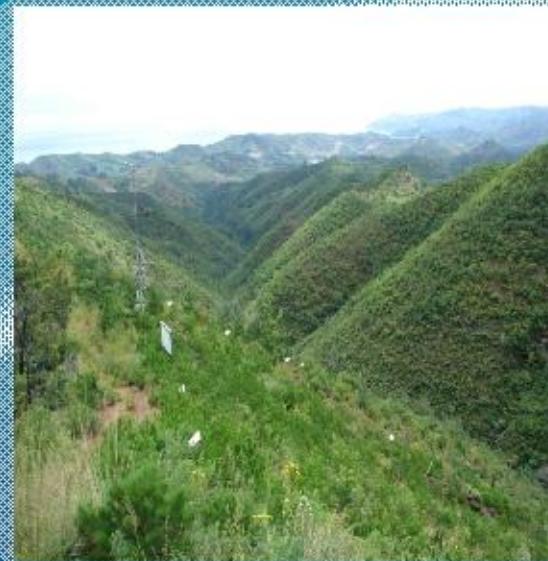


The Space and Time Evaluation of Forest Fire Occurrence Hazards Using Climate Data of Ten-day Intervals 30 Years in Spring, Korea



**WON, Myoung Soo¹, Kyo Sang KOO¹,
Myung Bo LEE¹, Woo Kyun LEE²,
Suk Hee YOON¹**

¹ Korea Forest Research Institute

² Korea University



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Contents

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



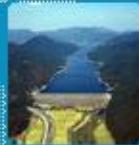
Introduction

● **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**

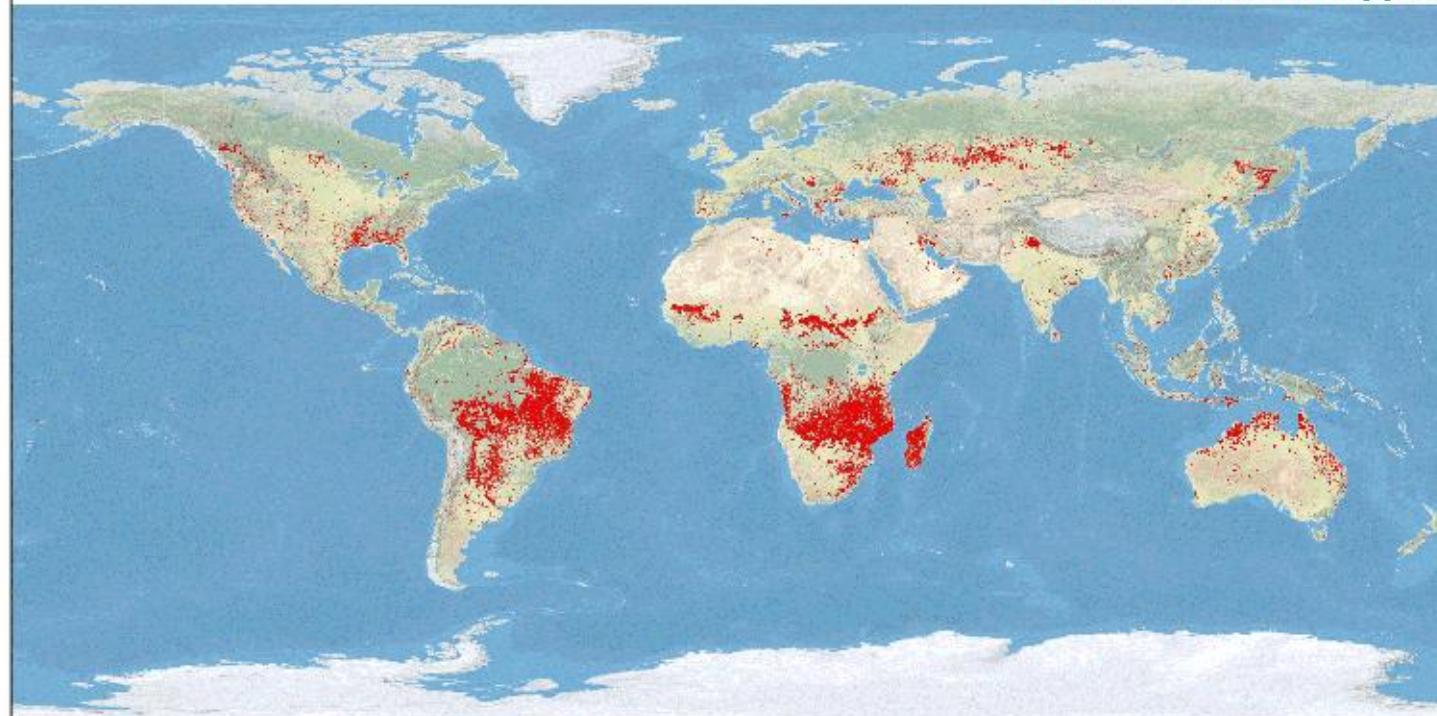
- ⇒ Increase possibilities of large-sized forest disaster such as forest fire, landslide and forest disease/insect. etc.
- ⇒ Needs to develop social disaster prediction techniques



Introduction

MCDIS Rapid Response Active Fire Detections for 2006

From : Web Fire Mapper

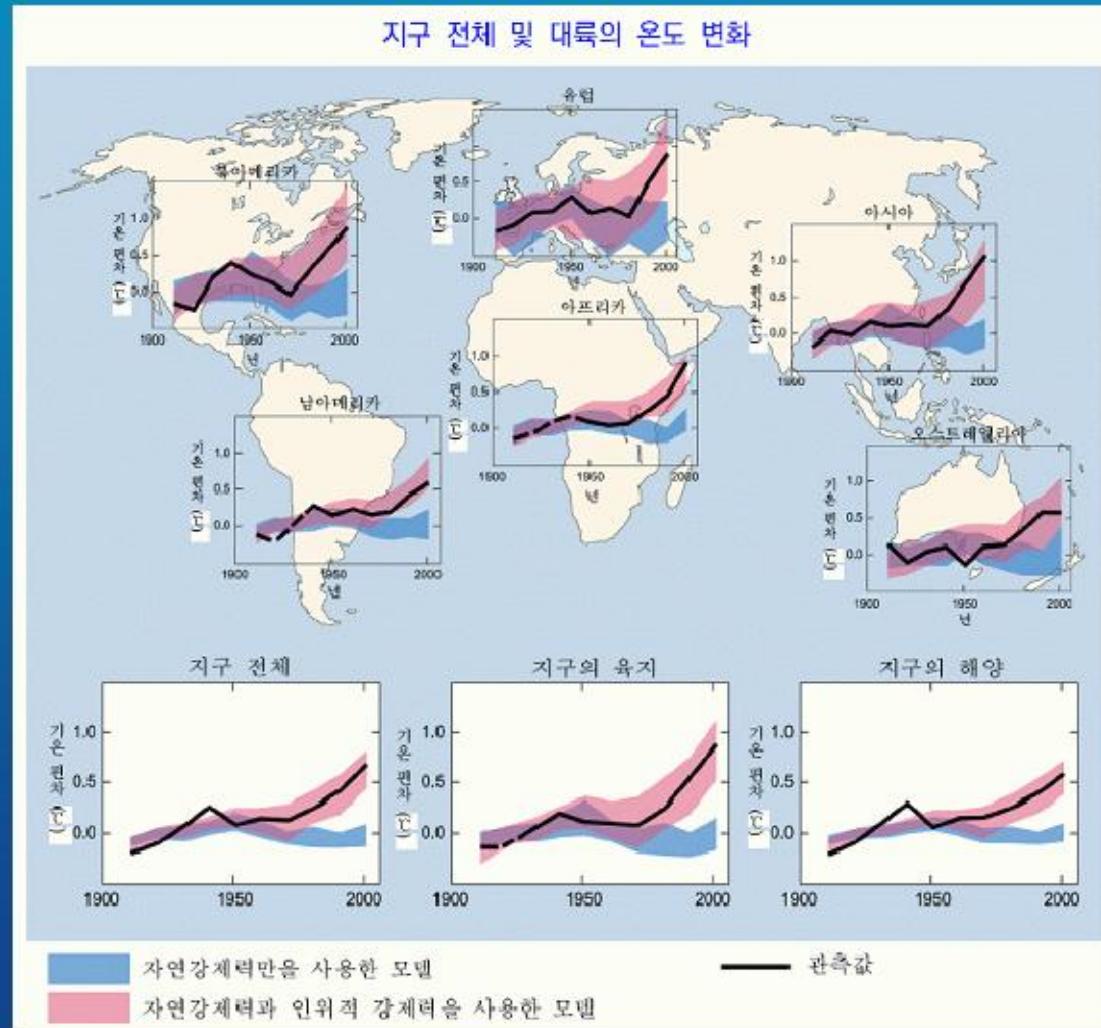


January February March April May June July August September October November December



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>

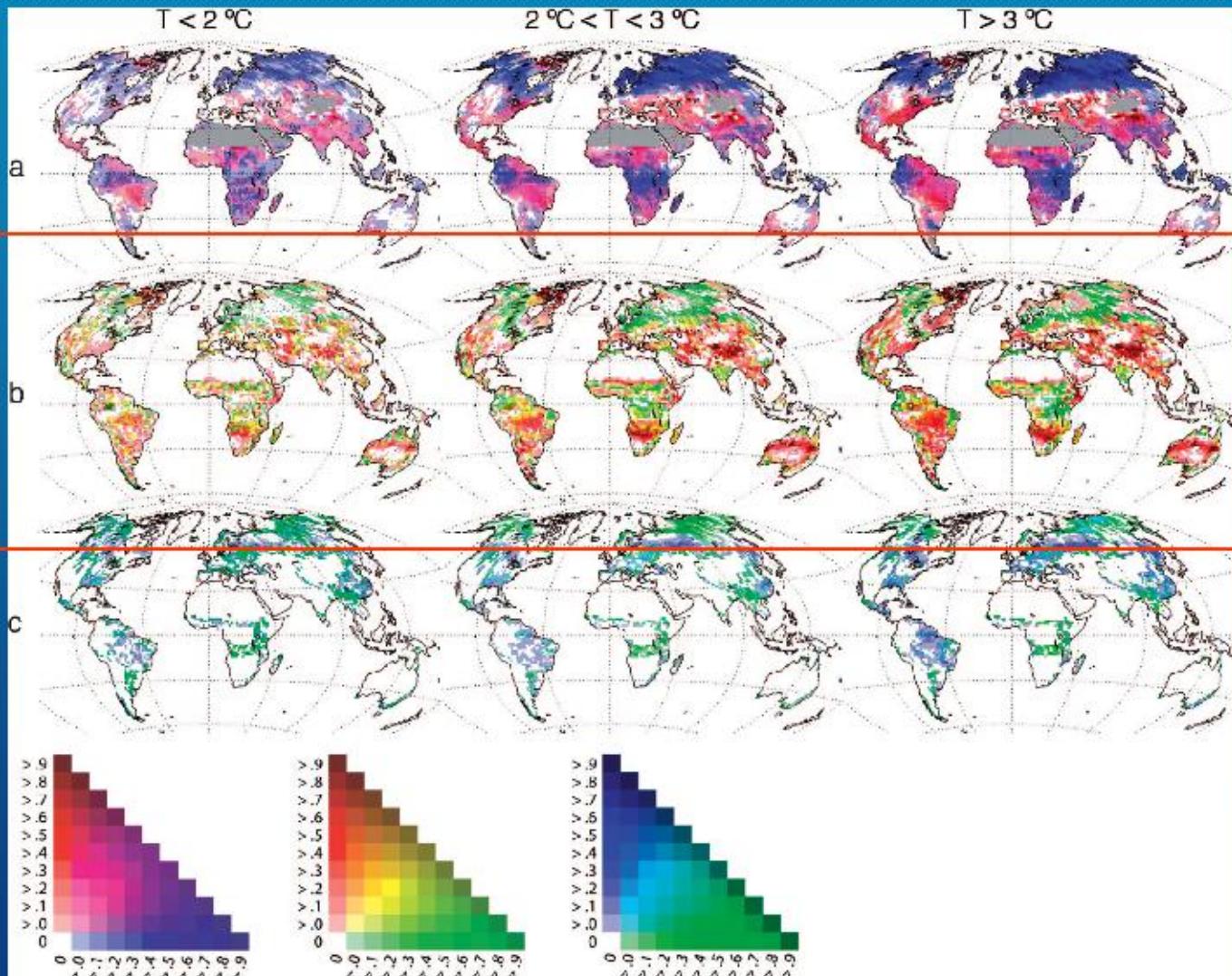
Introduction



(IPCC 2007, KMA)



Introduction

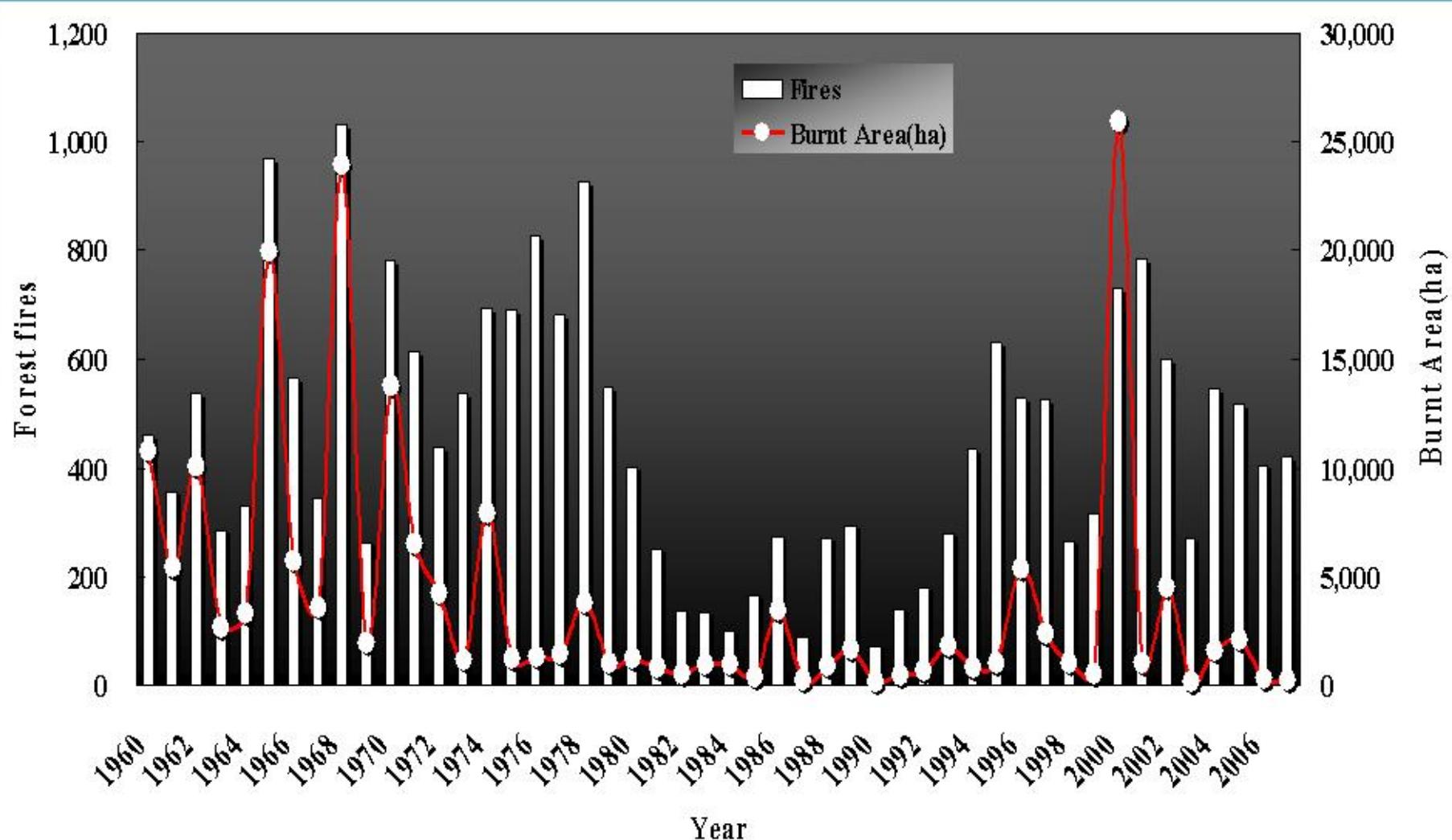


- Report for fire effects and terrestrial forest ecosystems(Southampton, 2006)



Introduction

Fire Status, Korea



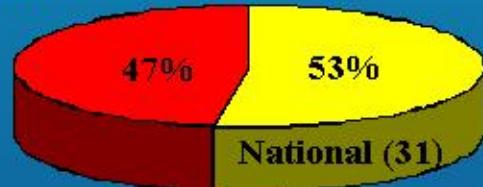


Introduction

Large fire distribution(30ha over)

Fire Number

East Coast (28)

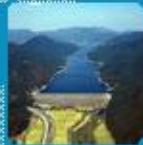


Burned Area

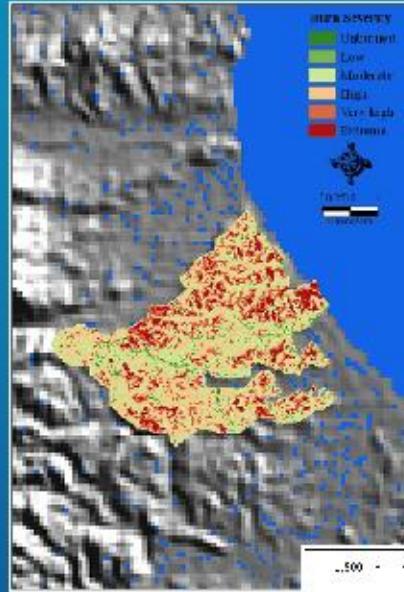
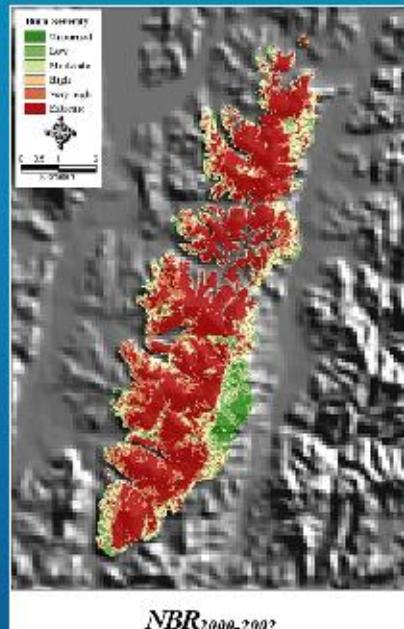
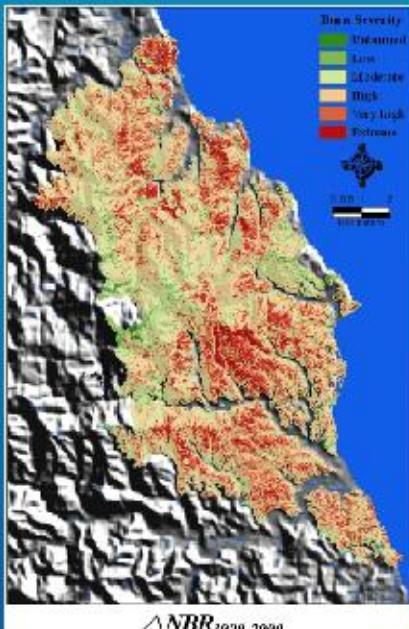
National(36,918ha)







Introduction Damaged area/Burn severity(NBR)

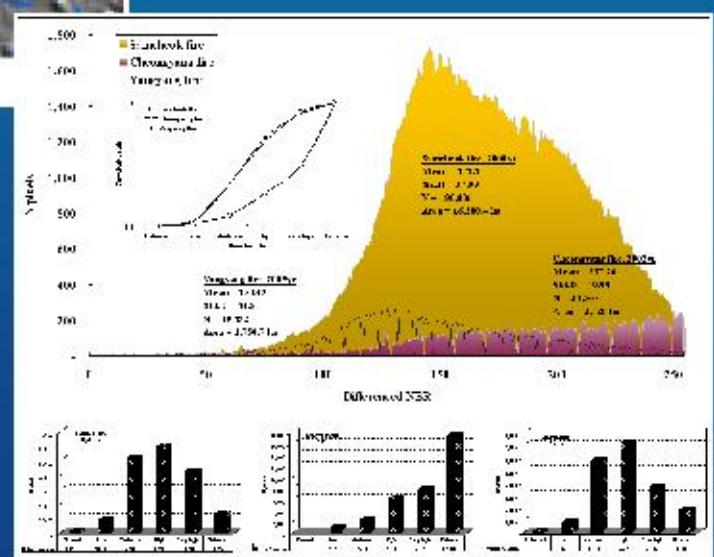


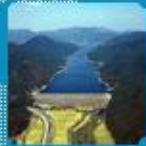
❖ NBR & ΔNBR

☞ Key and Benson 2002, 2006 (USFS RMRS)

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

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

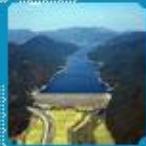




Introduction *Non-CO₂ Emissions from Biomass burning*

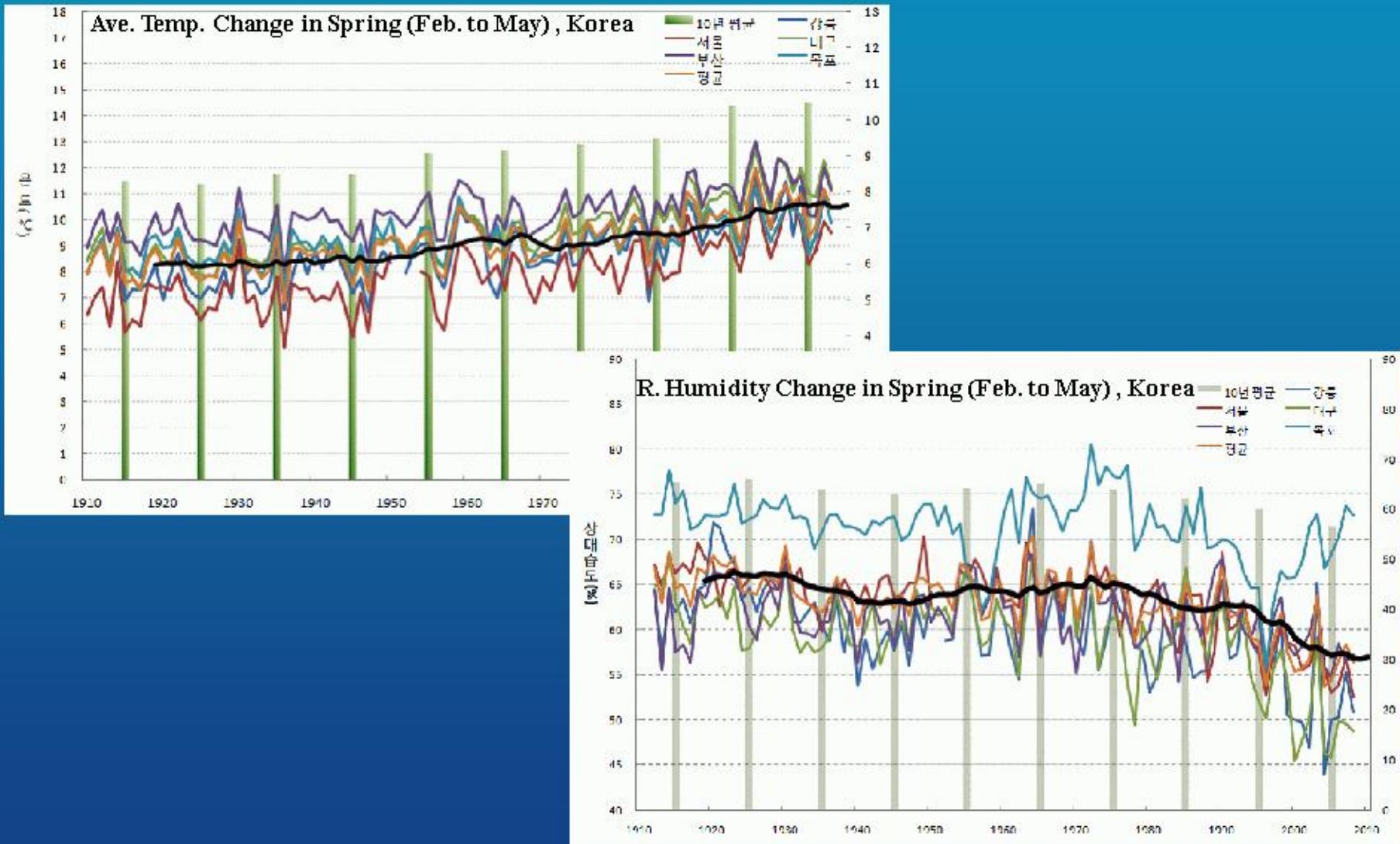
Classes	(Unit: Gg yr ⁻¹)									
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
CH ₄	1.11	0.52	0.26	14.85	0.58	2.82	0.09	1.09	1.47	0.19
CO	16.04	7.45	3.72	214.56	8.38	40.80	1.26	15.78	21.24	2.71
N ₂ O	0.01	0.01	0.00	0.18	0.01	0.03	0.00	0.01	0.02	0.00
NO _x	0.09	0.04	0.02	1.16	0.05	0.22	0.01	0.08	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

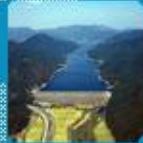
The results of applying IPCC Guidelines(2003 GPG, 2006 GL) equation to estimate non-CO₂ greenhouse gases emissions from biomass burning in South Korea is released 93% of CO, 6.4% of CH₄, 0.5% of NO_x, and 0.5% of N₂O in order.



Fire & Climate

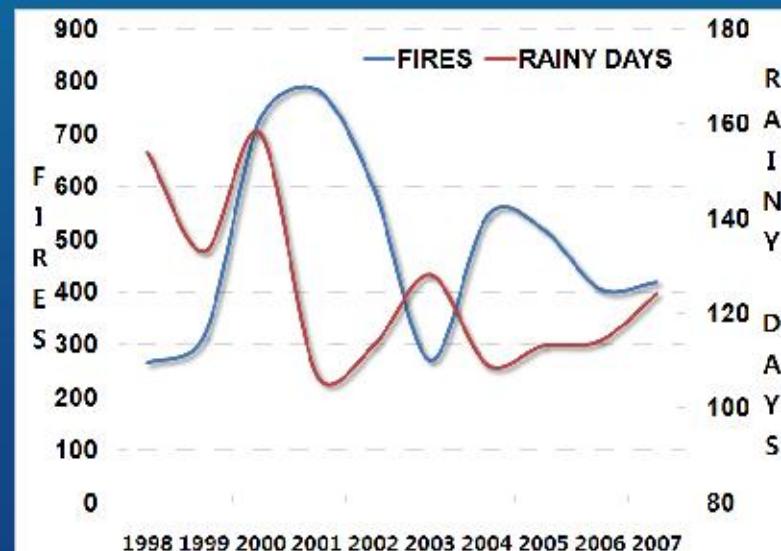
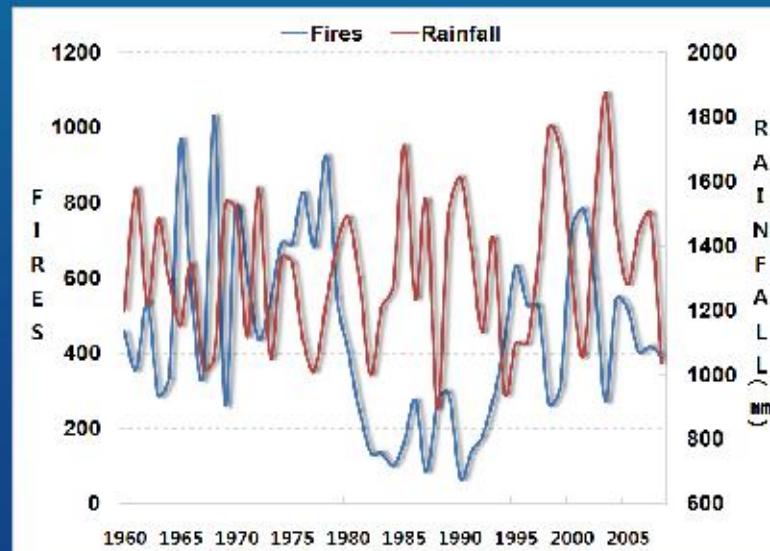
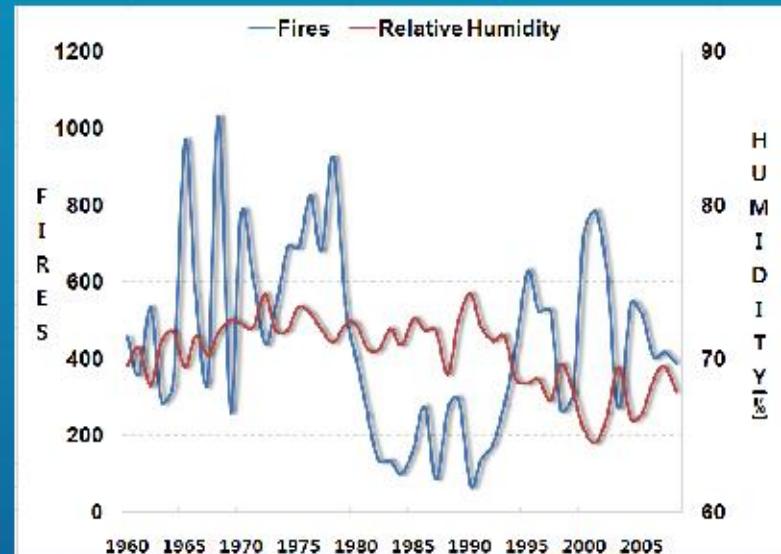
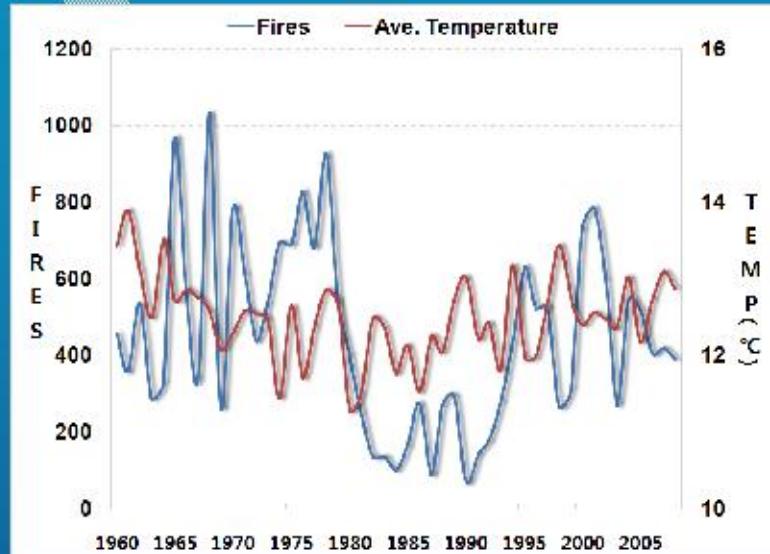
Climate change in Spring, Korea





Fire & Climate

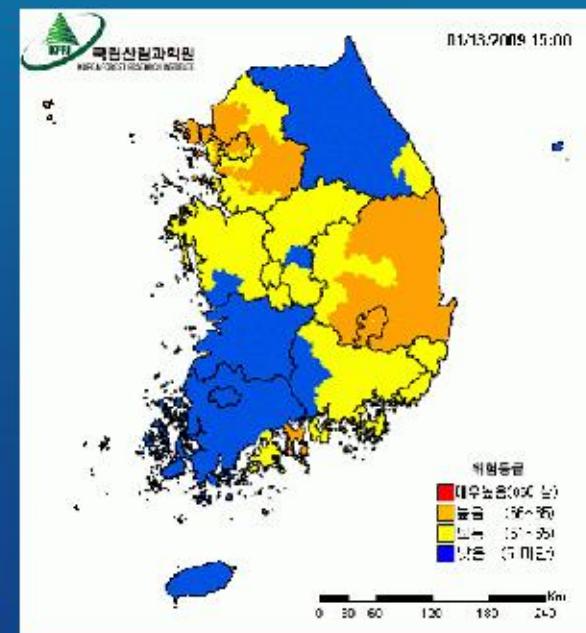
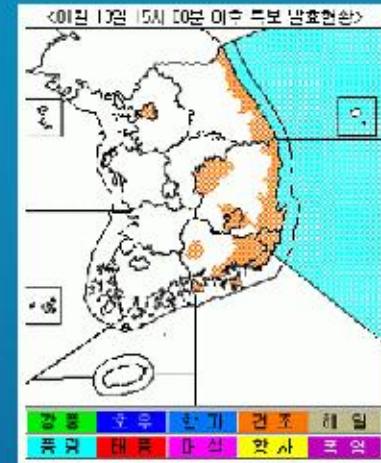
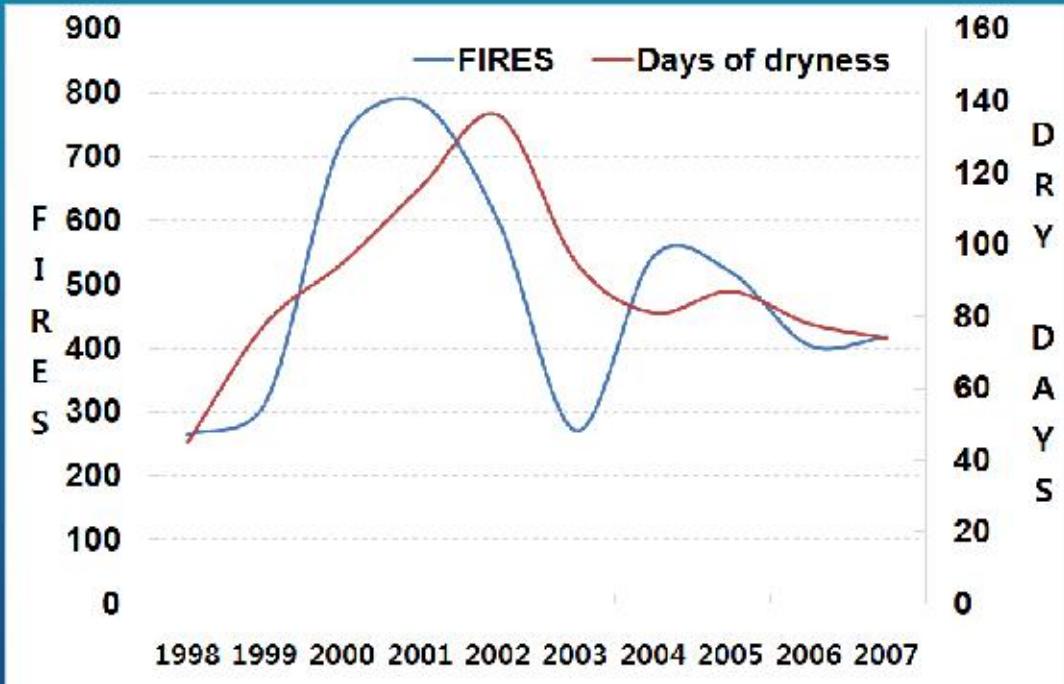
Fire frequency on Climate change





Fire & Climate

Fire frequency on Climate change

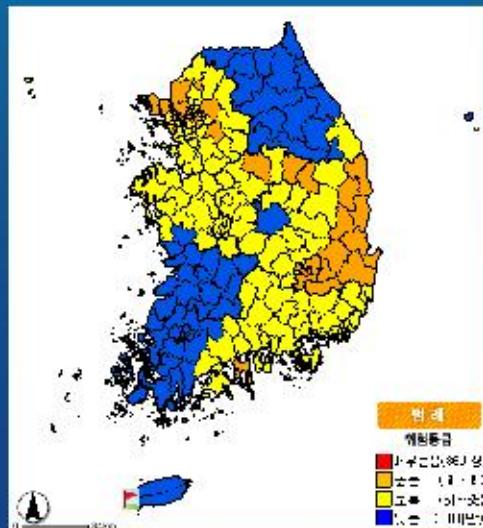
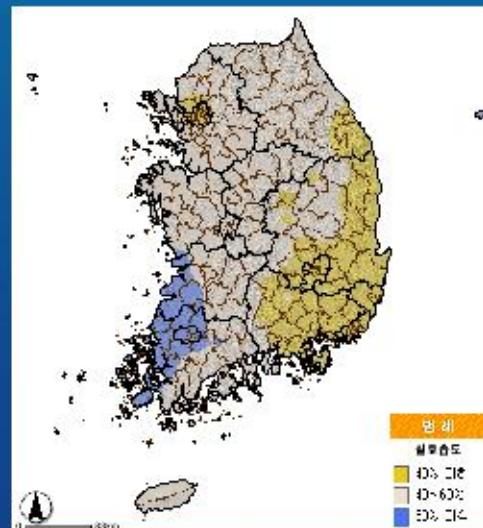
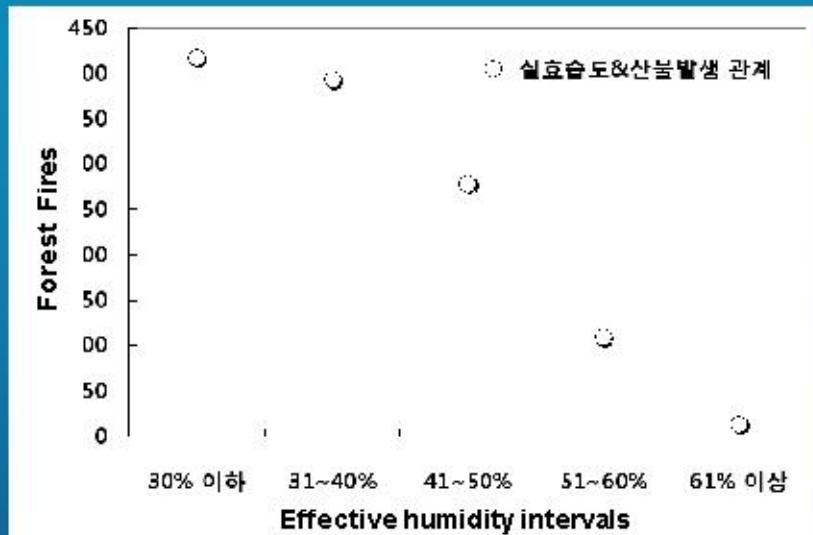
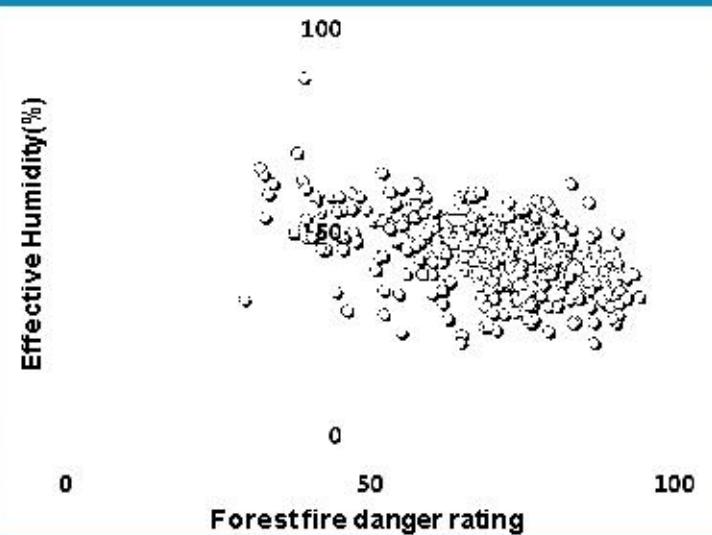


Forest fire danger rating



Fire & Climate

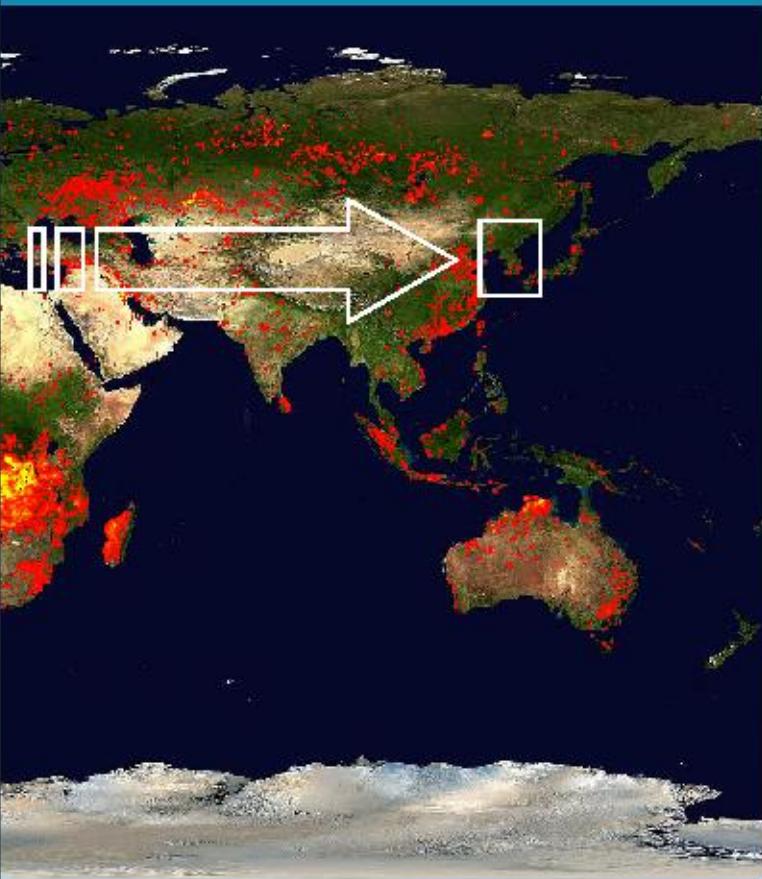
Fire frequency on Climate change





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

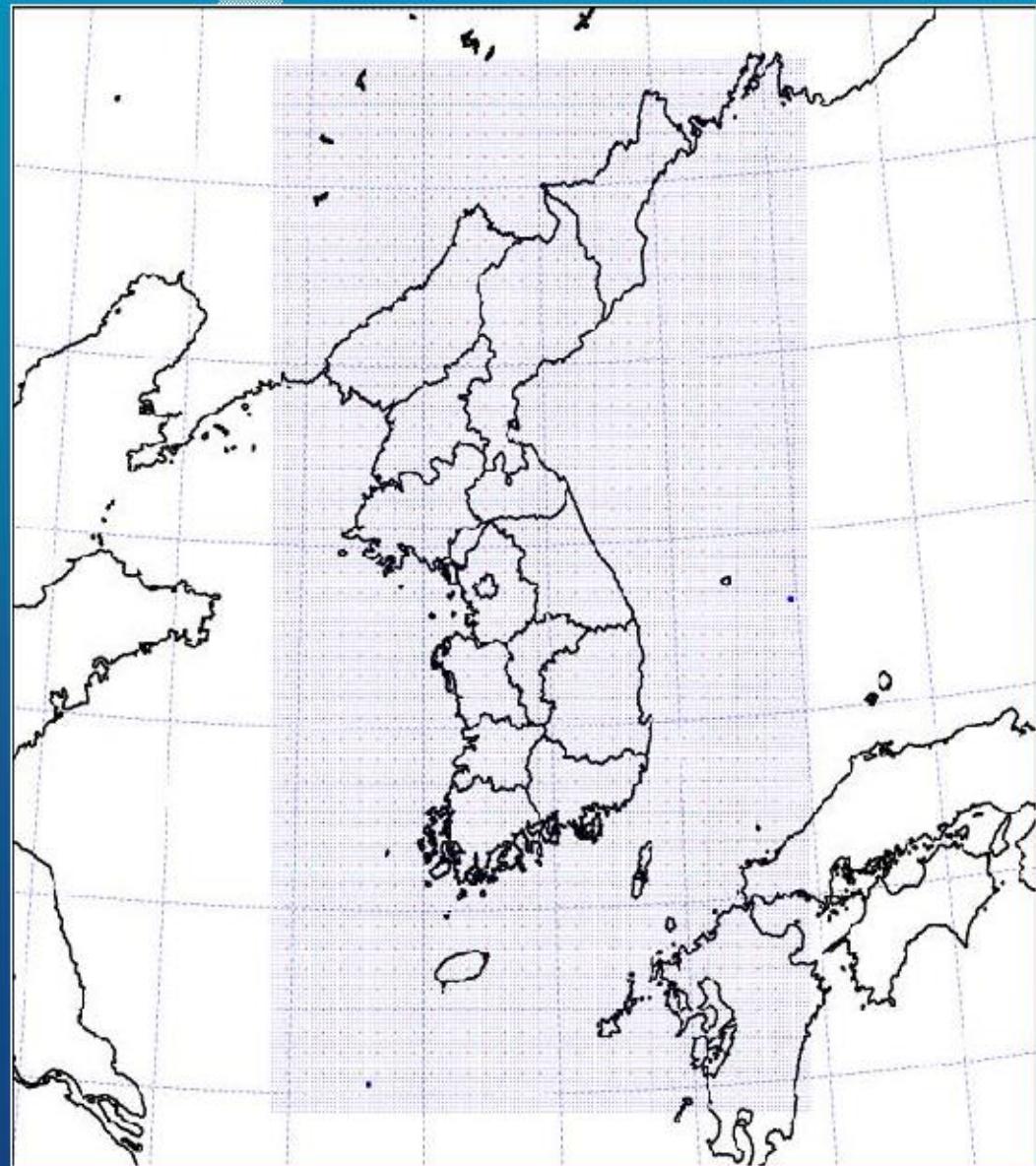
Application of digit weather forecast data





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

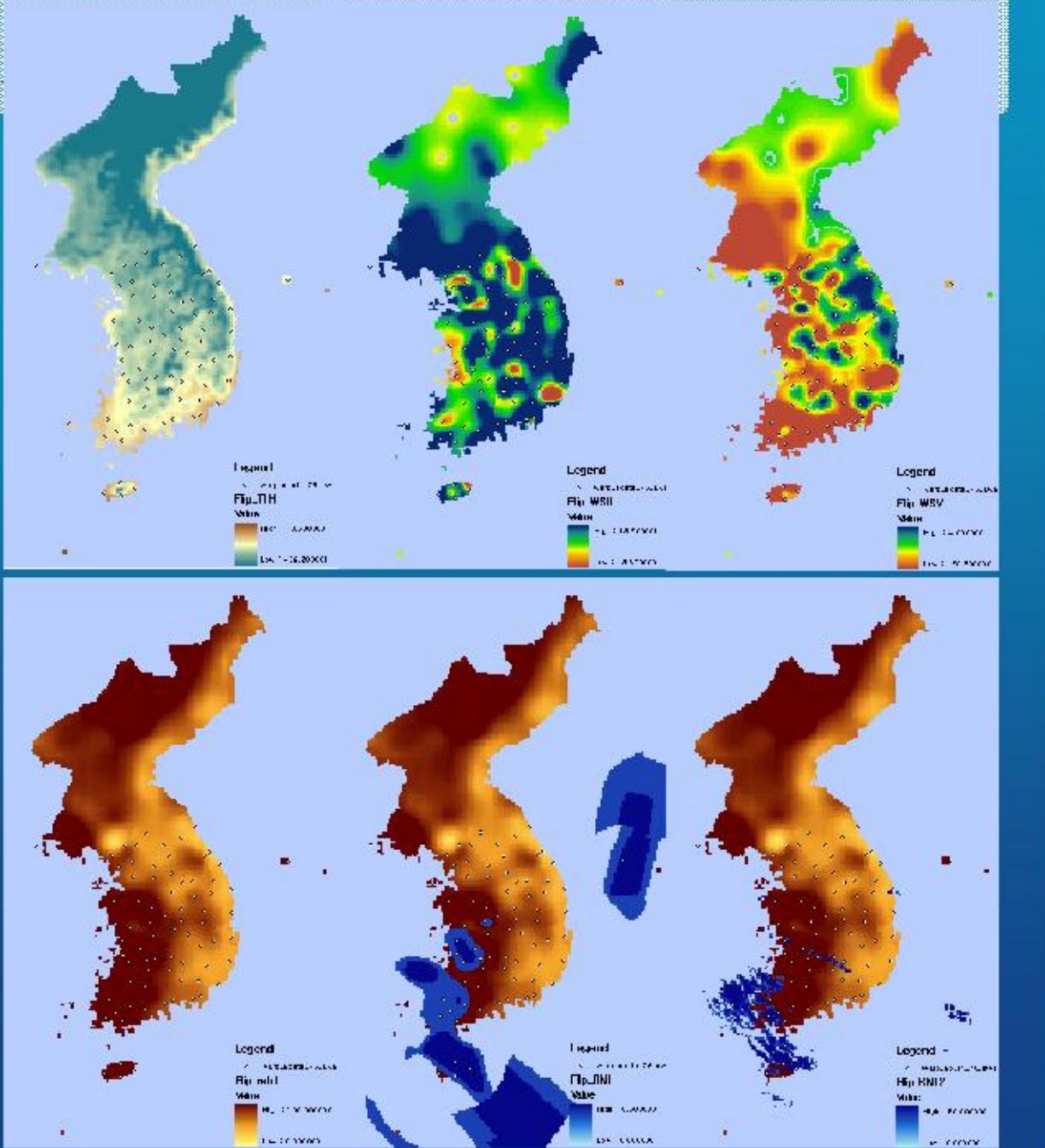


Fire & Cli

- ❖ Building of fire weather data using digit weather

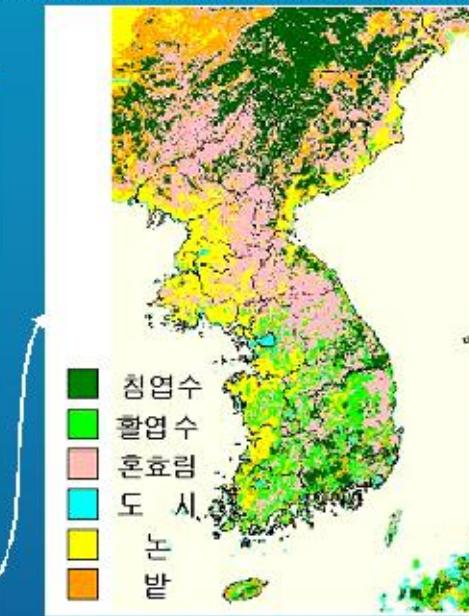
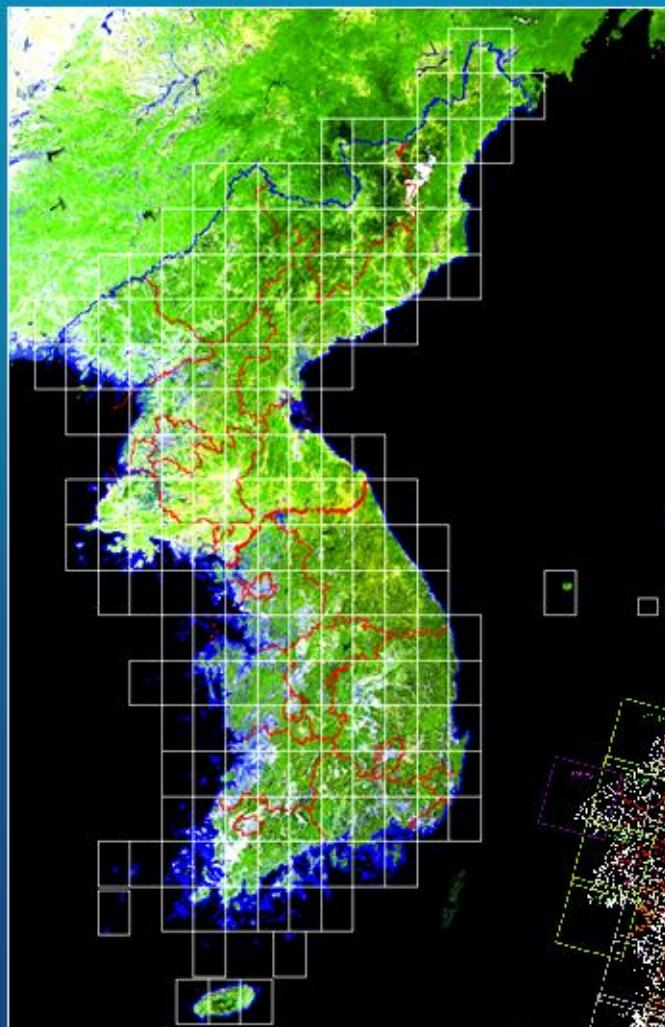
(2005.12.12 . 08:00)

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

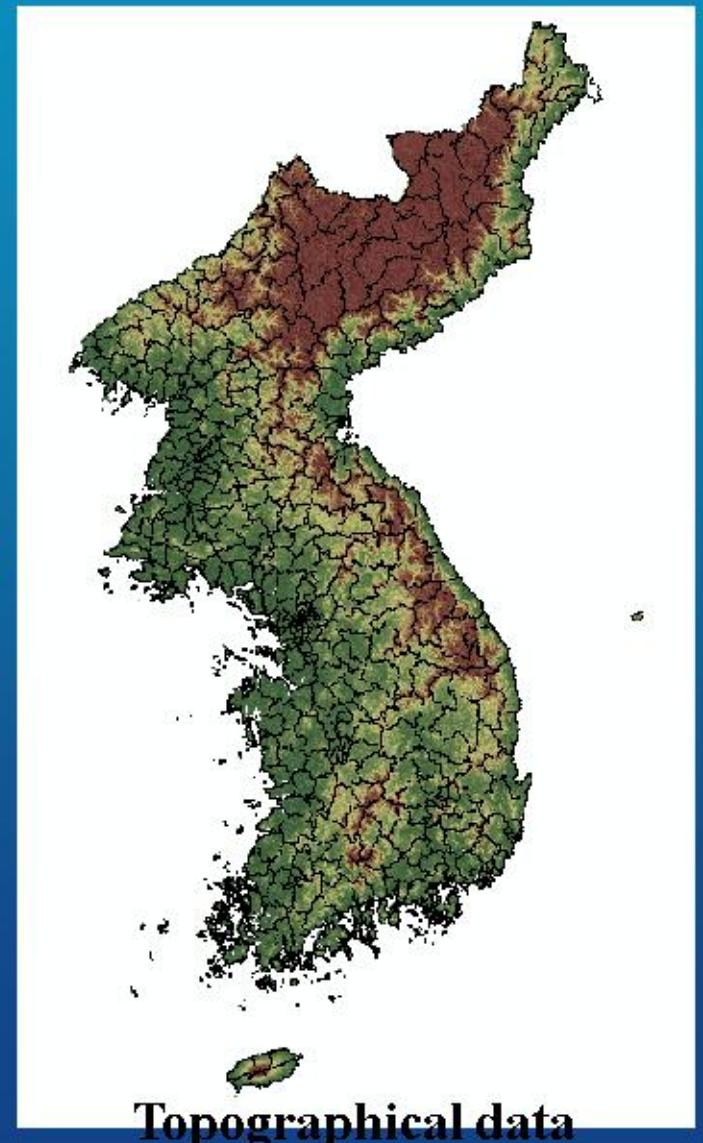




Fire & Climate Fire Danger Rating in Korean Peninsula



Fuel data

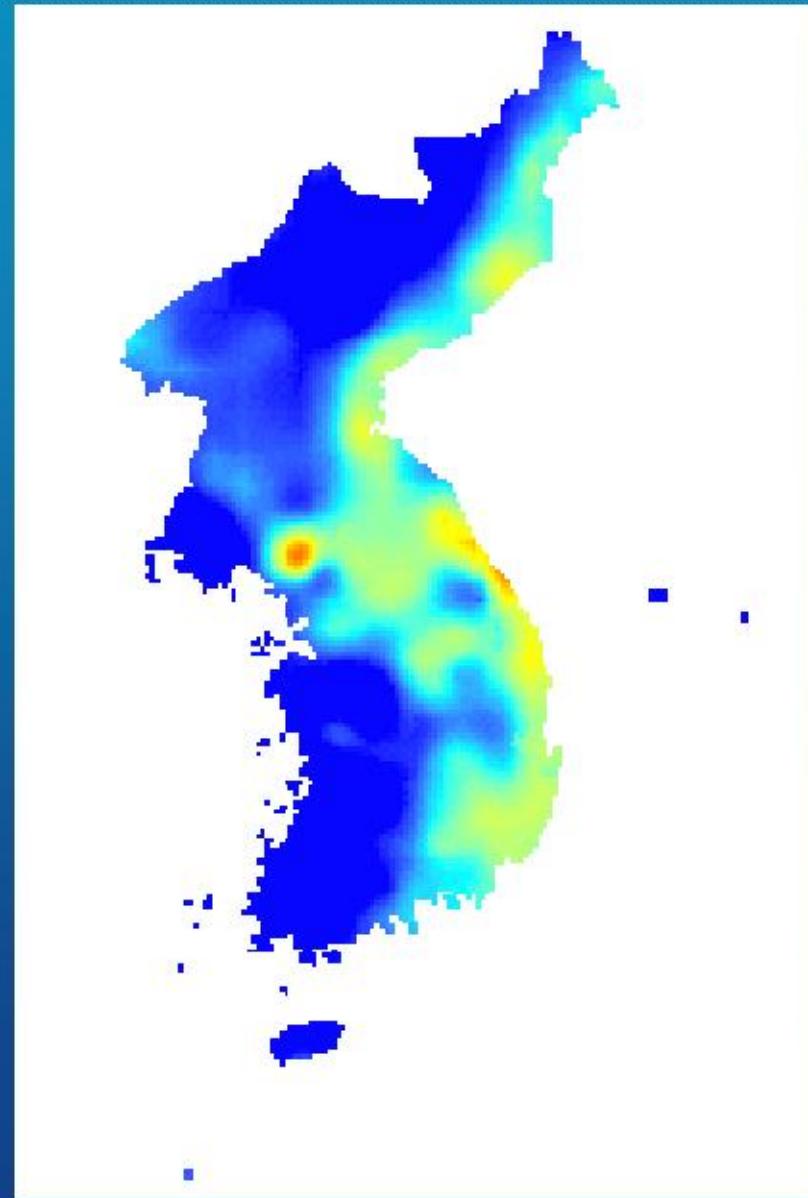


Topographical data



Fire & Climate Fire Danger Rating in Korean Peninsula

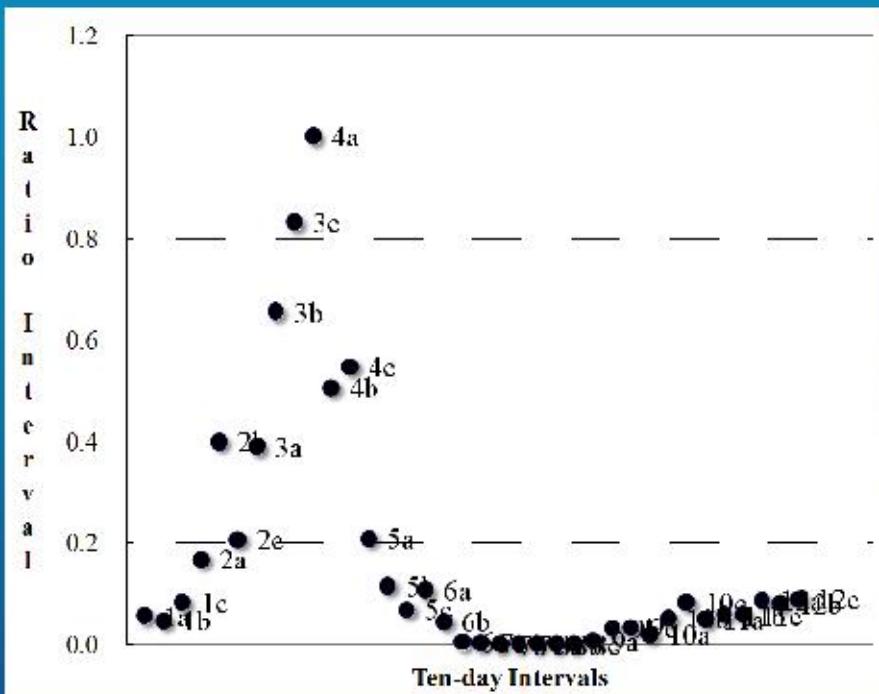
Forest Fire danger rating in Korean Peninsula





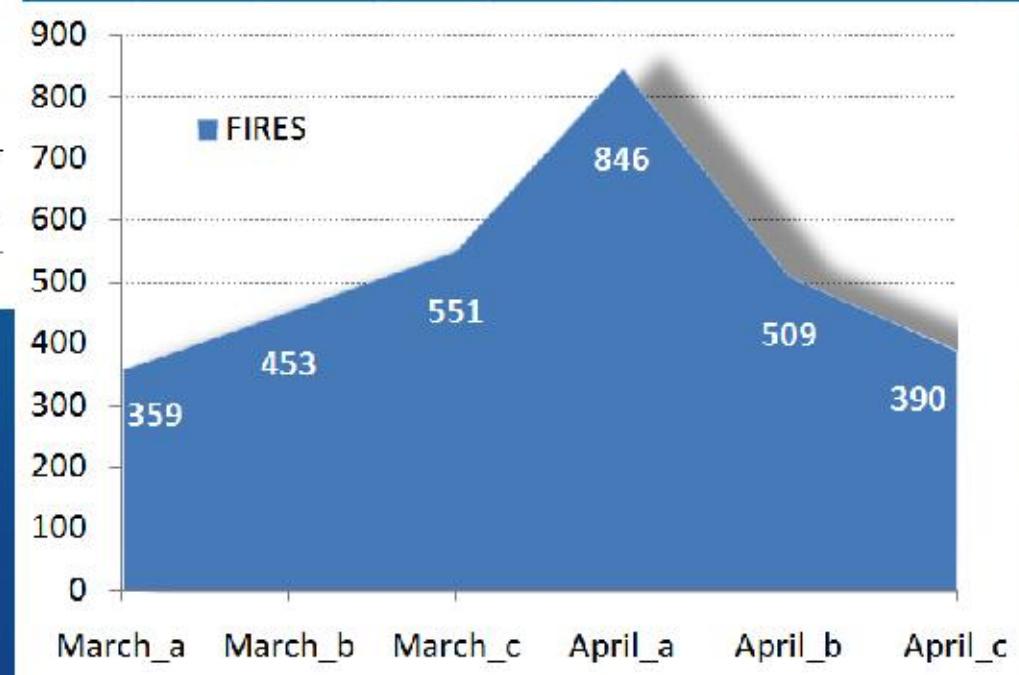
Fire Occurrence Hazard

Methods



Ratio Intervals of JAN to DEC, 10 yrs

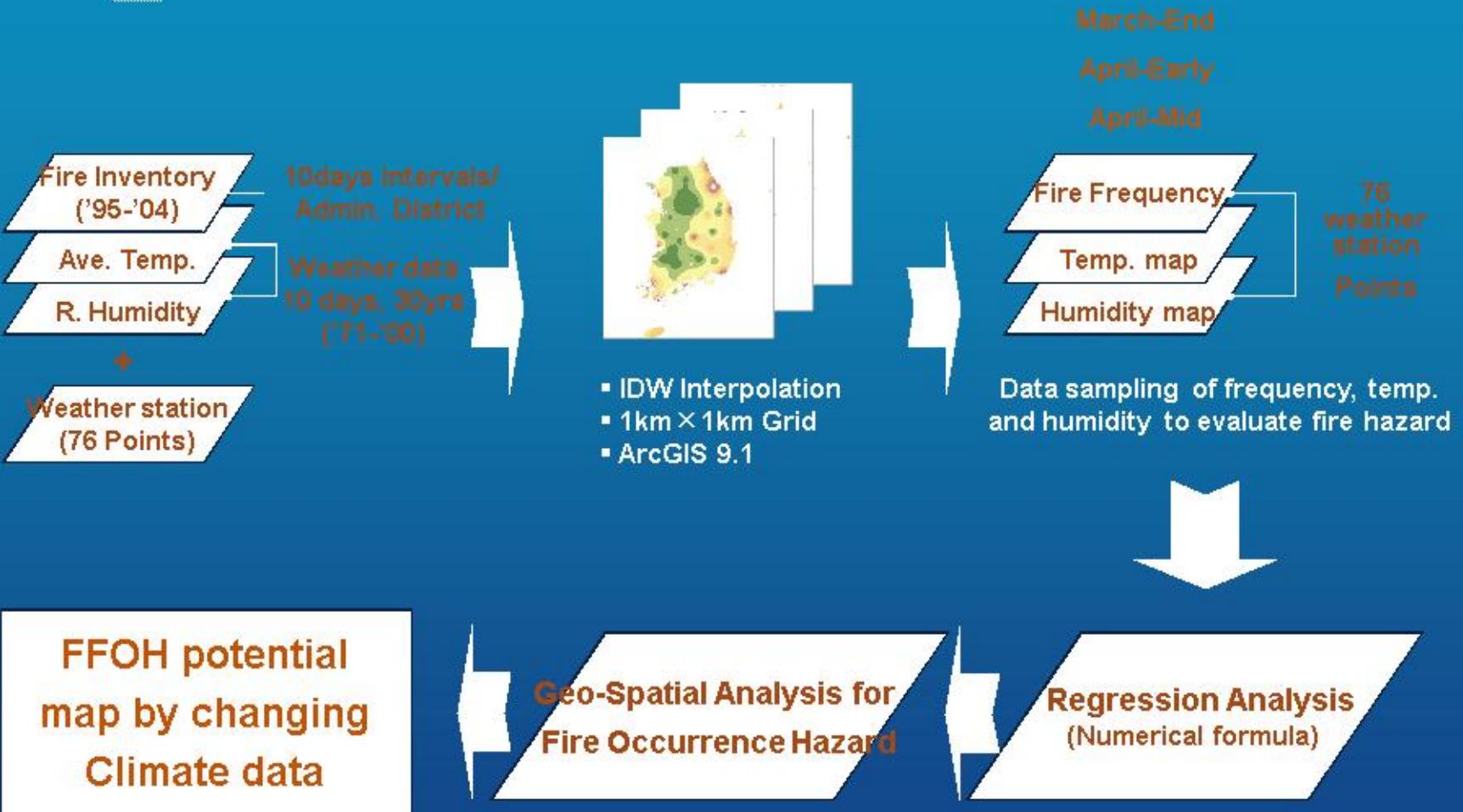
Cumulative Fires of 10 day intervals during MAR to APRIL, Extreme Fire Season

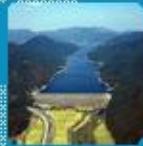




Fire Occurrence Hazard

Methods

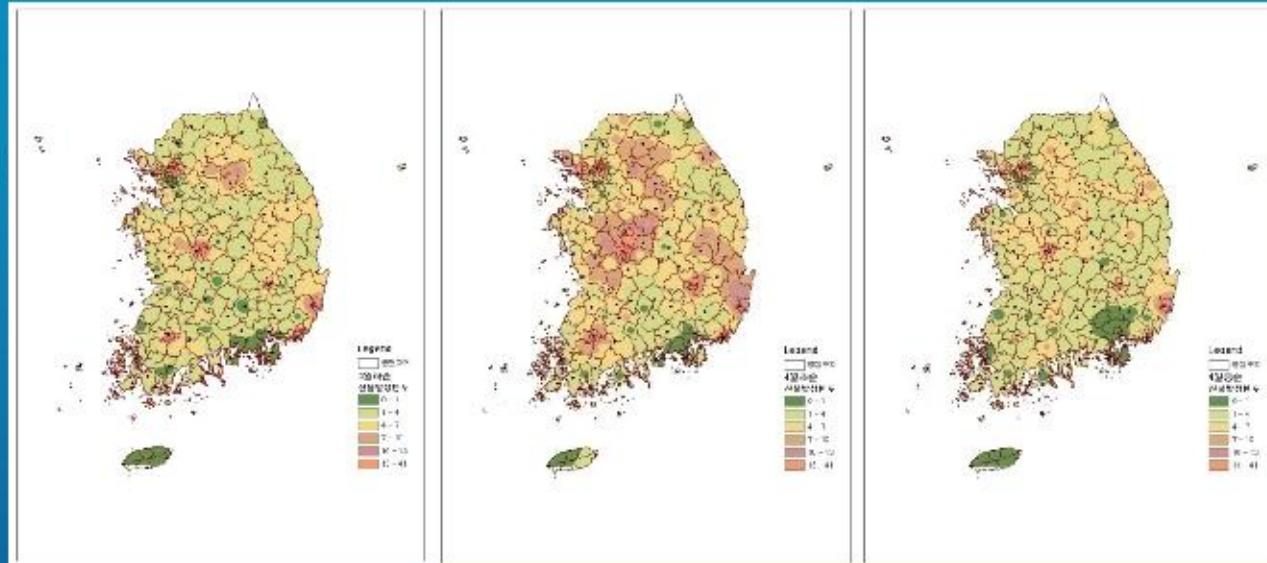




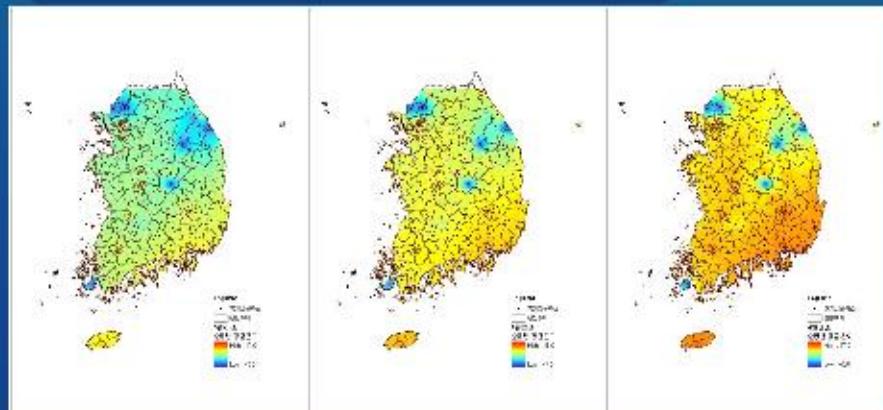
Fire Occurrence Hazard

Results

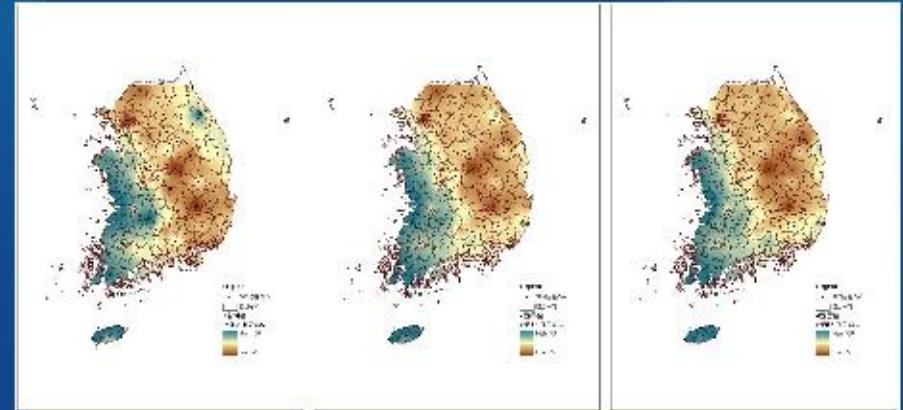
Fire frequency,
10-days intervals,
10 yrs



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



R. Humidity , 10-days intervals, 30 yrs

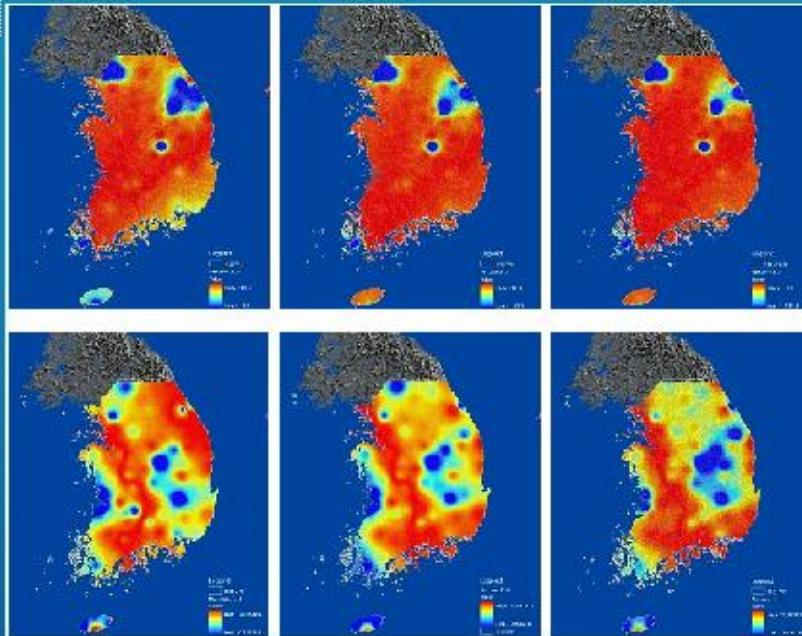


March end, April early, April mid



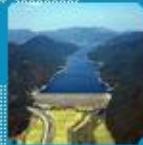
Fire Occurrence Hazard

Results



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





Fire Occurrence Hazard

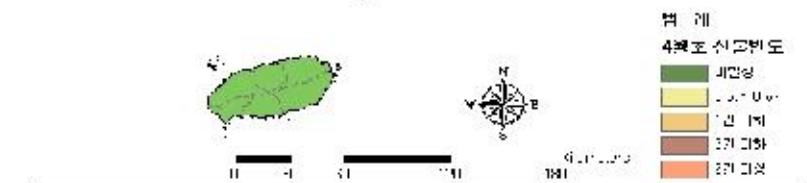
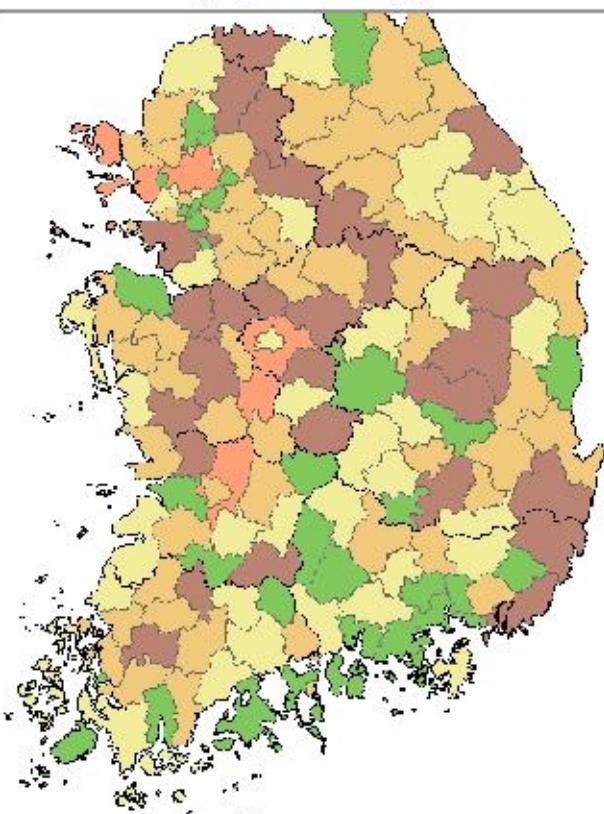
Results

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.

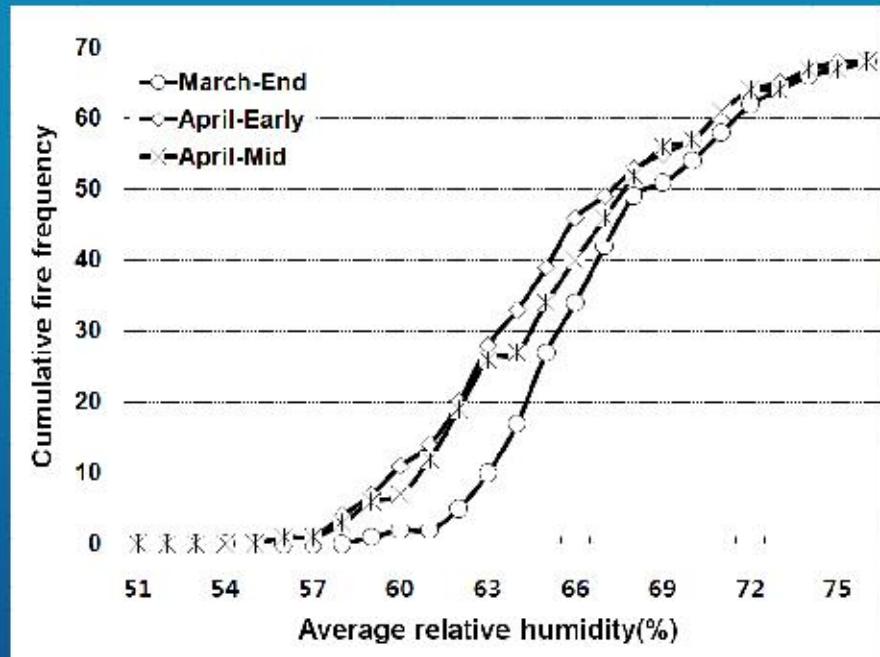
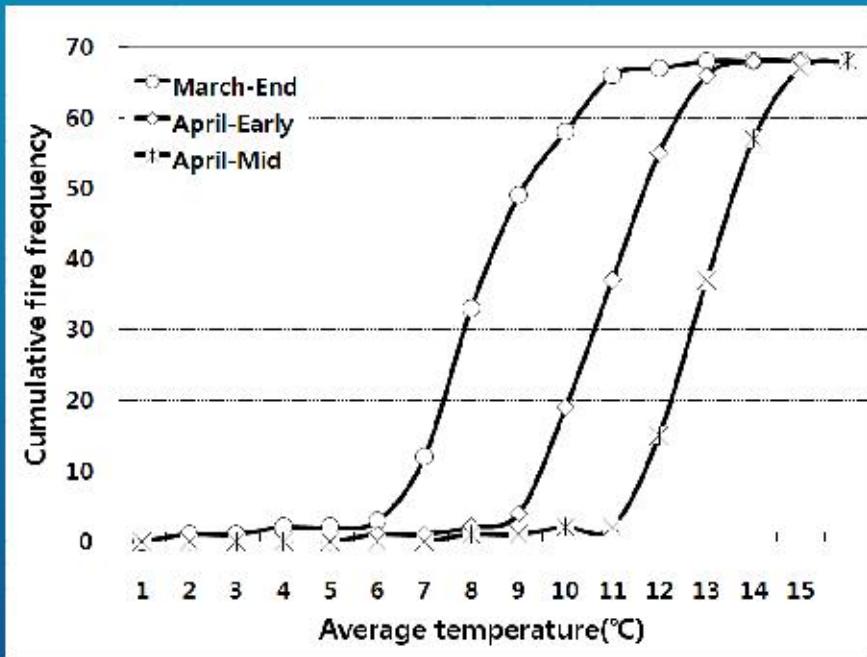
Fire Occurrence Hazard Map
(April Early)





Fire Occurrence Hazard

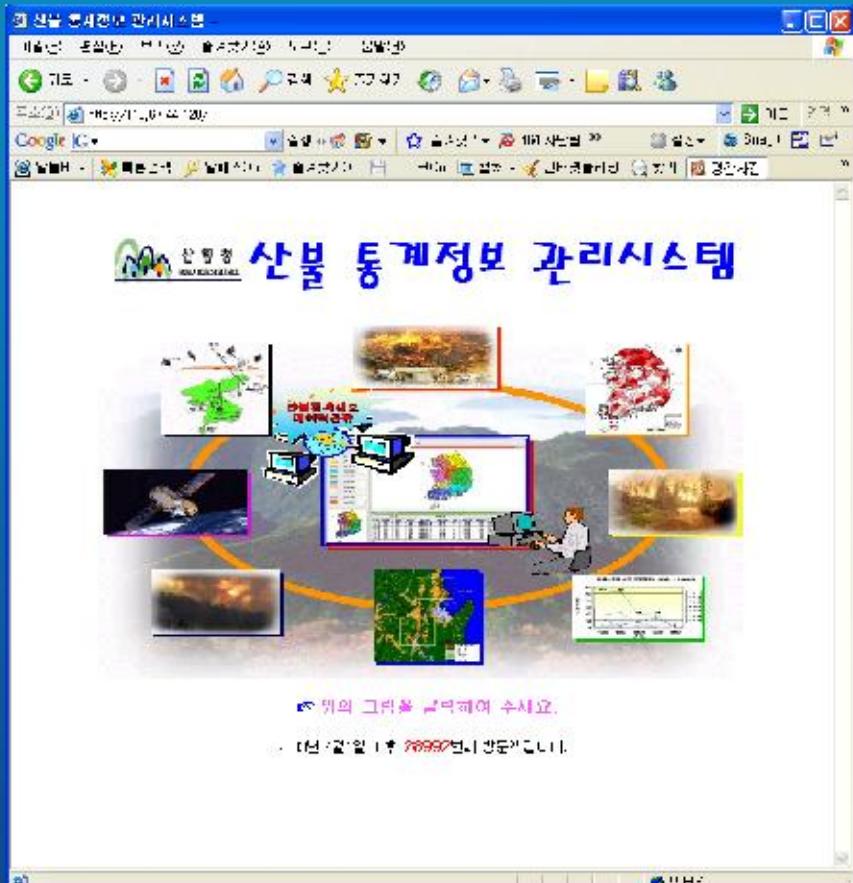
Results



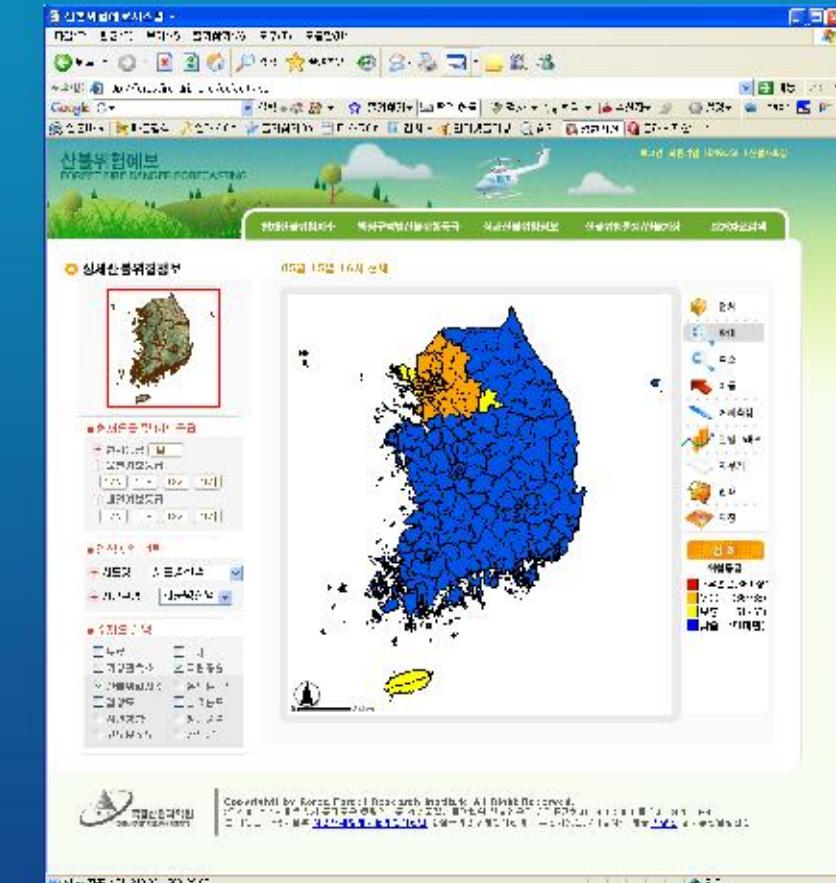
- Cumulative forest fire frequency by the change of temperature and relative humidity



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

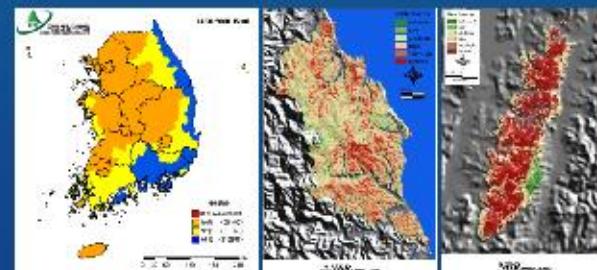
Satellite Images

- Landsat Mosaic



Forest fire DB

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

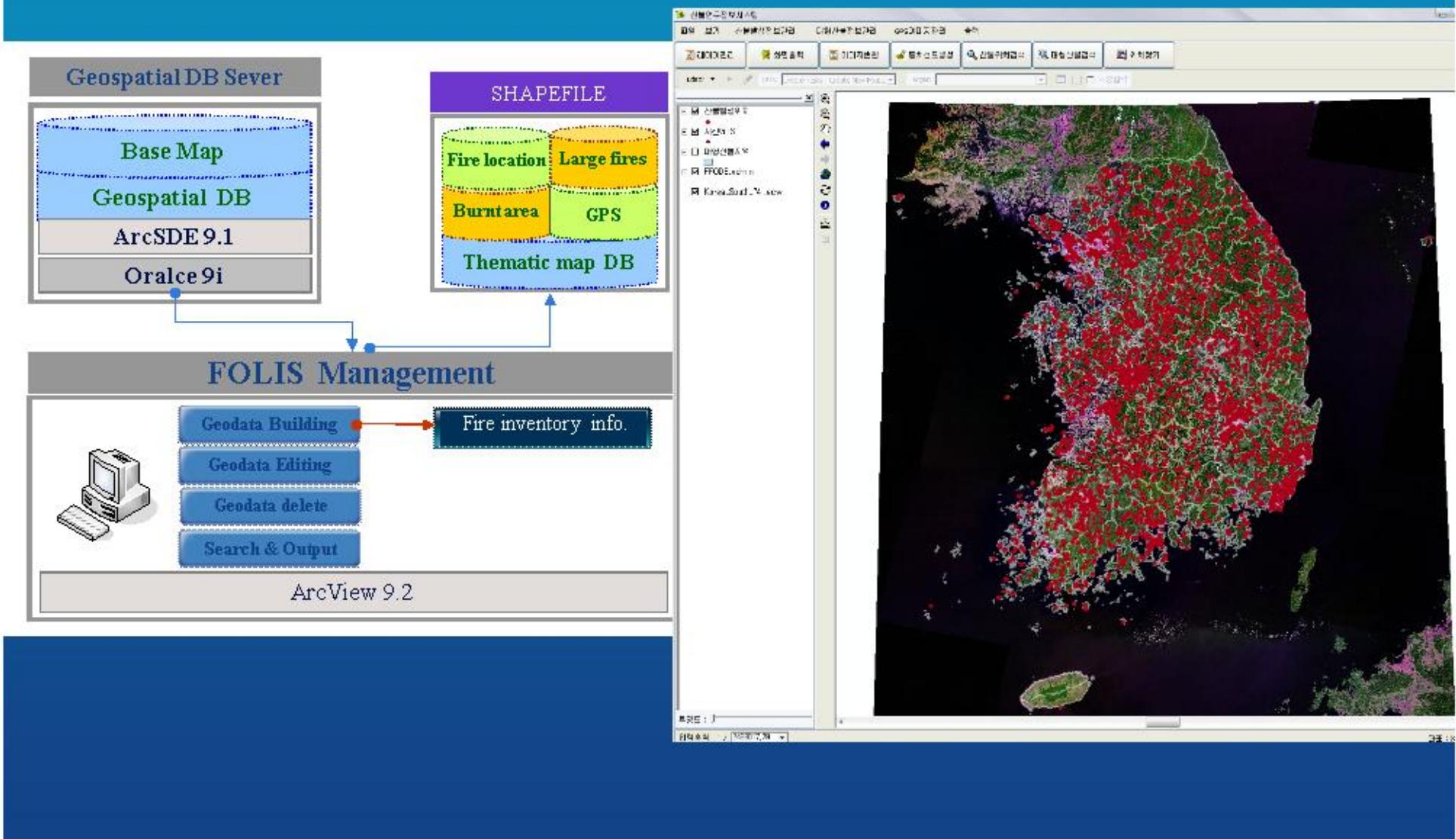


Reference Data

- 76 weather stations
- National park layer

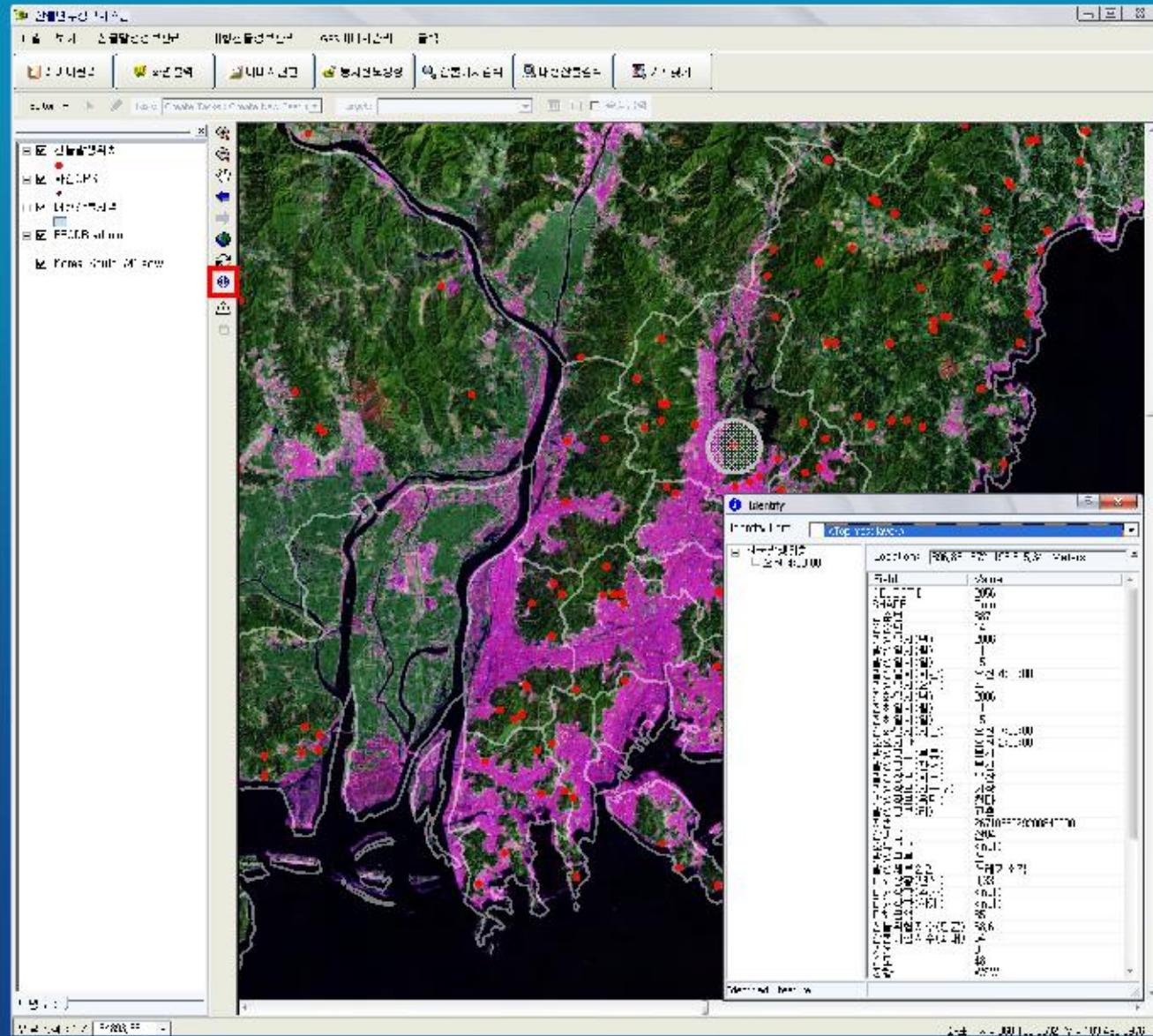


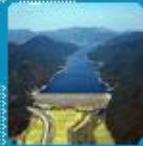
Forest fire and Geo-spatial data management



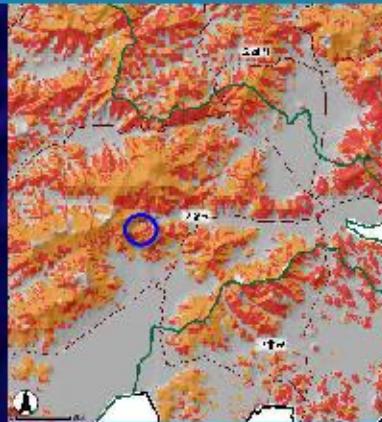


Forest fire and Geo-spatial data management





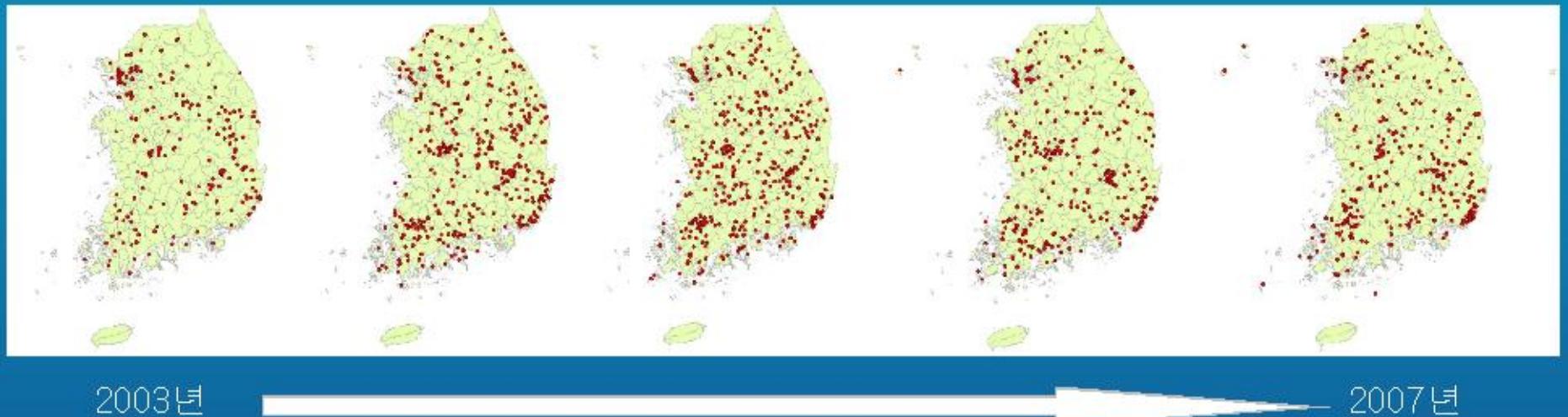
Forest fire and Geo-spatial data management



- ⦿ 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°C
 - 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

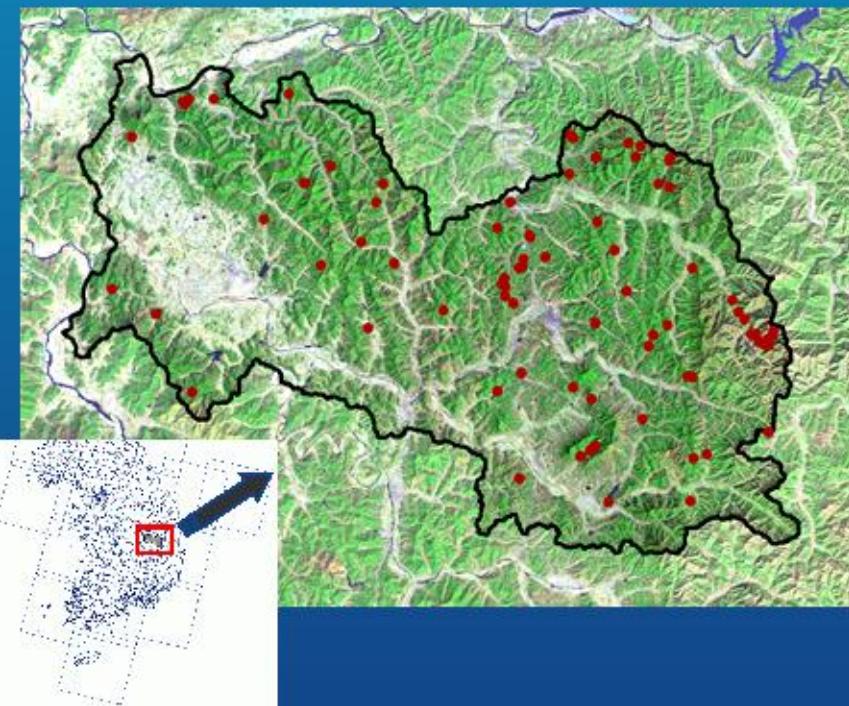


Fire & Fuel

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)

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

- Slightly dry soil (n=16)

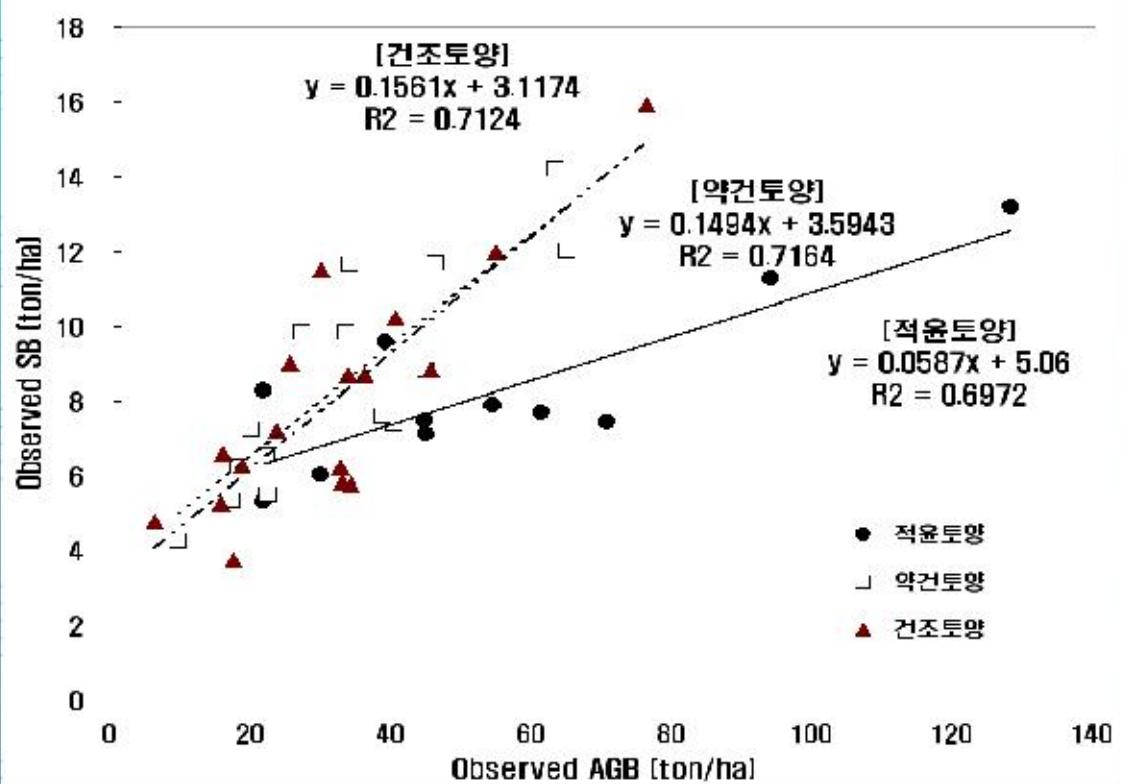
$$y = 0.1494x + 3.5943 \quad (R^2 = 0.7164)$$

- Dry soil (n=19)

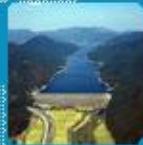
$$y = 0.1561x + 3.1174 \quad (R^2 = 0.7124)$$

▪ Deciduous forest (1type)

$$y = 1.99x0.4354 \quad (R^2 = 0.7221)$$



Pinus densiflora Sieb. et Zucc



Fire & Fuel

Fuel type classification, Fuel map

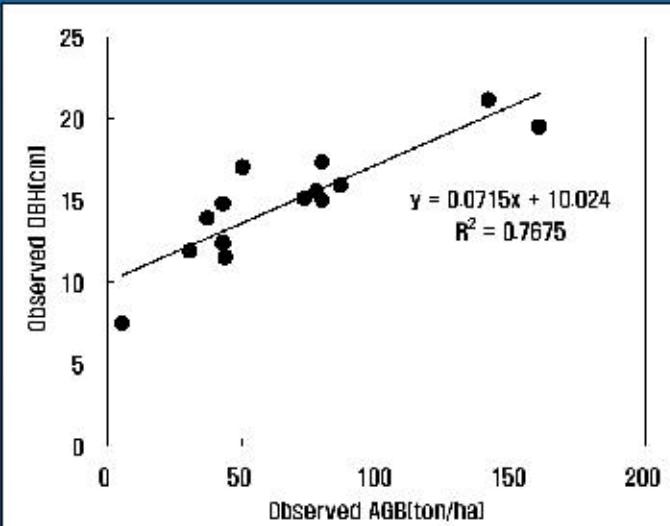
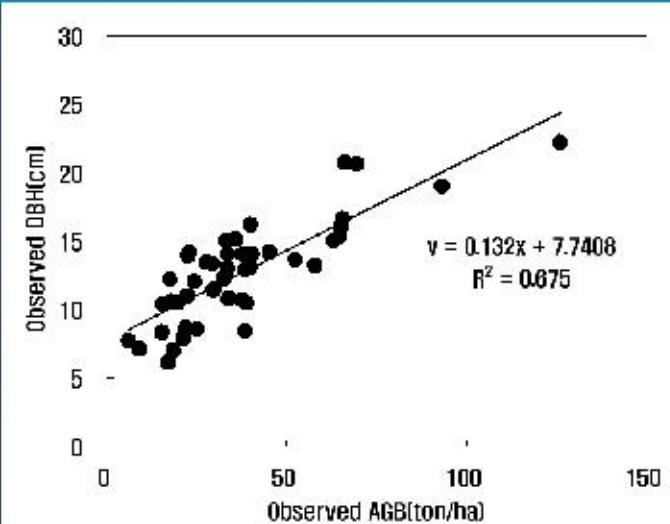
● DBH & AGB relation (On-site)

▪ Coniferous (n=48)

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

▪ Deciduous (n=15)

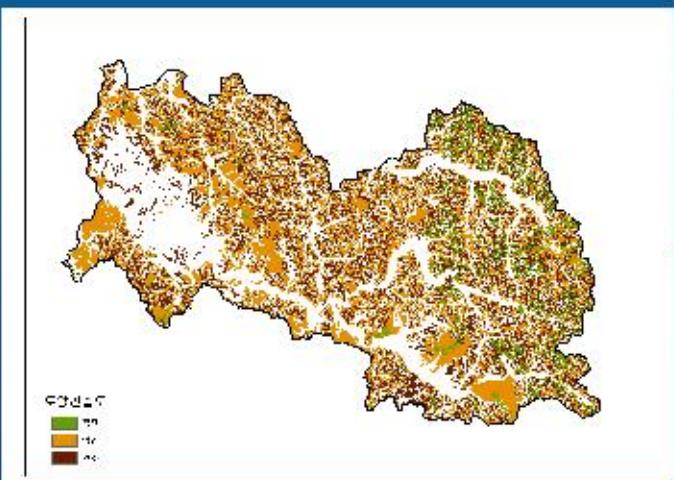
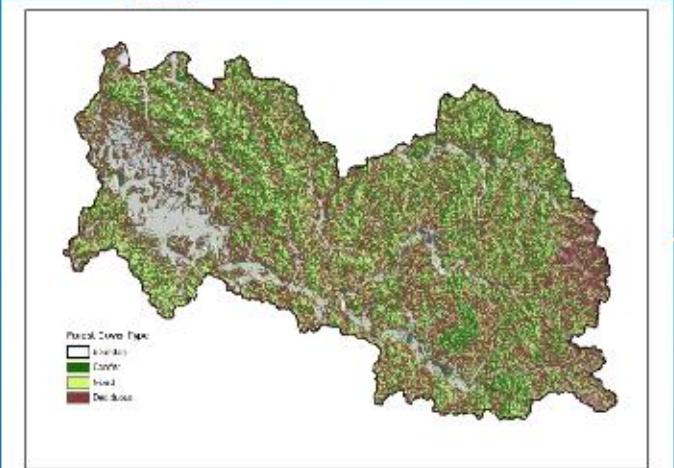
$$y = 0.0715x + 10.024 \quad (R^2 = 0.7675)$$





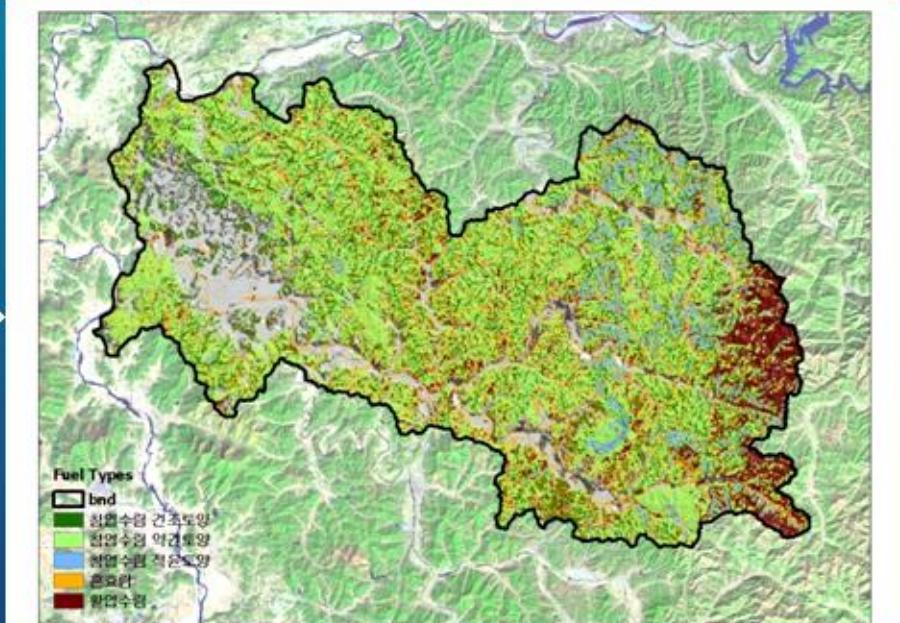
Fire & Fuel

Fuel type classification, Fuel map



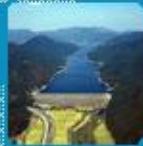
Fuel type Classification (5)

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



❖ Fuel type classification map

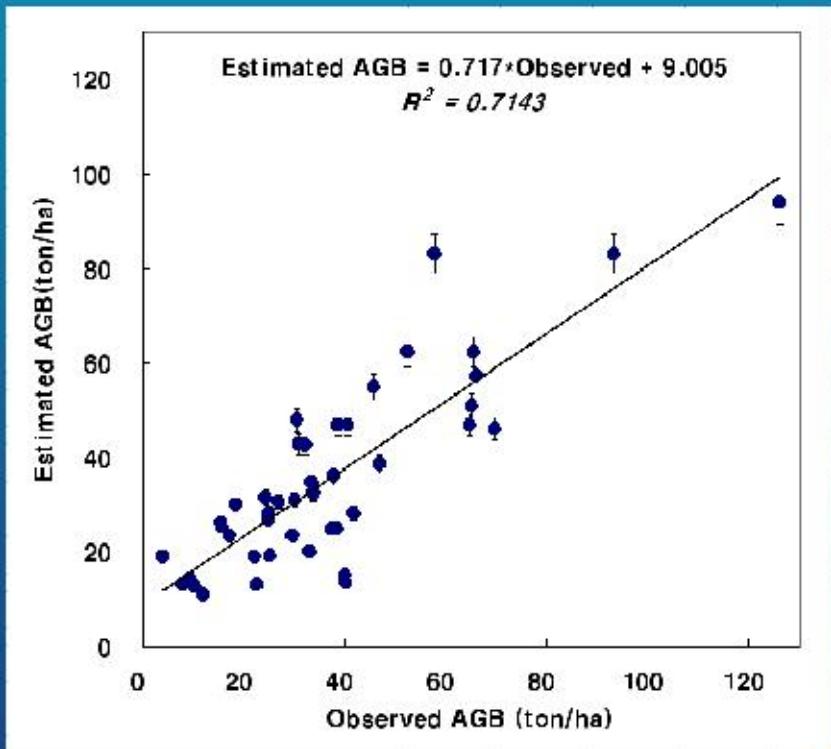
❖ Soil Condition : moderately moist, slightly dry, dry soil



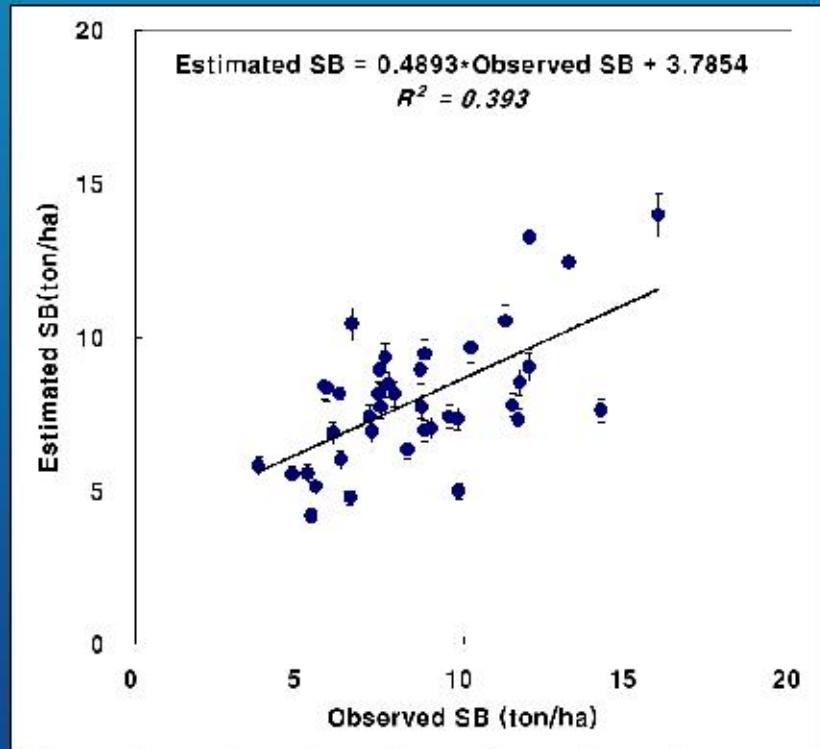
Fire & Fuel

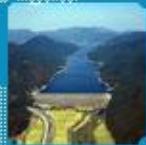
Fuel type classification, Fuel map

- AGB estimation of Coniferous forest
(3 types)



- SB estimation of Coniferous forest
(3 types)

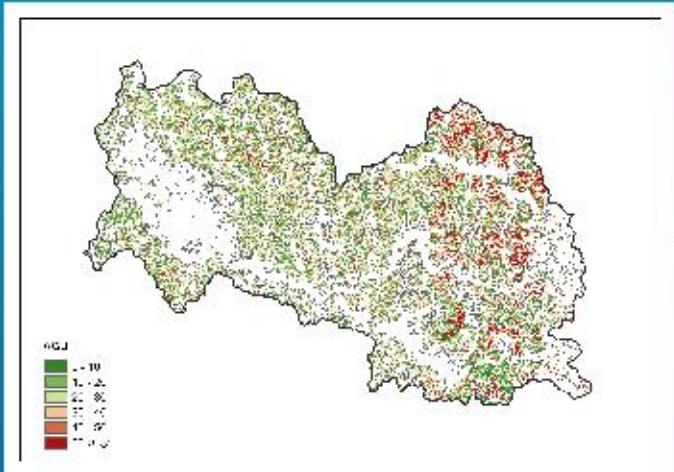




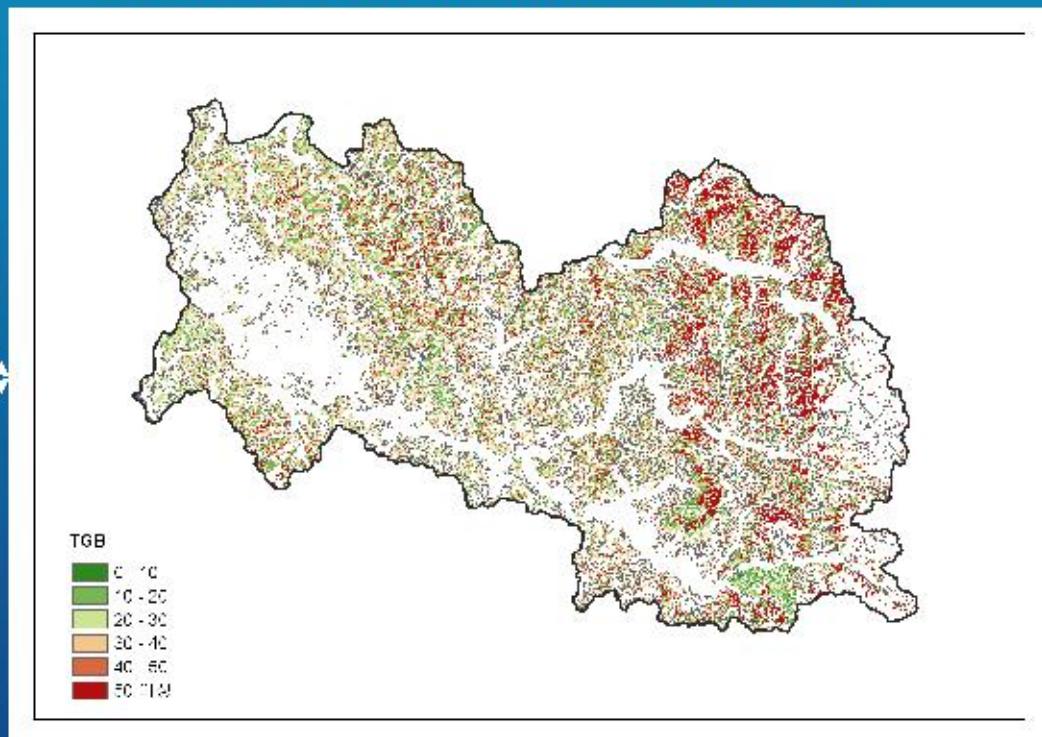
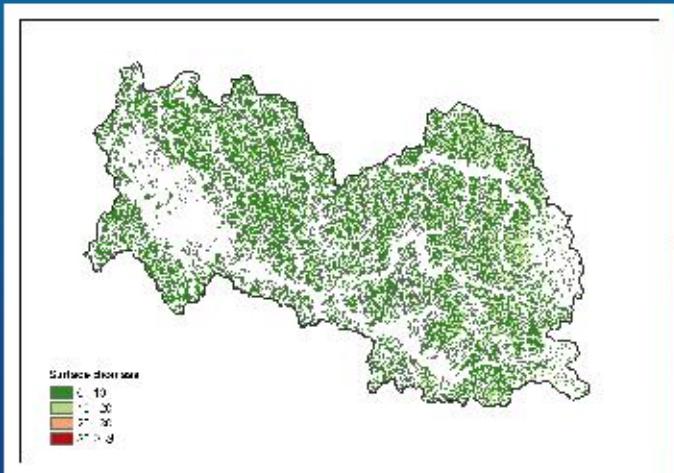
Fire & Fuel

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)



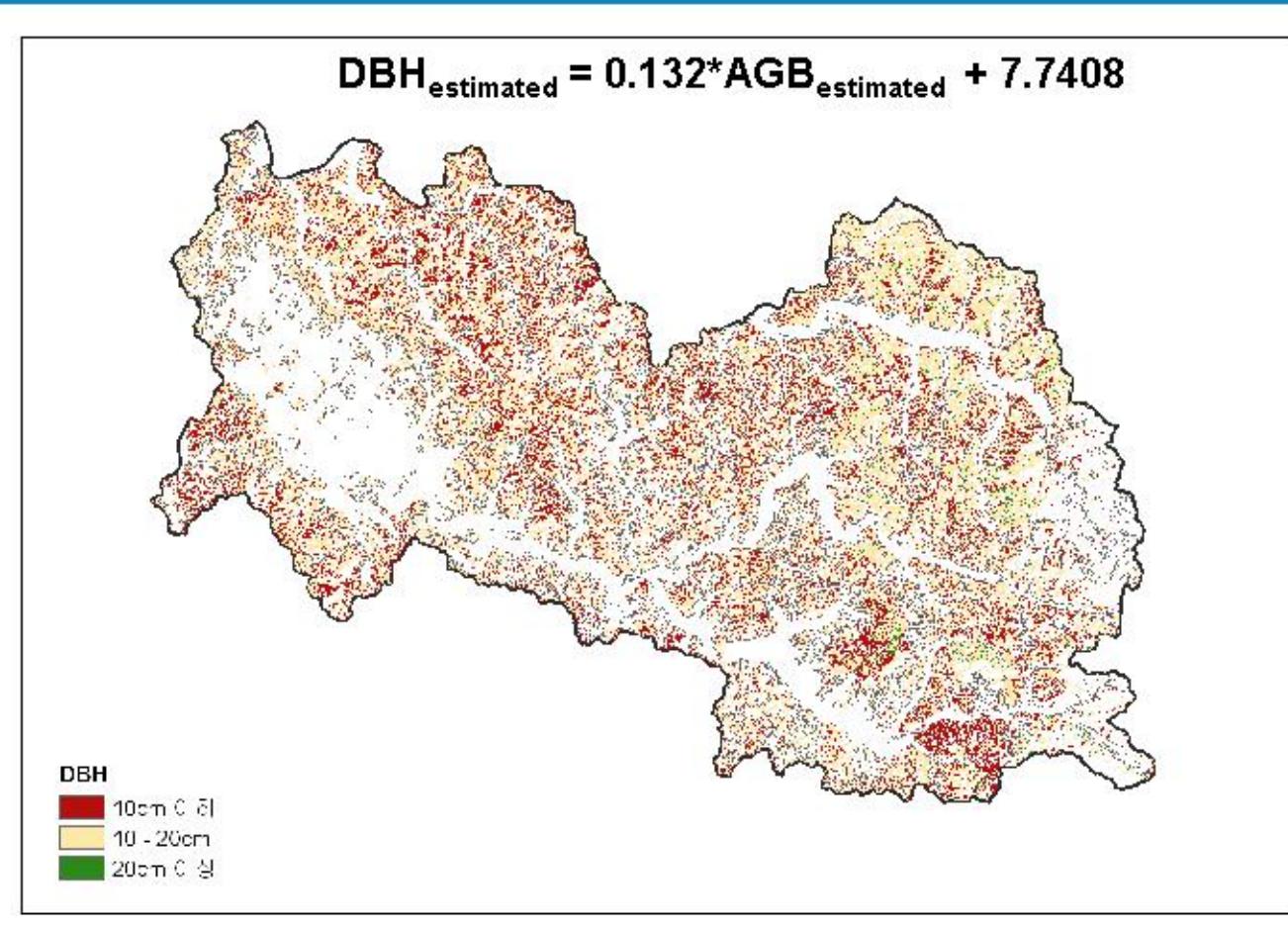
Total biomass(TB)



Fire & Fuel

Fuel type classification, Fuel map

- DBH map of coniferous forest estimated

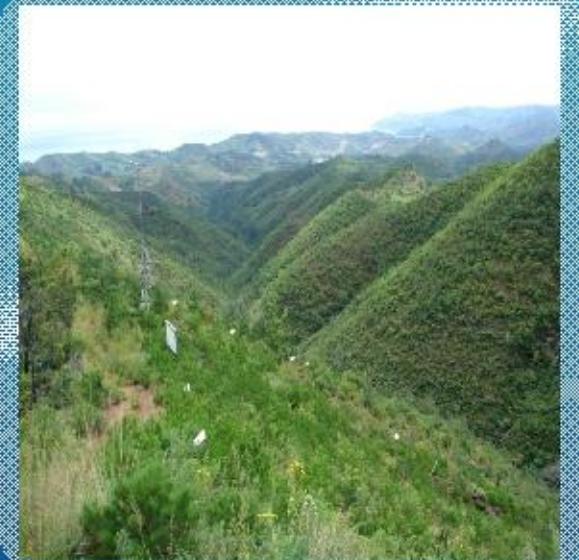
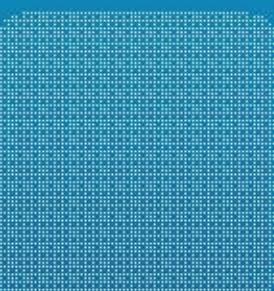




Research Plan

- 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 !