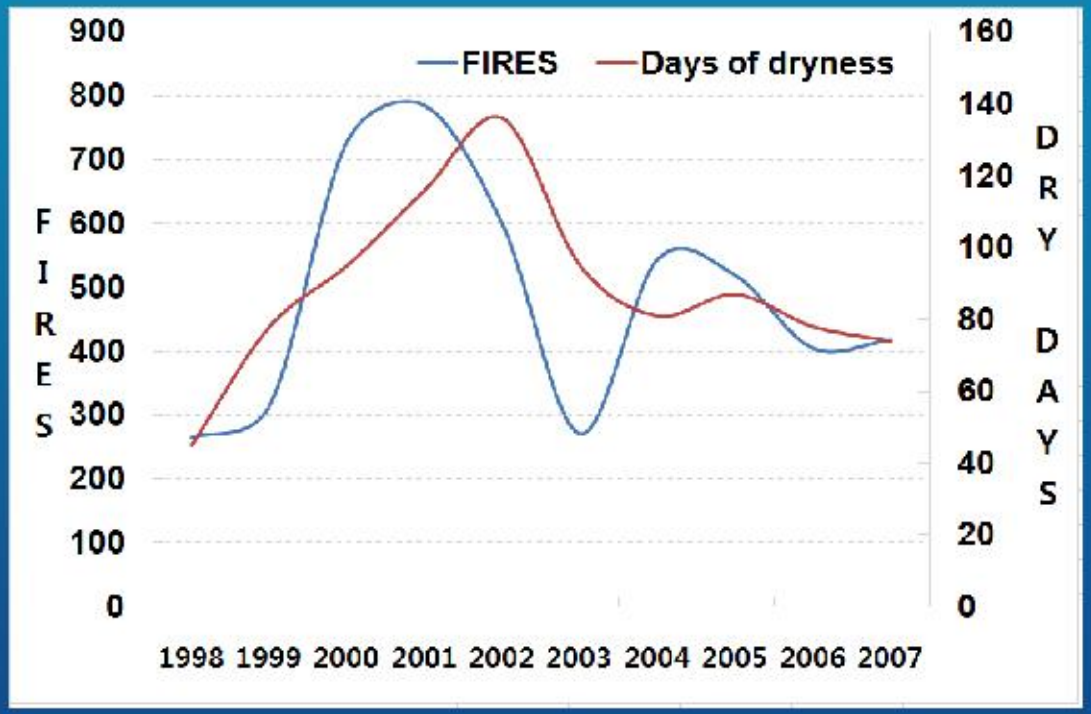


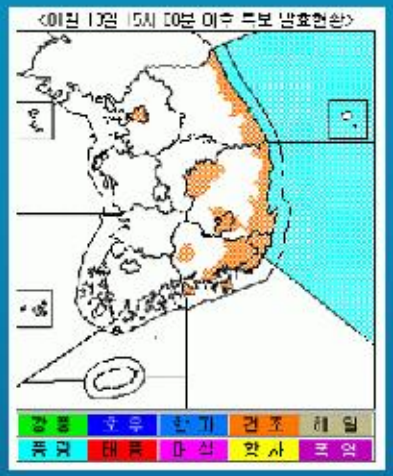


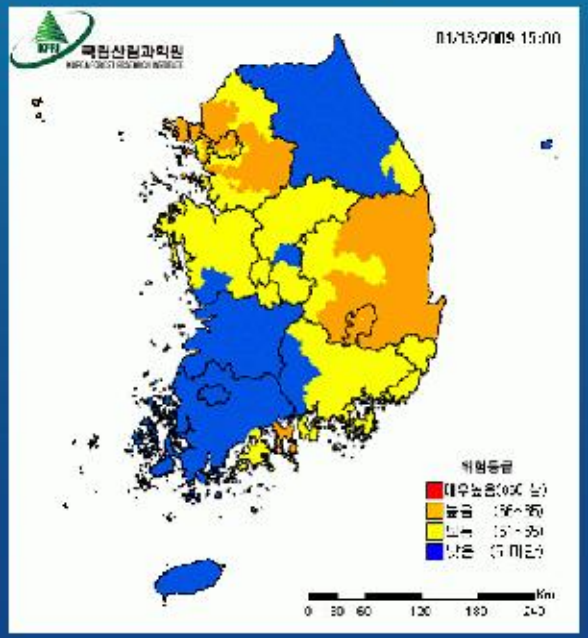




Fire & Climate Fire frequency on Climate change



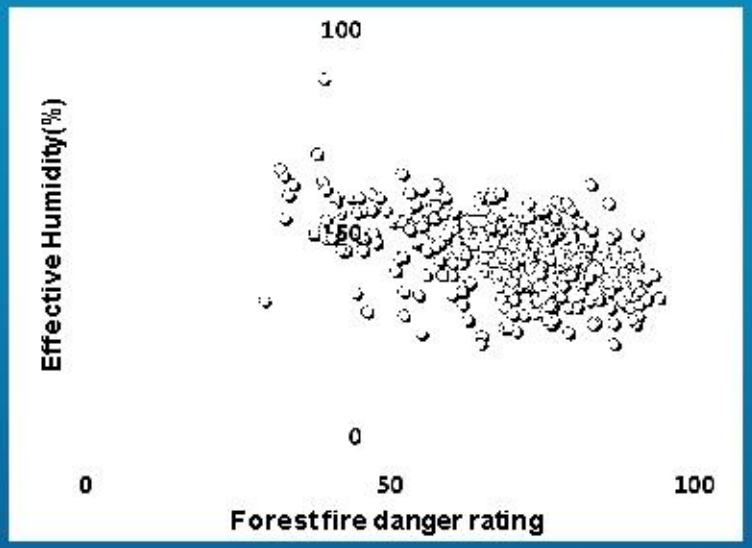


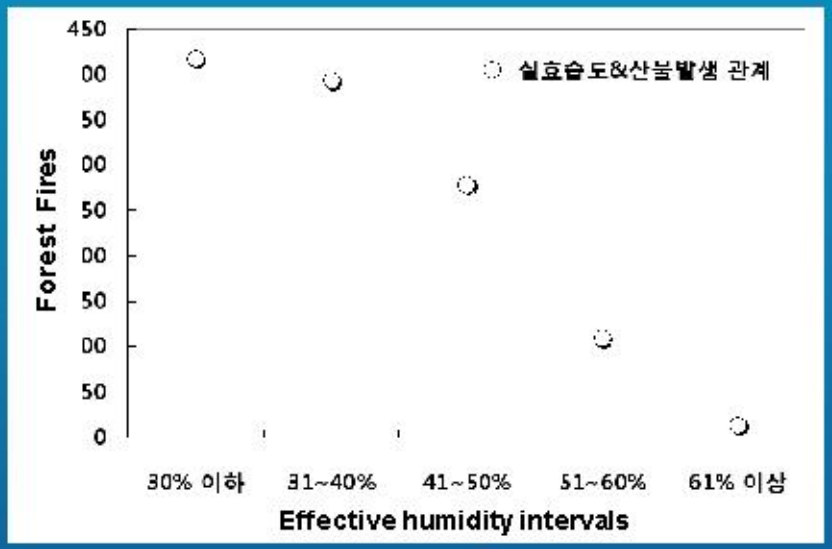


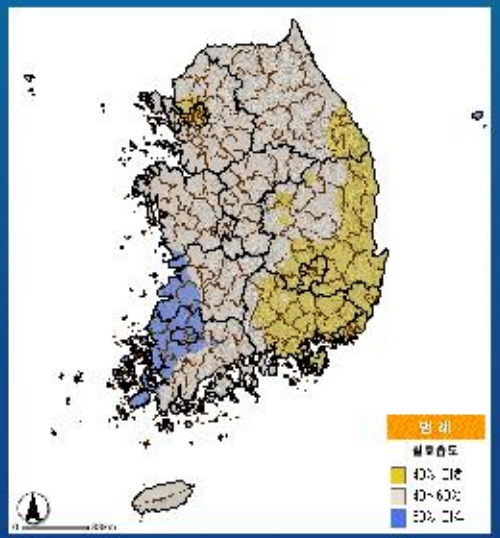
Forest fire danger rating

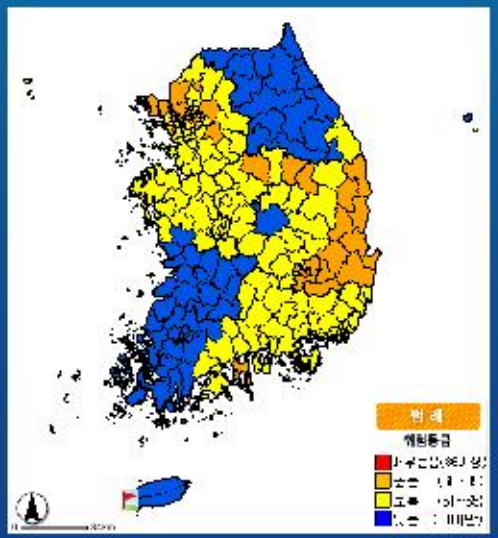
Fire & Climate

Fire frequency on Climate change

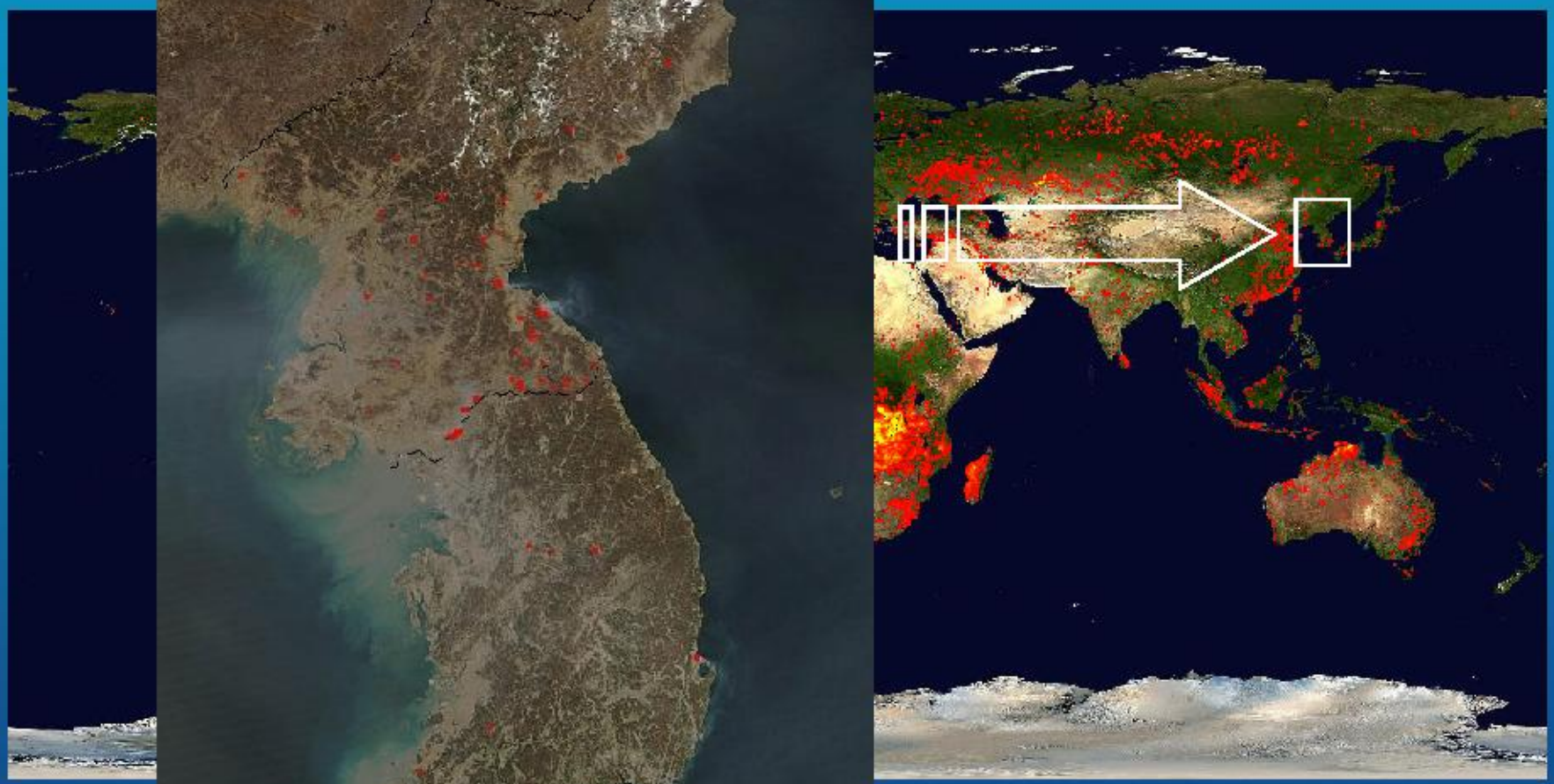








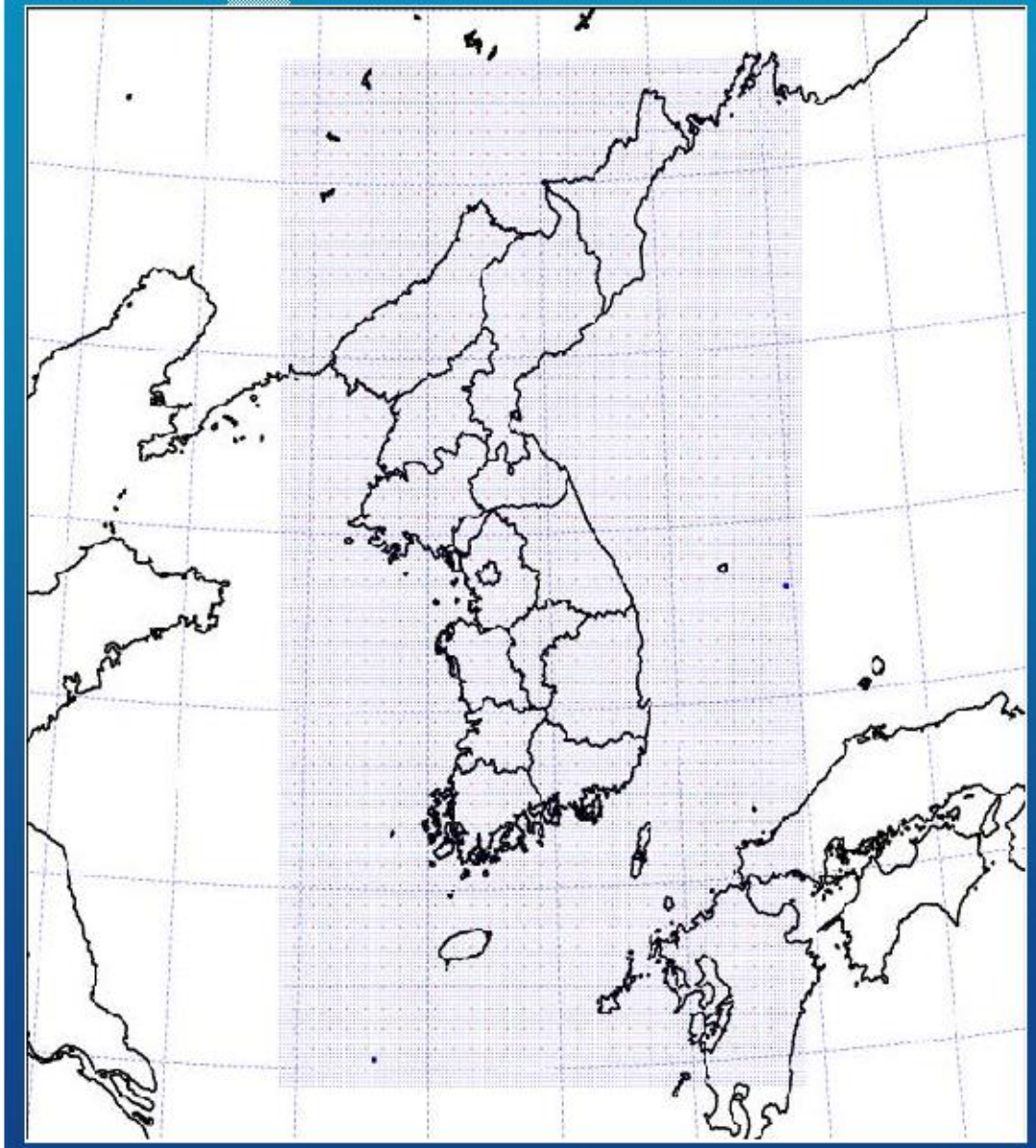
pplication of digit weather forecast data



The MODIS on the Aqua satellite captured this image of fires burning in the Korean Peninsula on April 9, 2004.

Fire & Climate

Application of digital weather forecast data



Digital weather data?

❖ Digital weather data info.

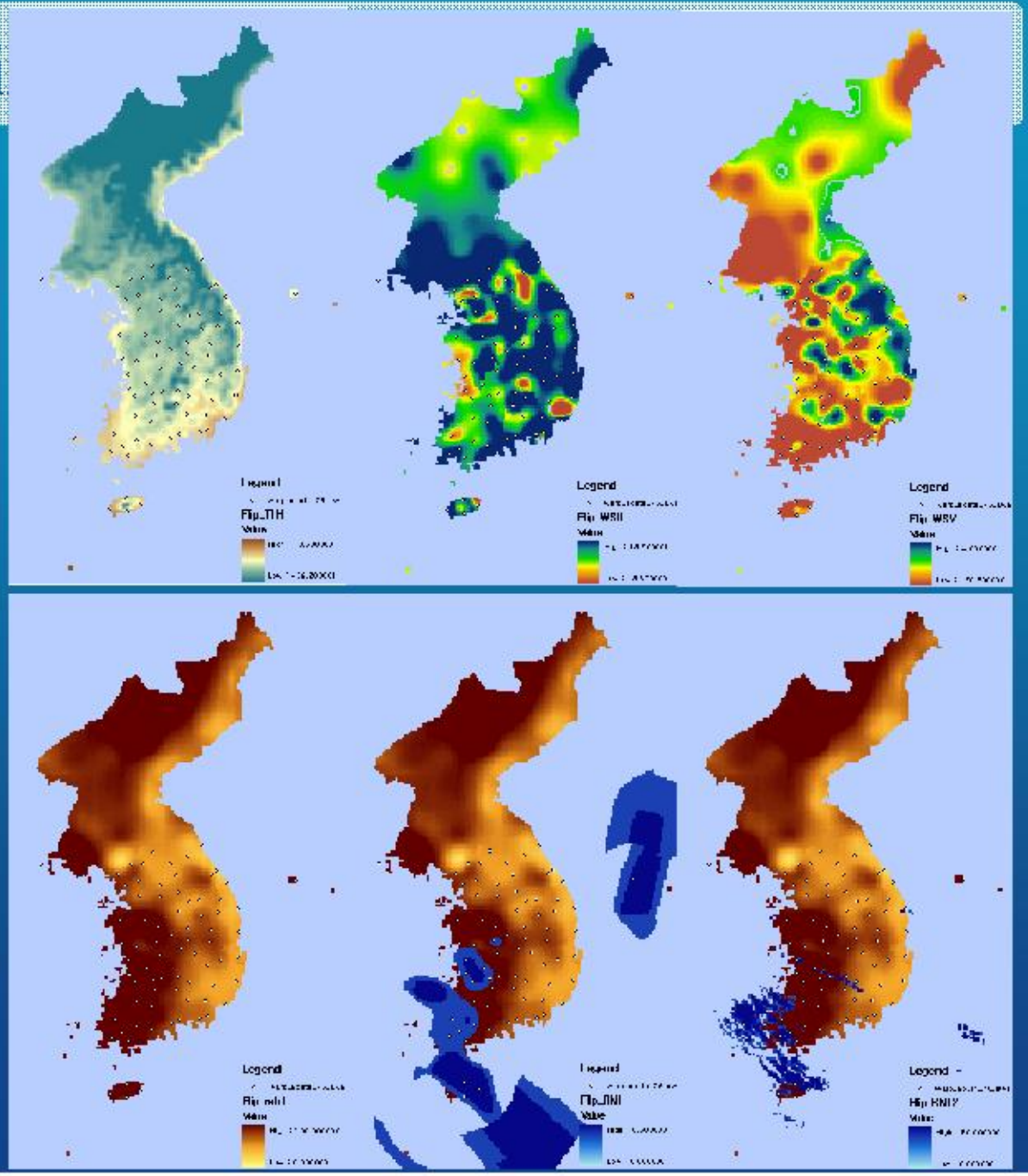
- Grid interval : 5km
- Grid points : E/W149 × S/N 253
  → 37,697 points)
- Grid points distance :
  E/W 745km, S/N 1,265km

Fire & Cli

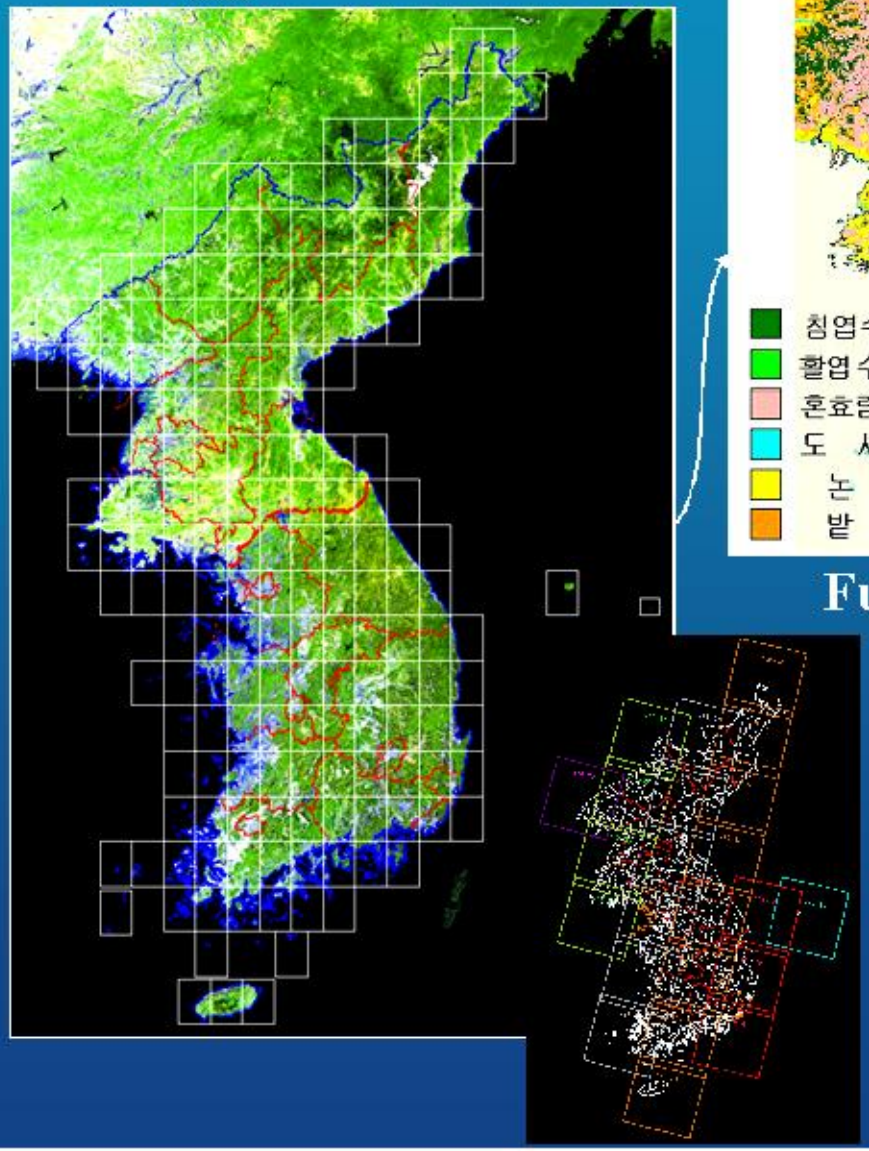
❖ Building of fire weather data using digit weather

(2005.12.12 . 08:00)

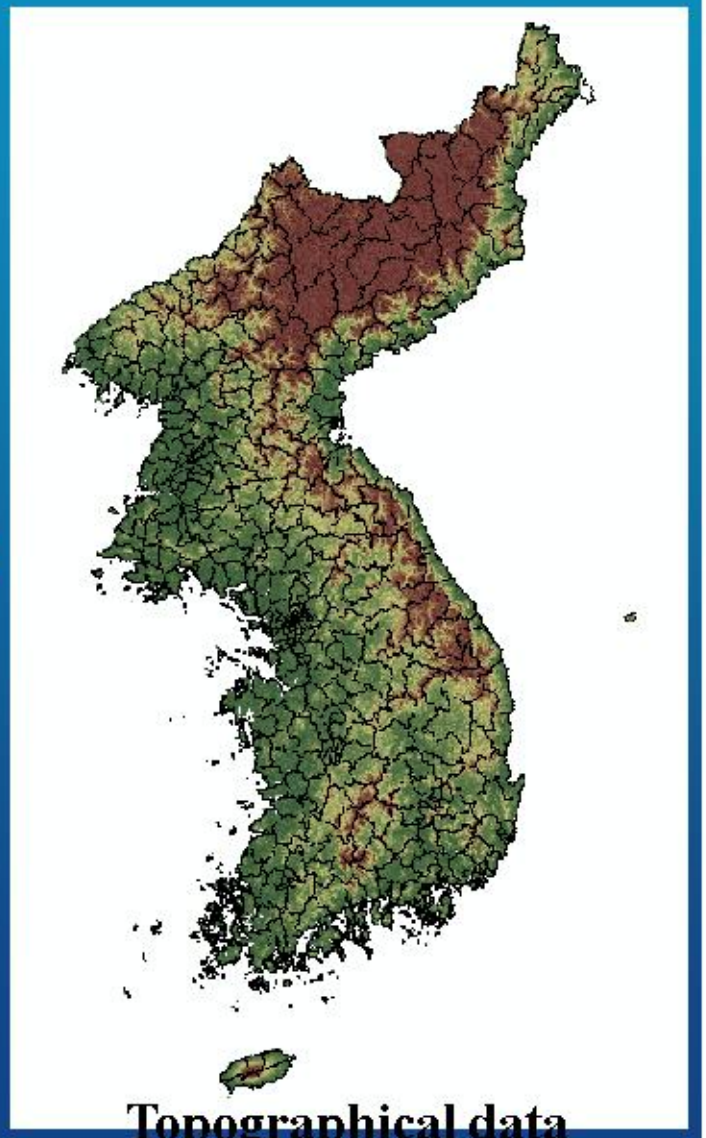
- 5km x 5km grid
- weather factors :
  - Temp.
  - R. Humidity,
  - UN Wind speed,
  - 1hr rainfall, 12hr rainfall



Fire & Climate Fire Danger Rating in Korean Peninsula



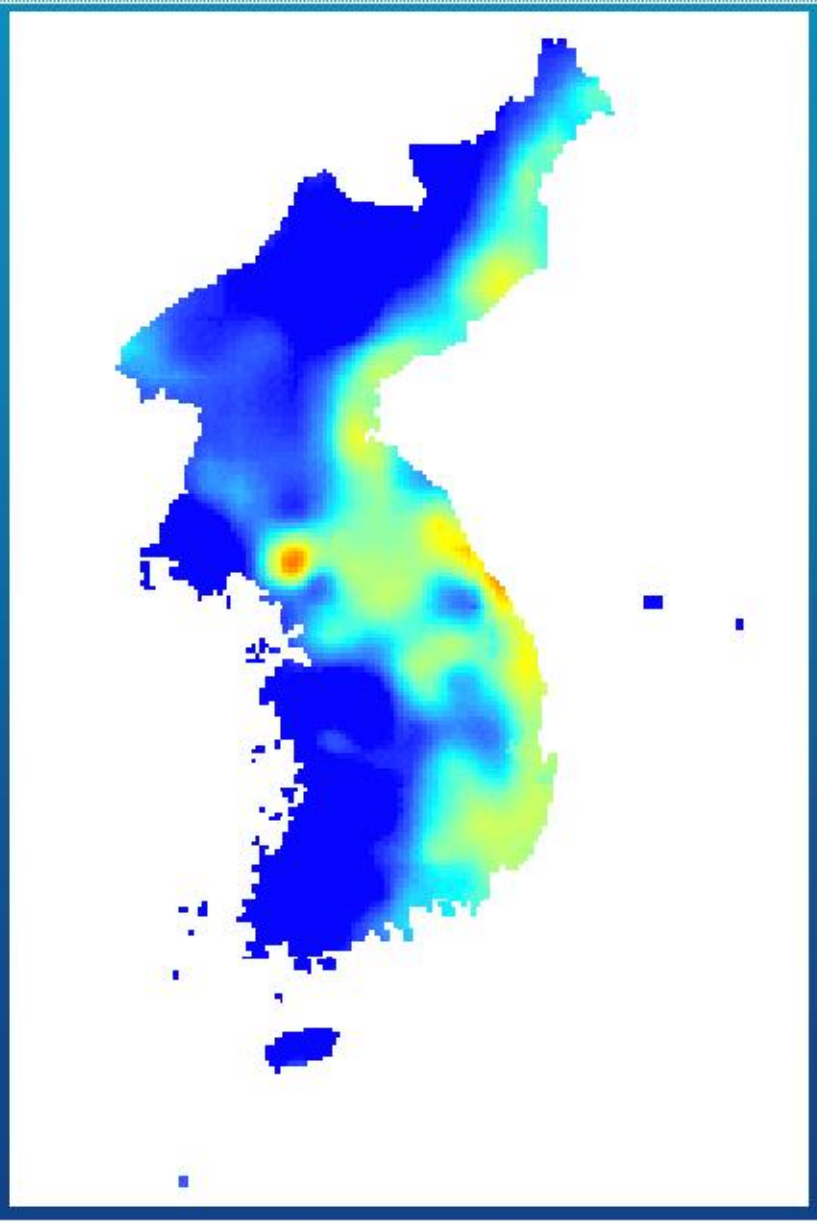
Fuel data



Topographical data

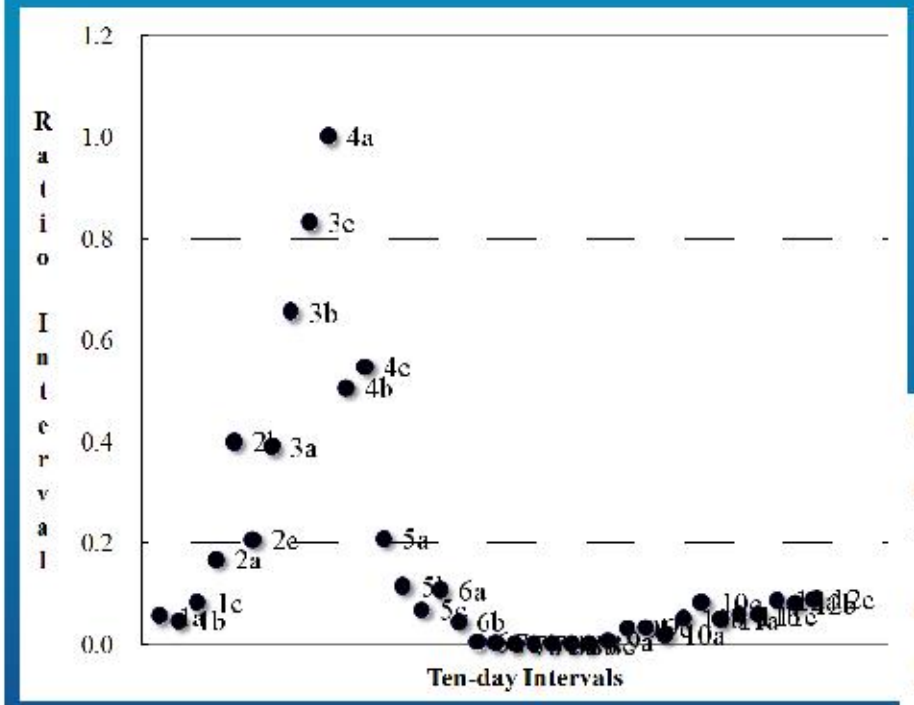
Fire & Climate Fire Danger Rating in Korean Peninsula

Forest Fire danger rating in Korean Peninsula



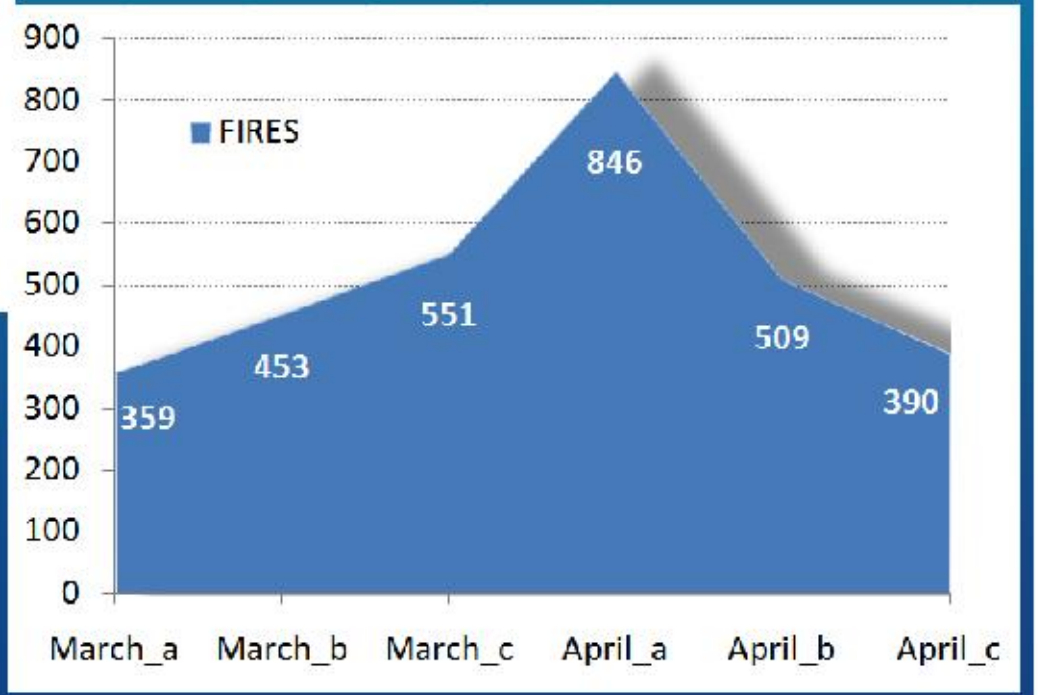
Fire Occurrence Hazard

Methods



Ratio Intervals of JAN to DEC, 10 yrs

Cumulative Fires of 10 day intervals during MAR to APRIL, Extreme Fire Season



Fire Occurrence Hazard Methods

Fire Inventory ('95-'04)

Ave. Temp.

R. Humidity

+

Weather station (76 Points)

10days Intervals/ Admin. District

Weather data 10 days, 30yrs ('71-'00)

- IDW Interpolation
- 1km × 1km Grid
- ArcGIS 9.1

March-End

April-Early

April-Mid

Fire Frequency

Temp. map

Humidity map

76 weather station Points

Data sampling of frequency, temp. and humidity to evaluate fire hazard

Regression Analysis (Numerical formula)

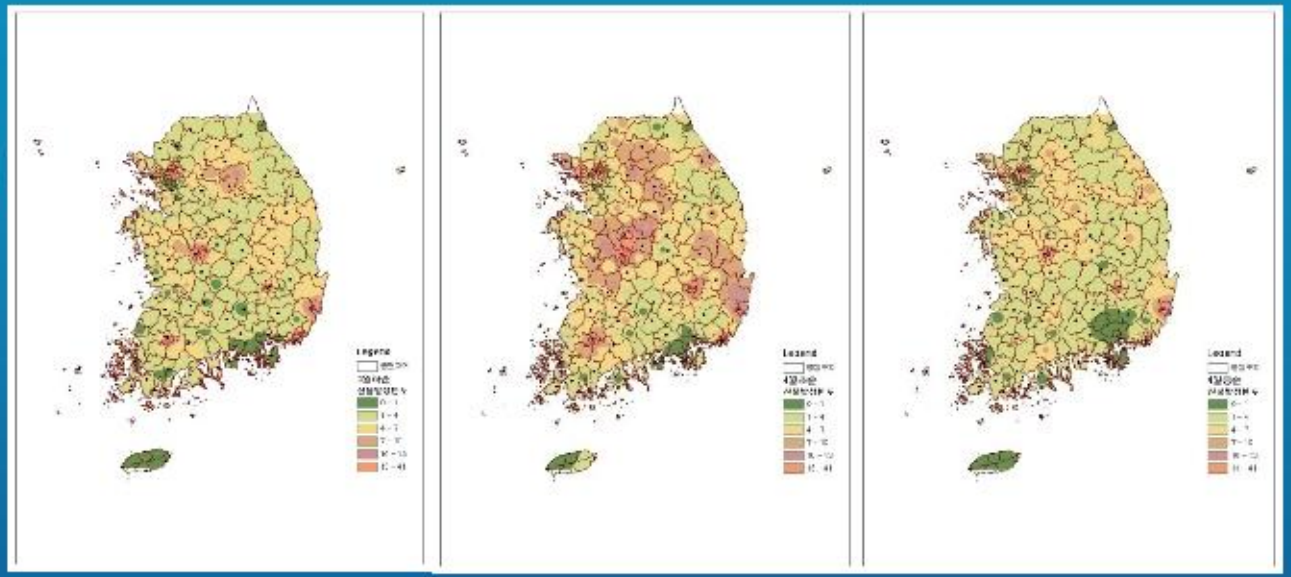
Geo-Spatial Analysis for Fire Occurrence Hazard

FFOH potential map by changing Climate data

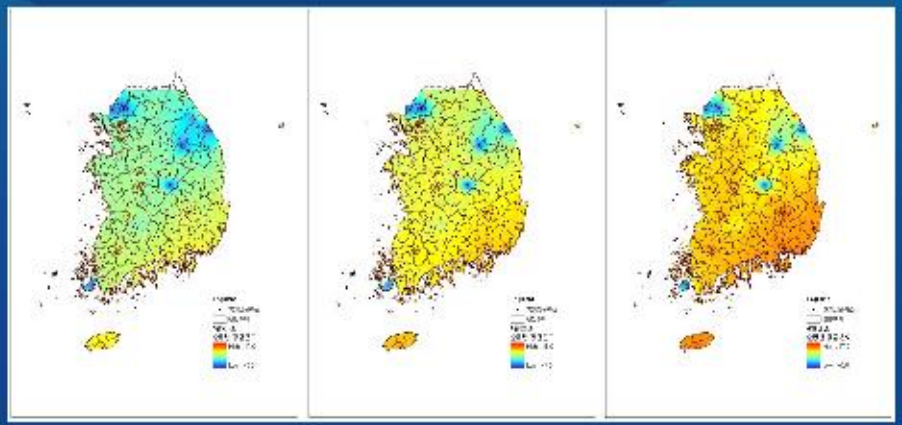
Fire Occurrence Hazard

Results

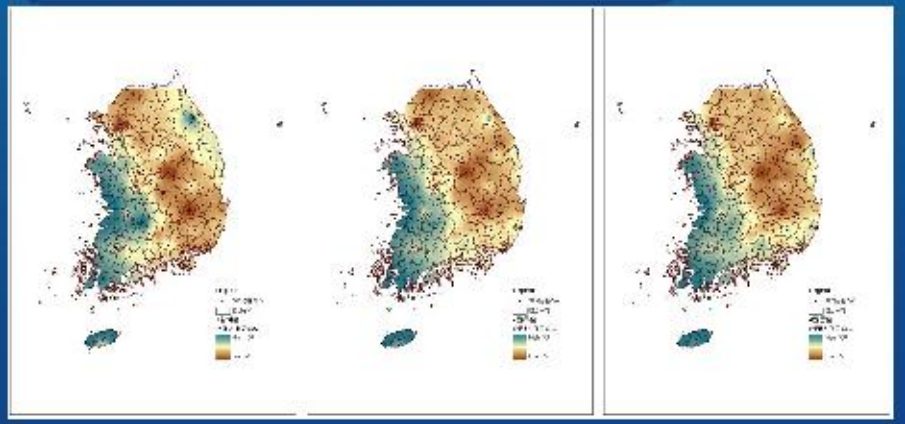
Fire frequency, 10-days intervals, 10 yrs



Ave. Temp. , 10-days intervals, 30 yrs



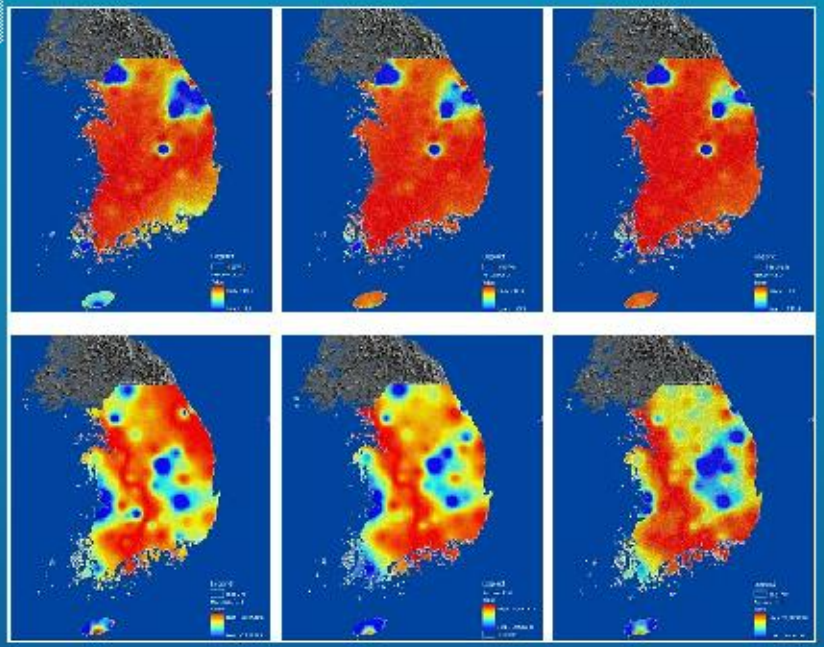
R. Humidity , 10-days intervals, 30 yrs



March end, April early, April mid

Fire Occurrence Hazard

Results



Forest fire occurrence hazard potential by changing Temp. and R. Humidity

Fire Occurrence Hazard Results

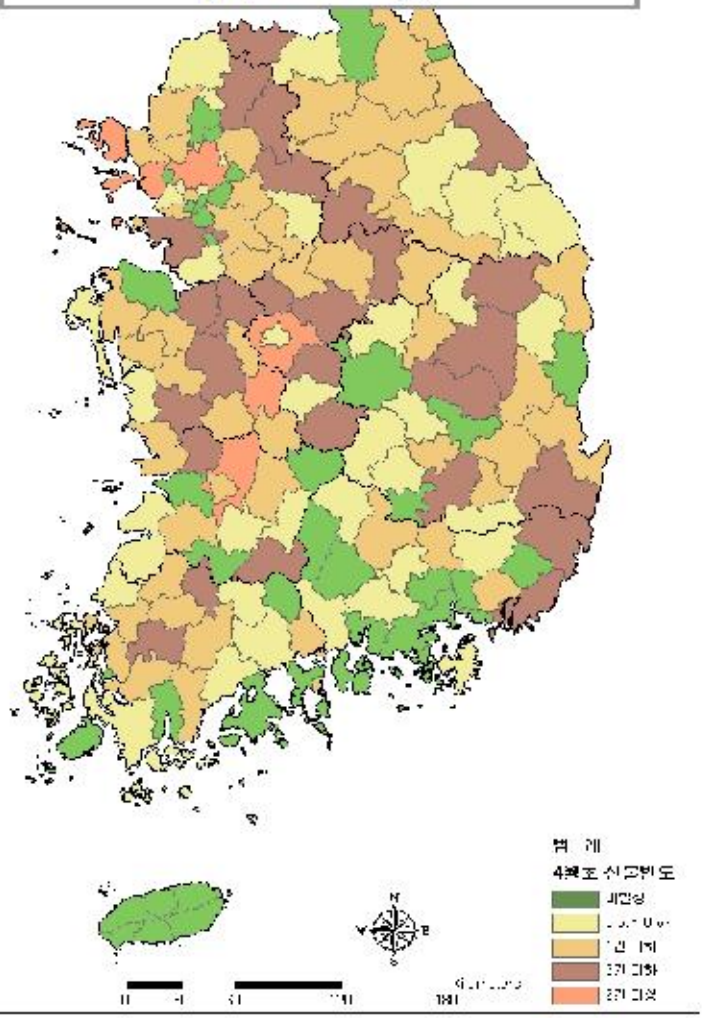
Fire frequency by regions

❖ April early, Extreme fire season

❖ Fire frequency by regions

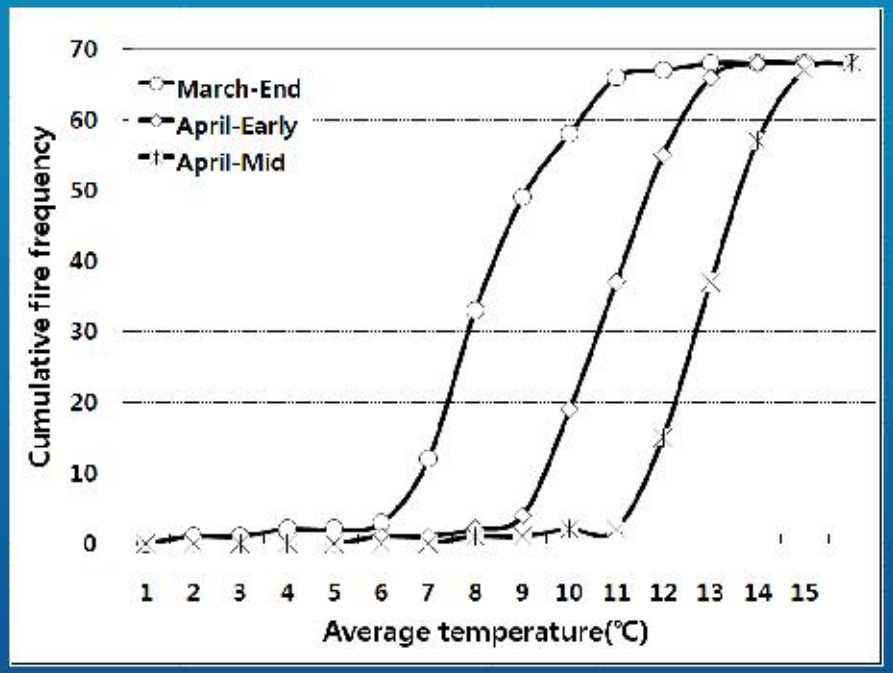
✓ Forest fire occur often in the Metropolitan area Seoul, Daejeon, Daegu ,etc.

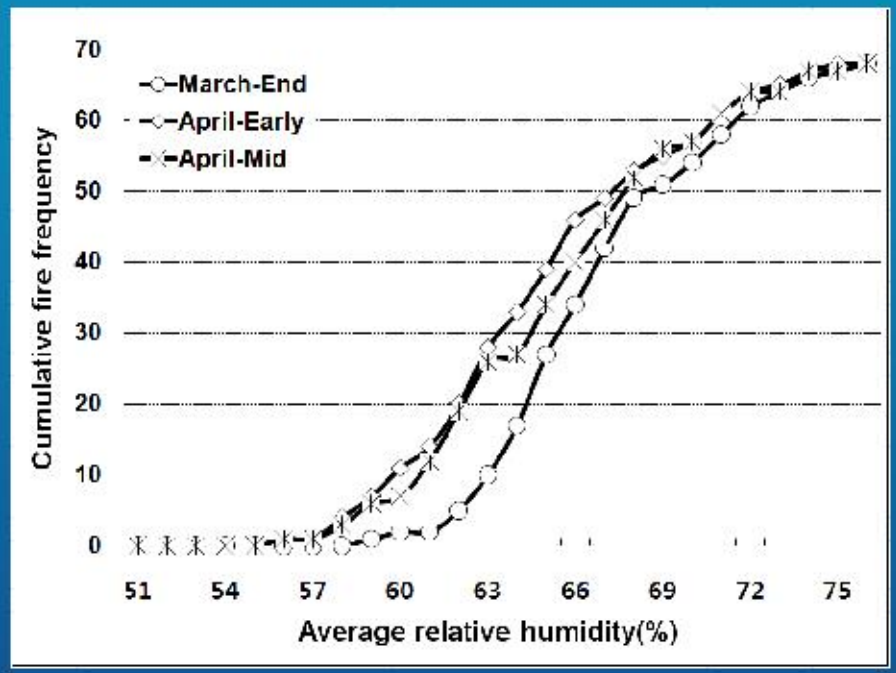
Fire Occurrence Hazard Map
(April Early)



Fire Occurrence Hazard

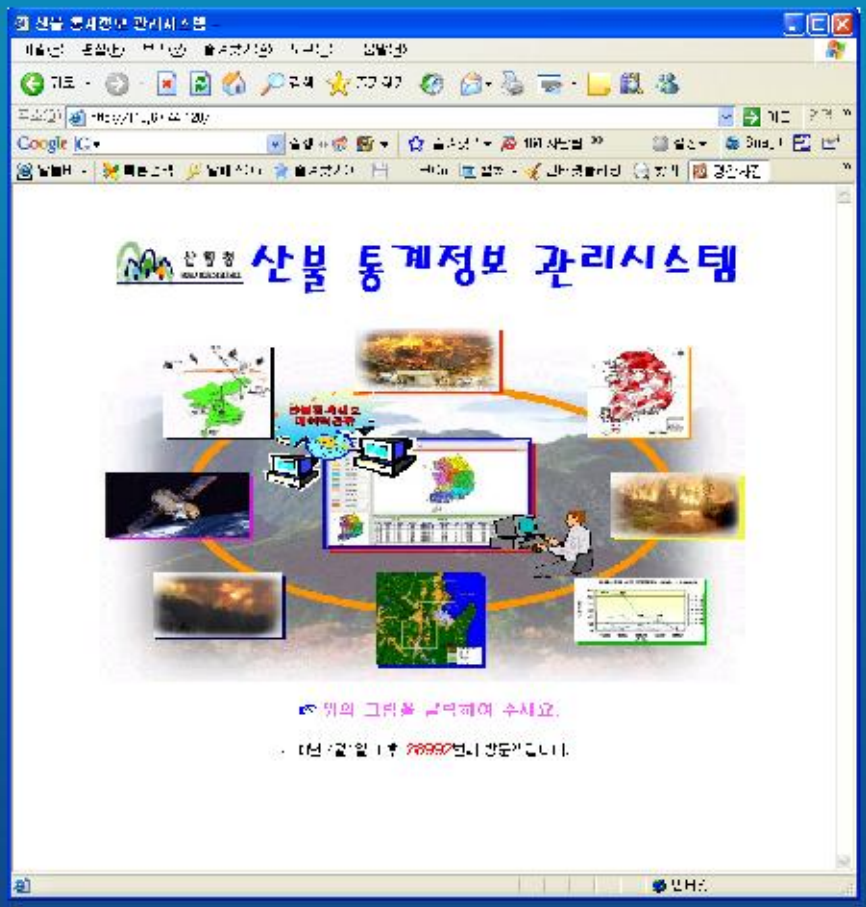
Results



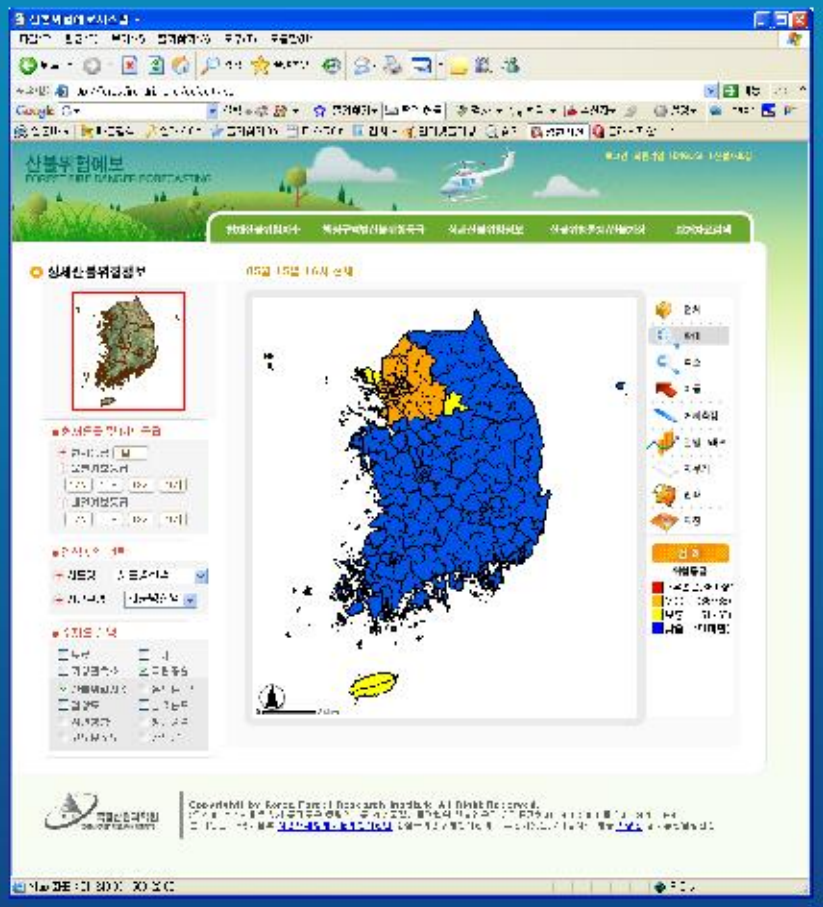


- Cumulative forest fire frequency by the change of temperature and relative humidity

Forest fire and Geo-spatial data management



Forest fire information management system (KFS)



Forest fire danger rating systems (KFRI)

Forest fire and Geo-spatial data management

Developing Tools

○ ArcObject, Visual Basic 6.0

Database

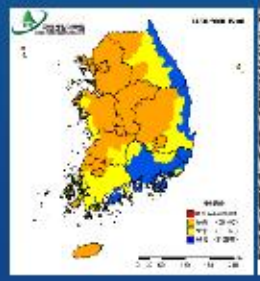
Cadastral Map

Admin. DB
- 법정동 행정경계
- 행정동 분류코드

Topographic DB
- Road, Agriculture, Building, Watershed

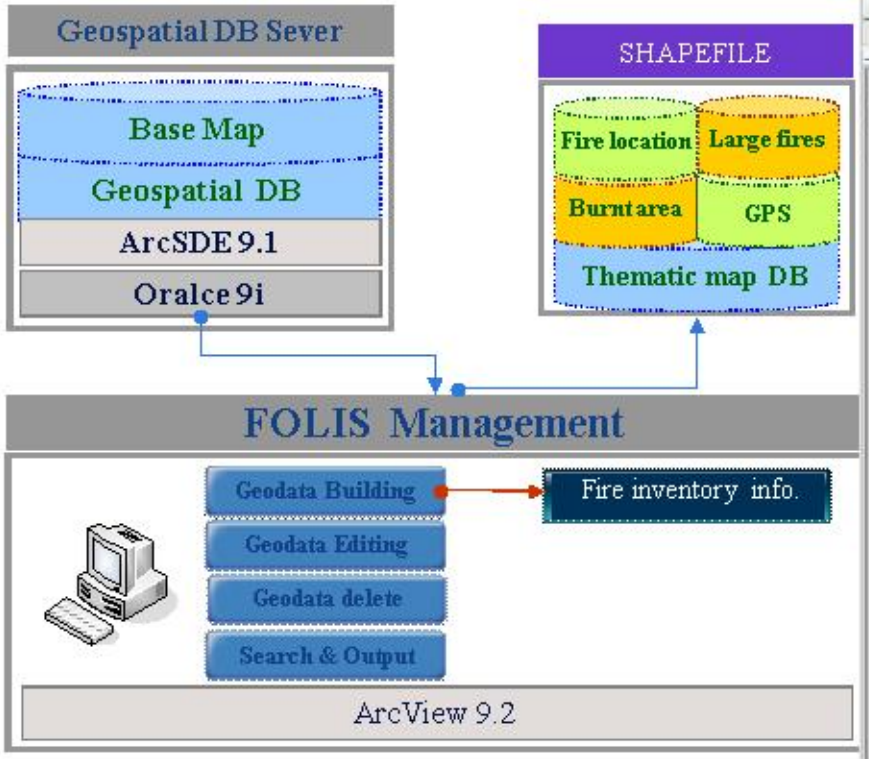
Satellite Images
- Landsat Mosaic

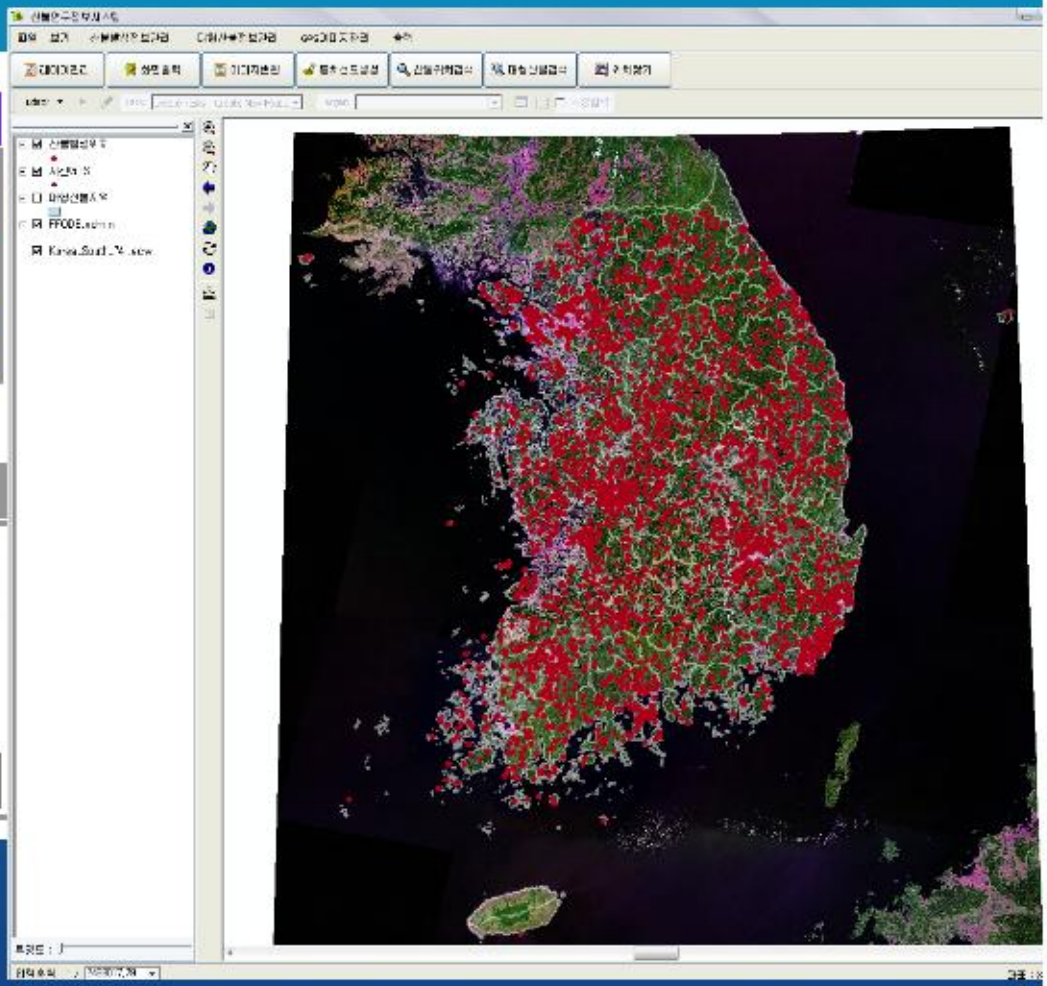
Forest fire DB
- Fire Inventory('98~)
- Large Fire DB
- Forest fire danger rating



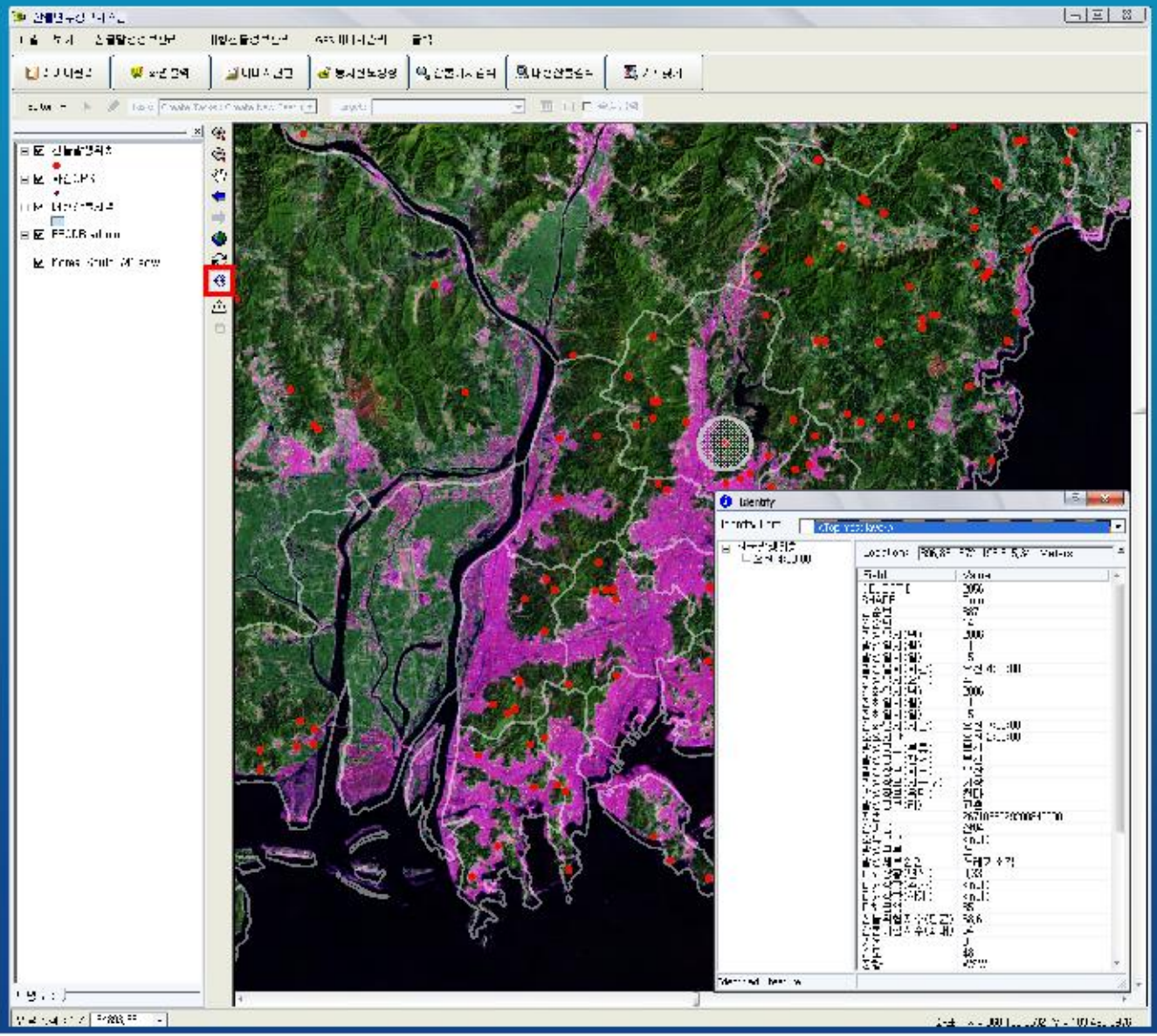
Reference Data
- 76 weather stations
- National park layer

Forest fire and Geo-spatial data management

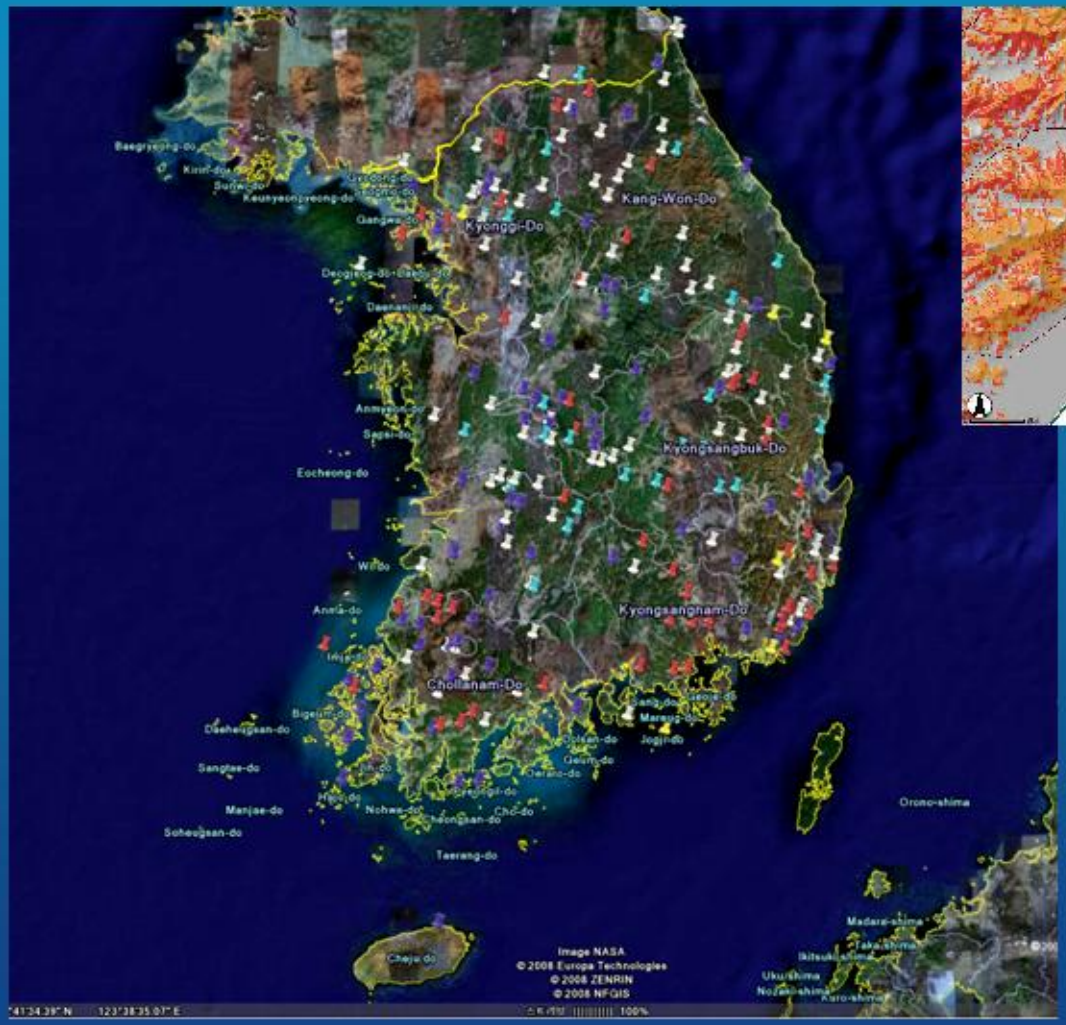


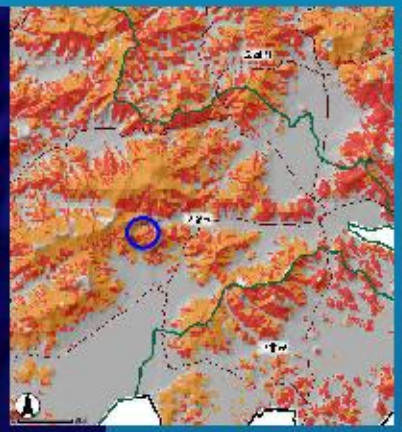


Forest fire and Geo-spatial data management



Forest fire and Geo-spatial data management

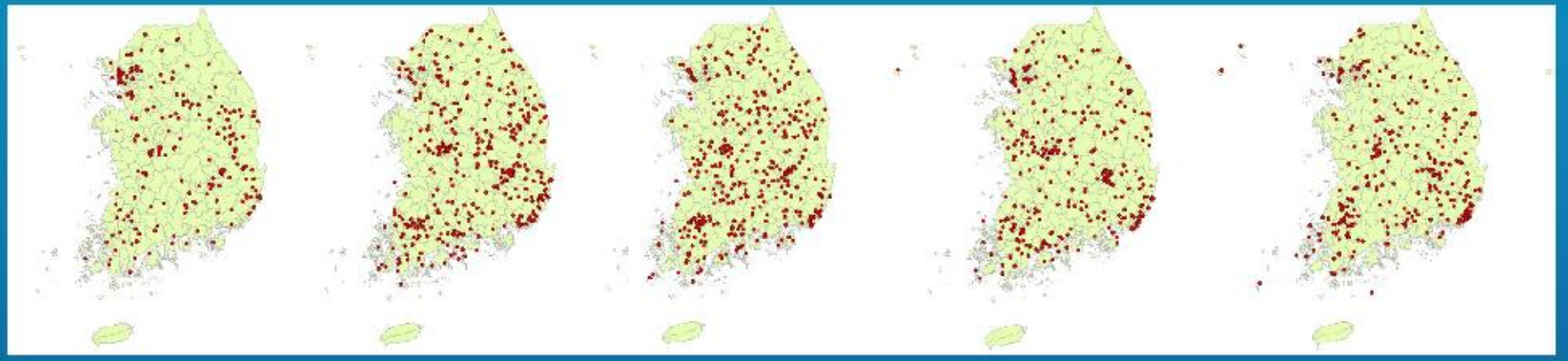




➲ Forest fire + FFDRI + Weather data

- 2008.04.04 16:00 ~ 17:30
- Fire cause : Weed burning
- Fire danger rating index : 85.1
  (danger rating : High)
- Suncheon weather station
- Temp. : 18.6℃
- Ave. WS/WD : 3.7m/s(WNW)
- Effective Humidity : 48.0%

Forest fire and Geo-spatial data management



➲ Application in the field of forest fire

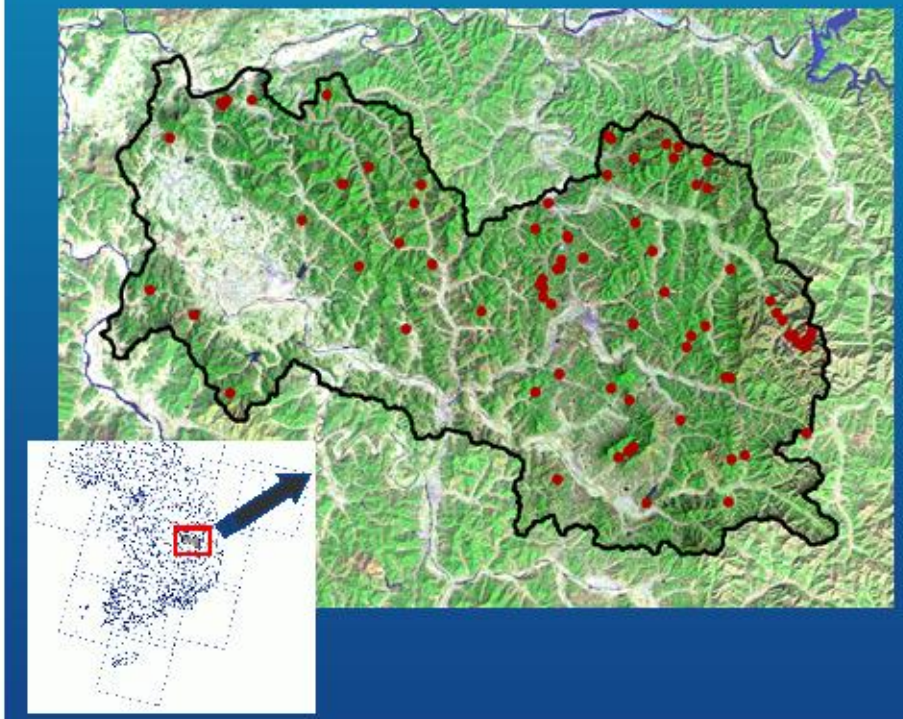
- Forest fire occurrence location by year/regions/10-day interval, 30 years

➔ Analysis of regional and 10-day interval forest fire

Fire & Fuel

Fuel type classification, Fuel map

- **Study area**
  - Central interior



- **Categories analyzing**
  - Landsat Satellites
    - Topo. Correction : C-Correction
    - Forest type classification (conifer, deciduous, Mixed)
    - AGB, SB Estimation
  - Soil condition : Soil humidity
  - On-site survey : AGB, SB
    - tree height, DBH, fuel load (78)

→ **Building Fuel Map**

Fire & Fuel

Fuel type classification, Fuel map

● Relation between AGB and SB of Conifer(On-site)

▪ Coniferous forest (3 types)

- Moderately moist soil (n=13)

  $y = 0.0587x + 5.06$ ($R^2 = 0.6972$)

- Slightly dry soil (n=16)

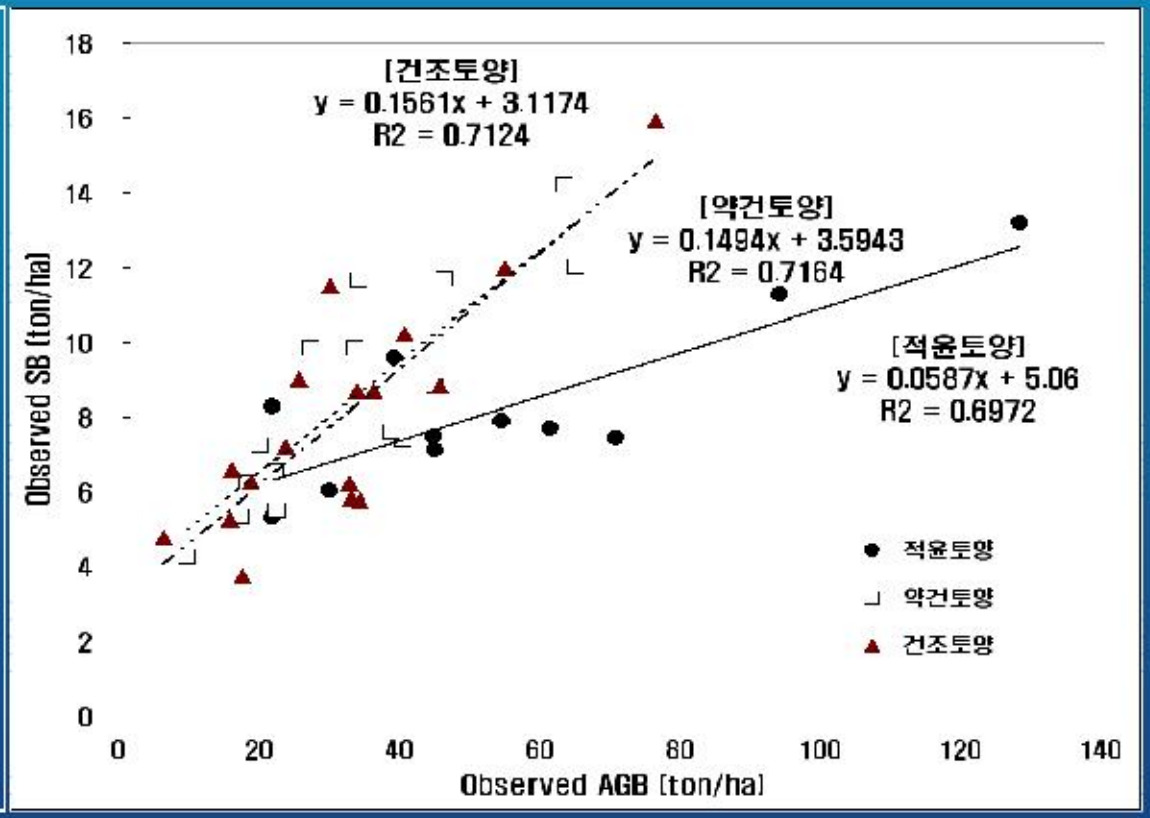
  $y = 0.1494x + 3.5943$ ($R^2 = 0.7164$)

- Dry soil (n=19)

  $y = 0.1561x + 3.1174$ ($R^2 = 0.7124$)

▪ Deciduous forest (1type)

$y = 1.99x0.4354$ ($R2 = 0.7221$)



Pinus densiflora Sieb. et Zucc

Fire & Fuel

Fuel type classification, Fuel map

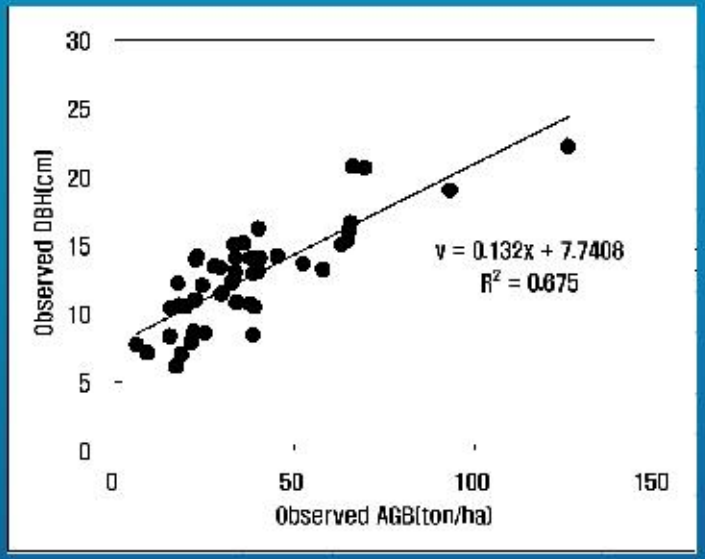
DBH & AGB relation (On-site)

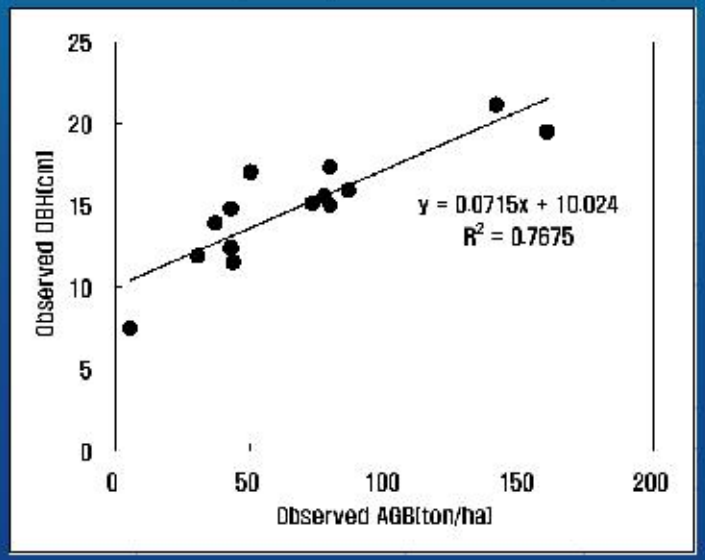
- Coniferous (n=48)

  $y = 0.132x + 7.7408$ ($R^2 = 0.675$)

- Deciduous (n=15)

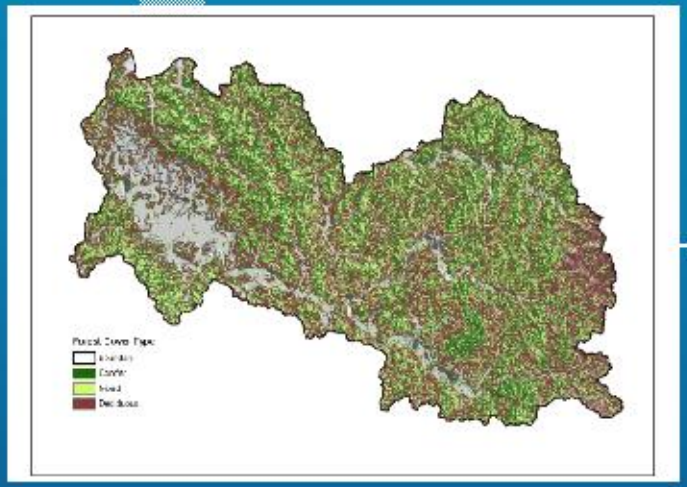
  $y = 0.0715x + 10.024$ ($R^2 = 0.7675$)



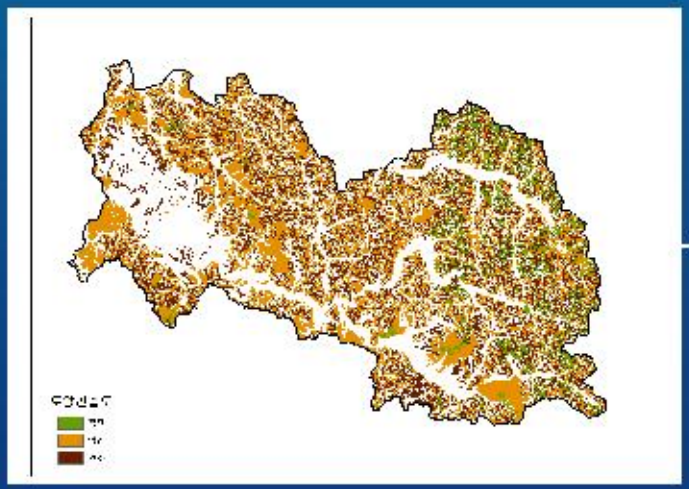


Fire & Fuel

Fuel type classification, Fuel map



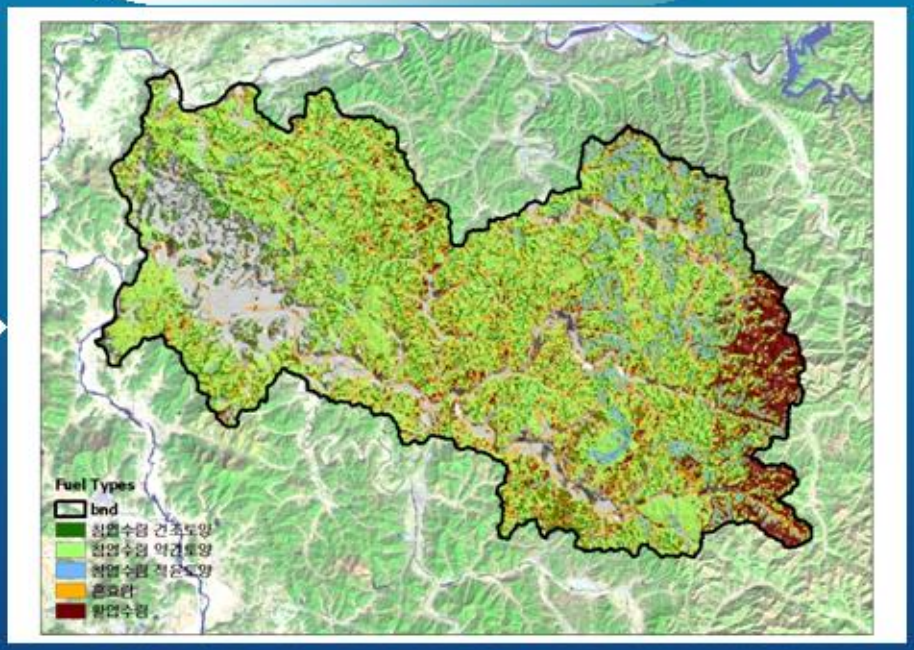
❖ Landsat classification : 3 types



❖ Soil Condition : moderately moist, slightly dry, dry soil

Fuel type Classification (5)

- Coniferous (3 types) : C1, C2, C3
- Deciduous (1 type) : D
- Mixed (1 type) : M

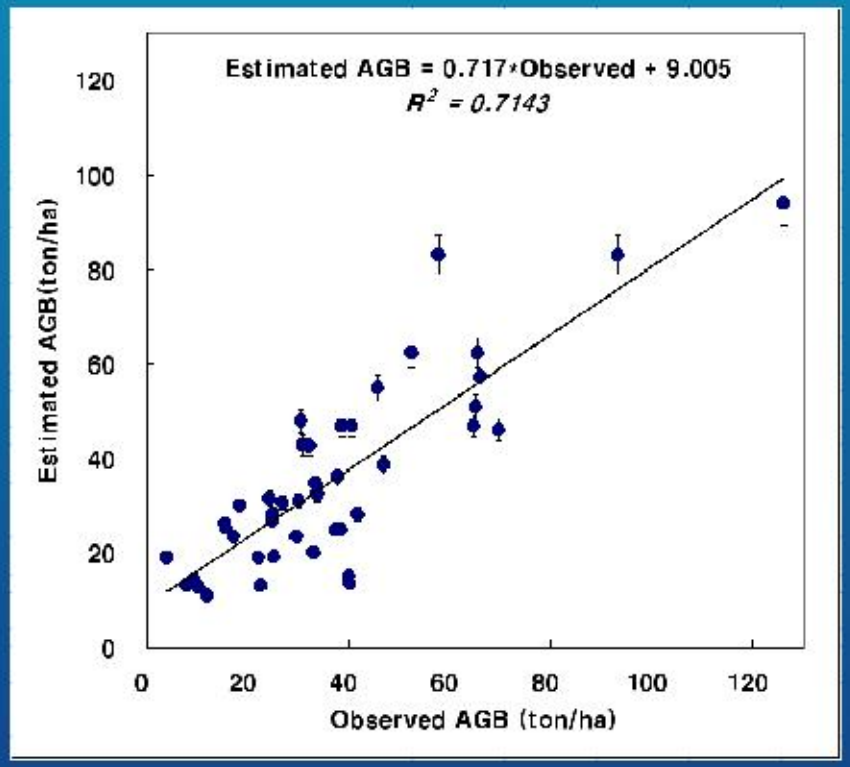


❖ Fuel type classification map

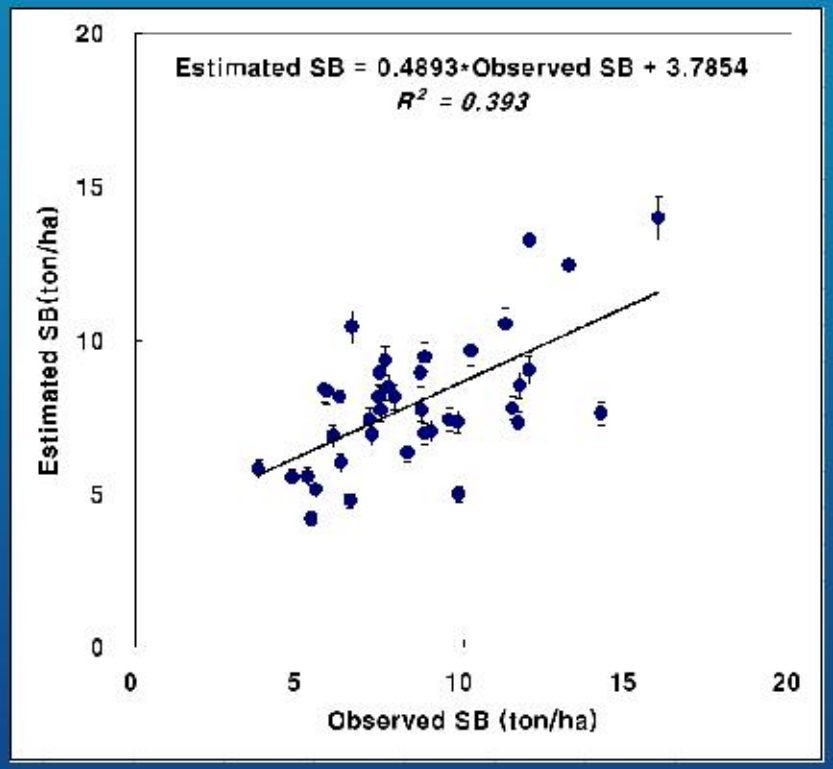
Fire & Fuel

Fuel type classification, Fuel map

○ AGB estimation of Coniferous forest (3 types)



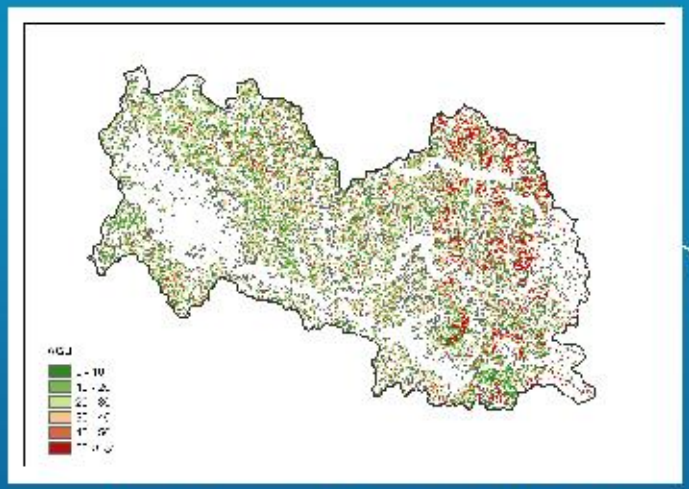
○ SB estimation of Coniferous forest (3 types)



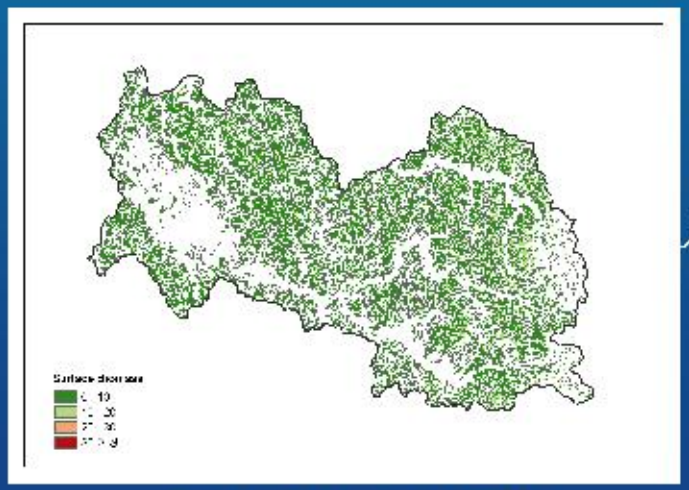
Fire & Fuel

Fuel type classification, Fuel map

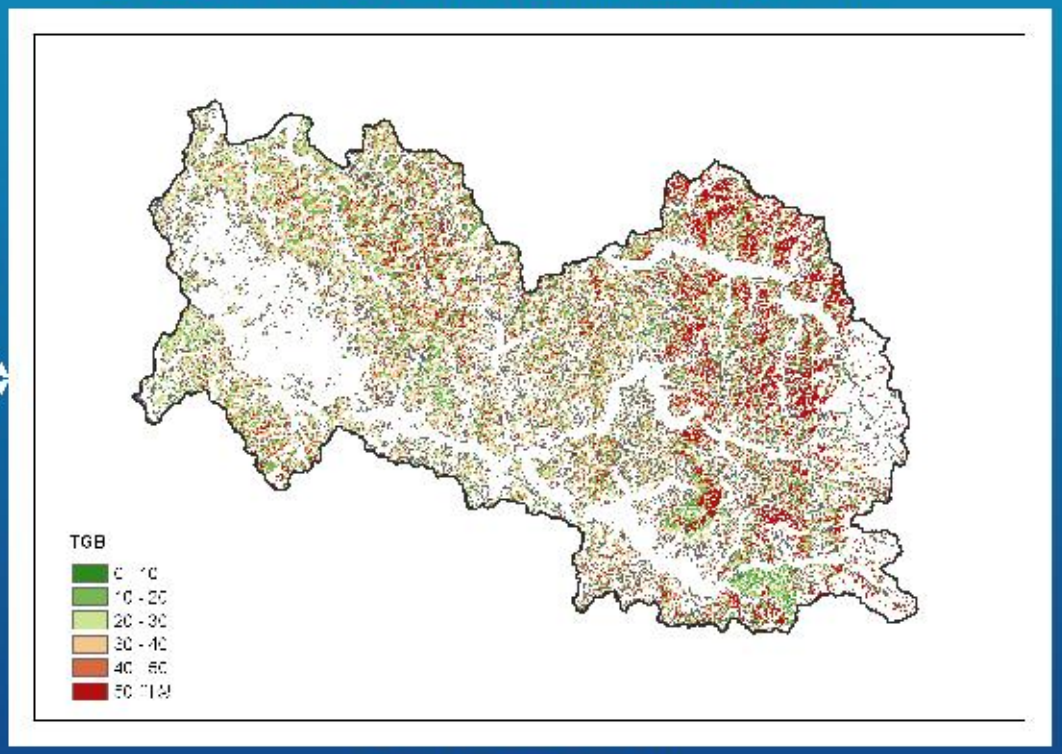
- C1 $AGB_{estimated}$: 59.3± 33.2 ton/ha, Max. 128.9 ton/ha
- C2 $AGB_{estimated}$: 16.7± 10.2 ton/ha, Max. 100.5 ton/ha
- C3 $AGB_{estimated}$: 34.4± 10.8 ton/ha, Max. 57.8 ton/ha



Aboveground biomass(AGB)



Surface biomass(SB)



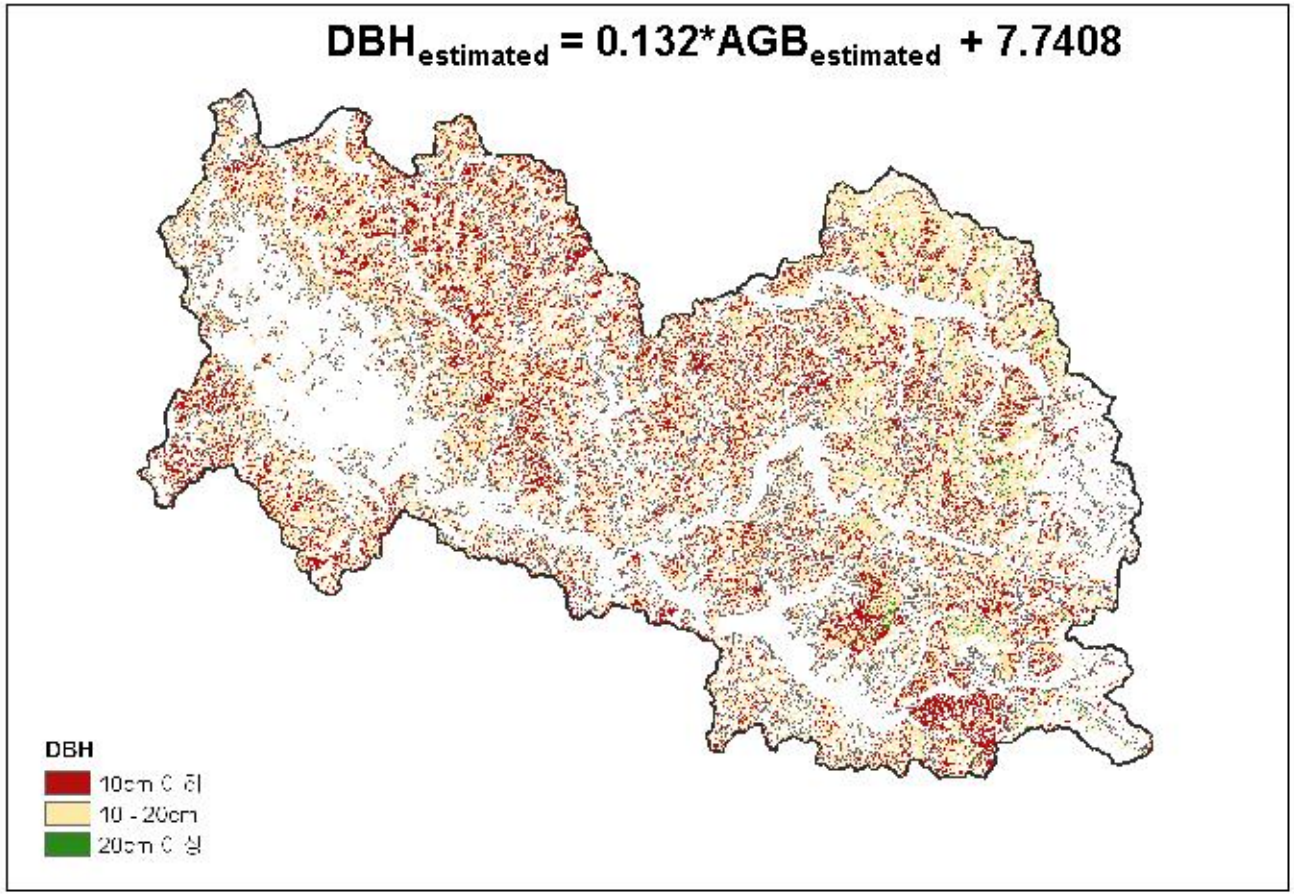
Total biomass(TB)

Fire & Fuel

Fuel type classification, Fuel map

○ DBH map of coniferous forest estimated

$$DBH_{estimated} = 0.132*AGB_{estimated} + 7.7408$$



Research Plan

- Evaluation of hazards potential and fire occurrence pattern prediction
- Evaluation of fire hazards on changing fuel load
- Web-based forest fire occurrence location information systems(FOLIS)
- Developing evaluation model by short-and-middle term forest fire occurrence senarios

Q & A

Thank you for attention !