



국립산림과학원

Prediction of forest fire danger rating(FFDR) in DPRK: Modeling of MODIS fire product, 5km-resolution meteorological data, daily weather index(DWI), fuel model index(FMI) and topography model index(TMI)

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Korea Forest Fire Danger Rating System(KFFDRS)

본문바로가기 | **상장판** | 공지사항 | English | **국립산림과학원** | 정보공개 | 휴양·문화 | 분야별 산림정보 | 행정·정책 | 민원·참여 | 산림청소개

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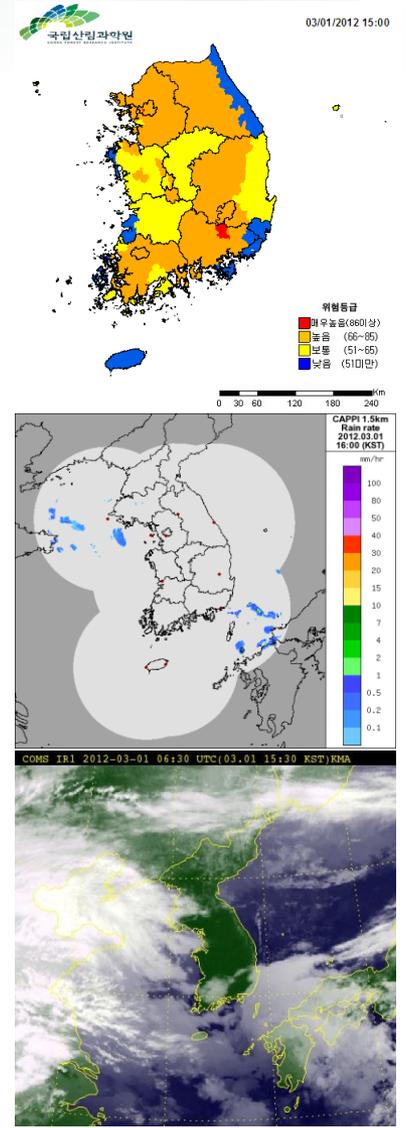
[산불위험예보시스템은 연중무휴로 운영됨을 알려드립니다.]

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국가산불위험예보
KOREA FOREST FIRE DANGER RATING

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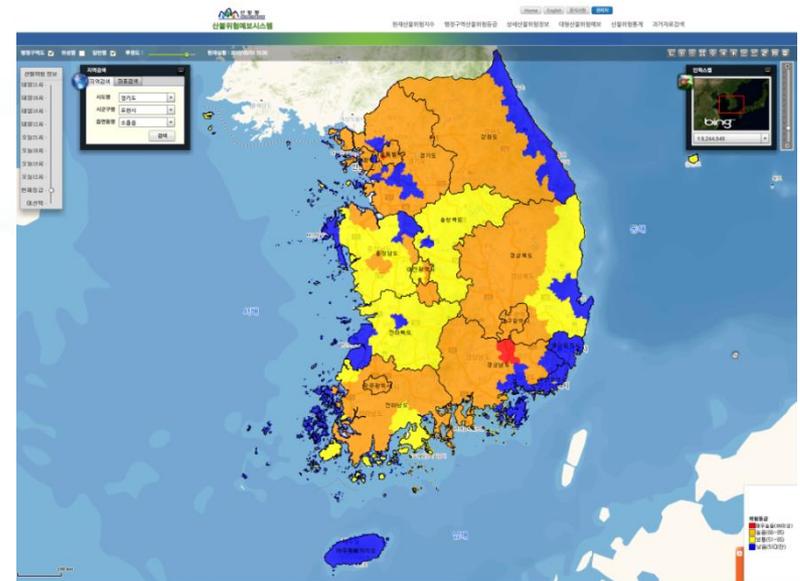
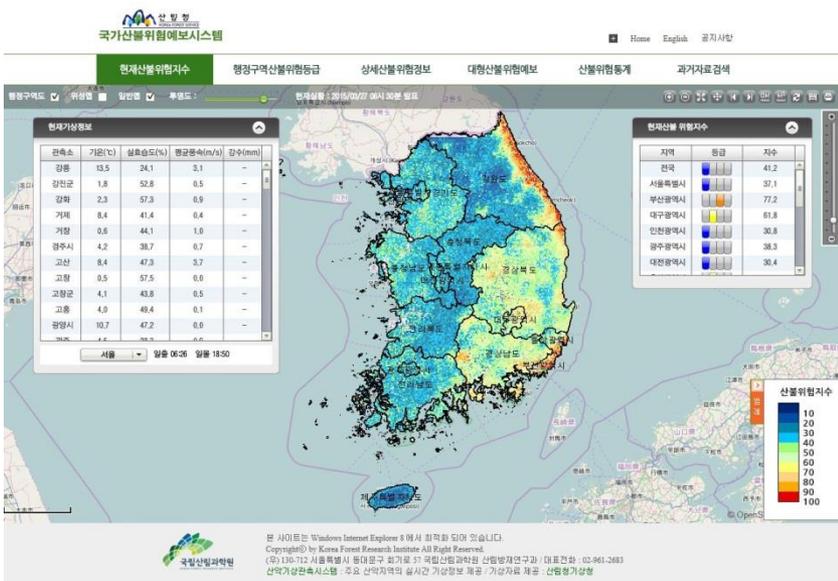
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<p>공지사항</p> <p>실시간 산불위험예보 모바일 웹 서비스 알림 2016-11-02</p> <p>산불위험예보시스템 도메인 변경 안내 2015-11-05</p> <p>2015년 4월 24일 대형산불주의보 발효 지역 2015-04-24</p>				+ more



KFFDRS

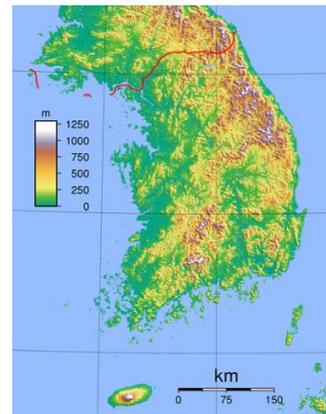
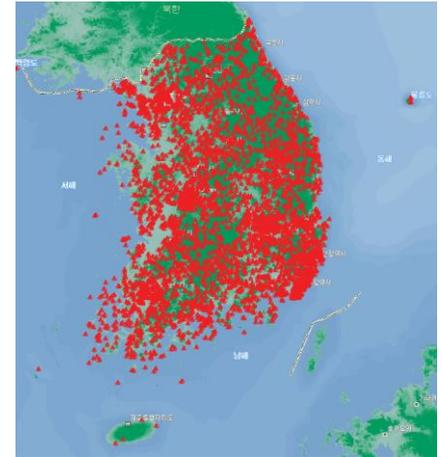
- **Korean Forest Fire Danger Rating System**

- This system has been operating at the NIFoS since 2003.
- Forest fire danger rating index is provided to people, central and local government every hour.



KFFDRS Database

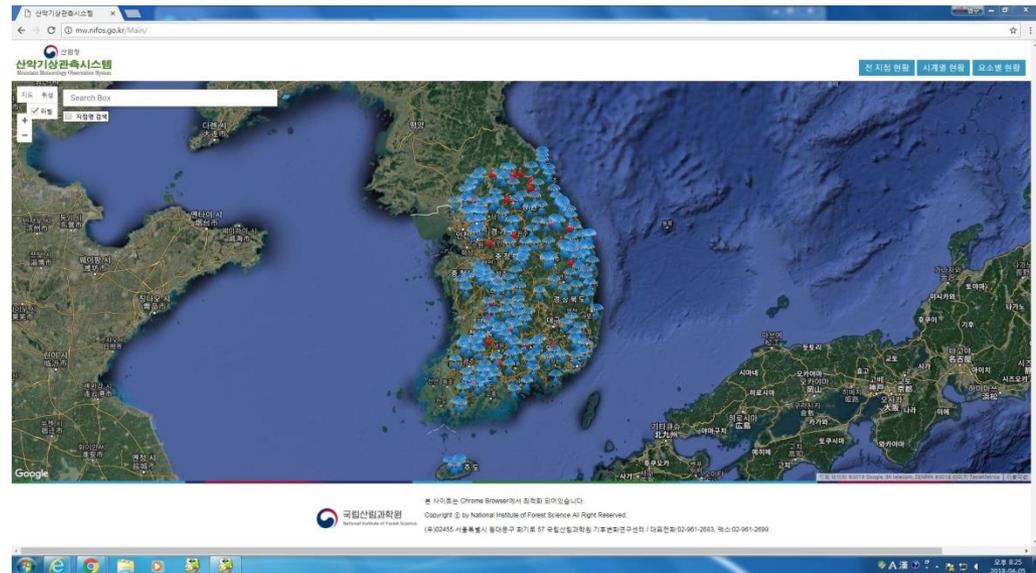
- Korean Forest Fire Danger Rating System Database
 - National Fire Database (from NIFoS and KFS)
 - Weather Database (KMA)
 - Mountain Weather Database (NIFoS)
 - Hotspot Database (NIFoS)
 - National Topography Database (NGII)
 - National Forest Database (NIFoS and KFS)



KoMIS

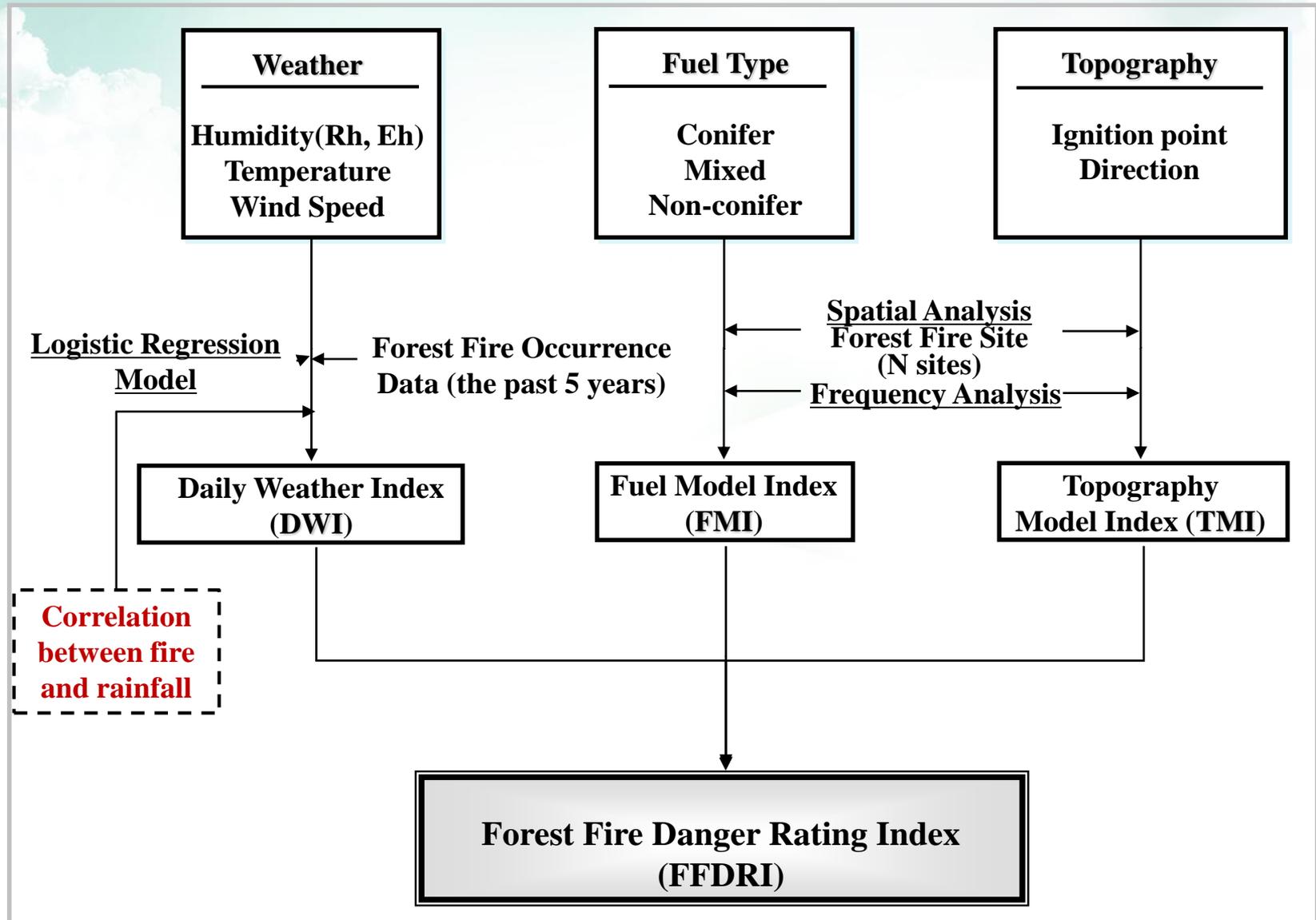
- **Korean Mountain Meteorology Information System**

- KoMIS supply mountain weather data such as a temperature, humidity, wind and precipitation per minute from NIFoS.
- In current, 200 automatic mountain meteorology stations(AMOS) were installed at the mountain area.
- AMOS will be installed more than 620 stations by 2021





R&D Flow chart: Forest fire occurrence probability model





Key results

1

Extraction of fire spot using MODIS data

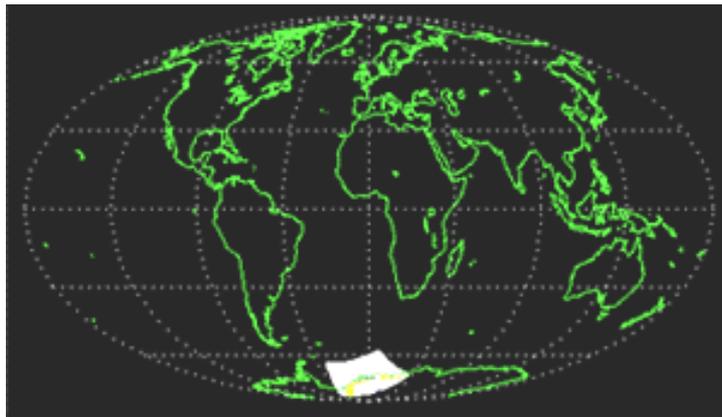
➔ Building Database of fire ignition points for the inaccessible area



Materials and Methods: info. collection of fire spots



Terra MODIS



MODIS Sensor

- Pixel resolution: 250, 500, and 1000 m
- Overpass times: 10:30
- Spectral bands: 36 (0.4 – 14.5 um)

✓ Info. Gathering Web site

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Search, order, and download MODIS Level 1, Atmosphere and Land data products and VIIRS Level 1 and Land data products. Products may also be subset by parameter, area, or band, mosaiced, reprojected, or masked.

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Access tools to use with MODIS Level 1, Atmosphere and Land data products and VIIRS Level 1 and Land data products.

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Information about the production, archive and distribution of the data products in LAADS can be found at the MODAPS Services website.

Any questions should be directed to MODAPS user support. Contact information can be found on the Contacts page.

NEWS

2016.08.26 - LAADS VIIRS and MODIS Disks Going Down for Maintenance 2016-09-01
Certain LAADS archive hosts and disks will be taken down for maintenance on Thursday, 01 Sep 2016 for the whole day.
[+ Read More](#)

2016.08.15 - Lance-MODIS and Forward Terra 2016-08-13+ C6 PGE02+ reprocessing Beginning Saturday (2016-08-13) C6 Terra PGE02 was run in forward production (lads) and Lance-MODIS (nr13) with an incorrect set of coefficients.
[+ Read More](#)

2016.08.11 - Lance-MODIS Aqua 0625-0645z reprocessing
Near Real Time Aqua data between about 2016-08-11 06:25 and 06:45z has been reprocessed as data in this time period was produced with an Aqua L0 (MYD00S) input that was missing data in this time range, and MYD00S has since been resent to us with the missing data included.
[+ Read More](#)

2016.08.09 - 0449z to 08-09 2049z Aqua L0 issue (update)
Lance-MODIS NRT and LAADS forward Aqua production were impacted by an issue making Aqua L0 unusable from 2016-08-08 0449z to 08-09 2049z.
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2016.08.05 - LAADS MODIS and VIIRS Disks Going Down for Maintenance 2016-08-11
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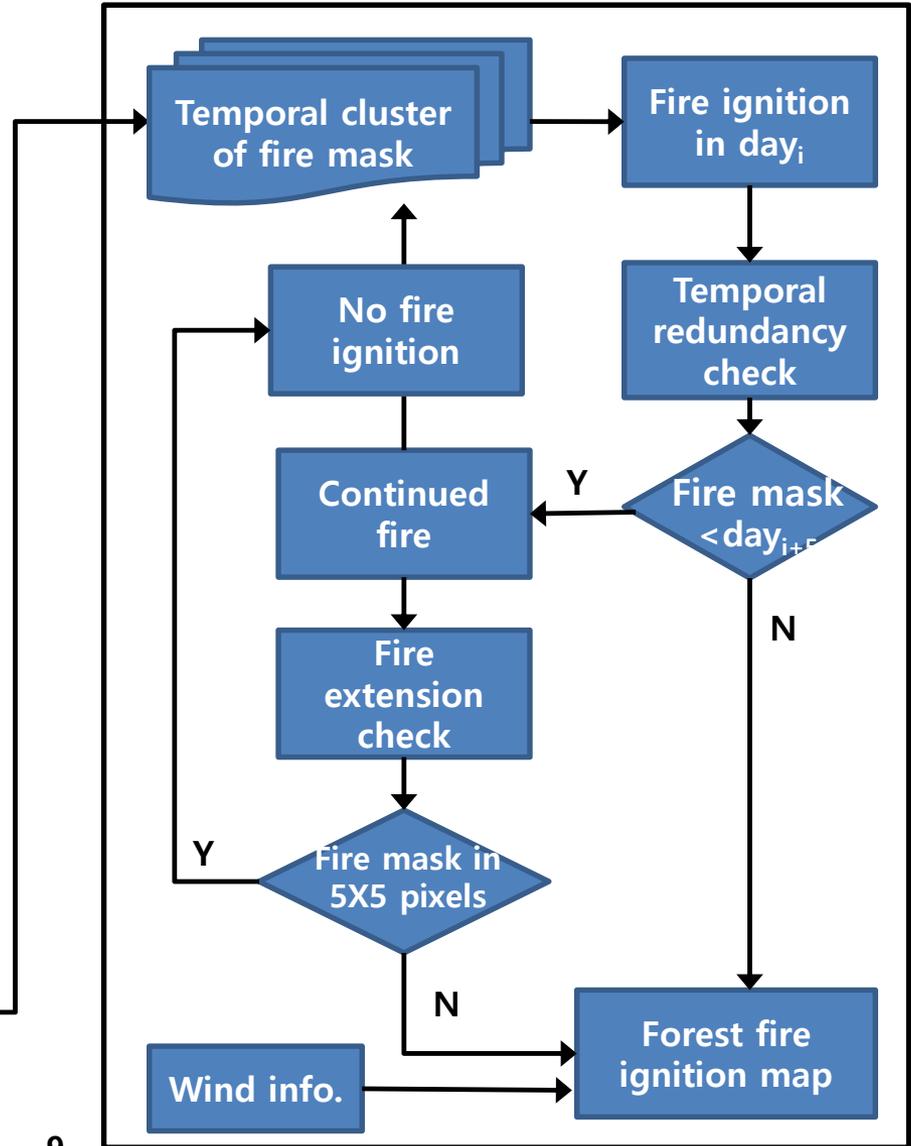
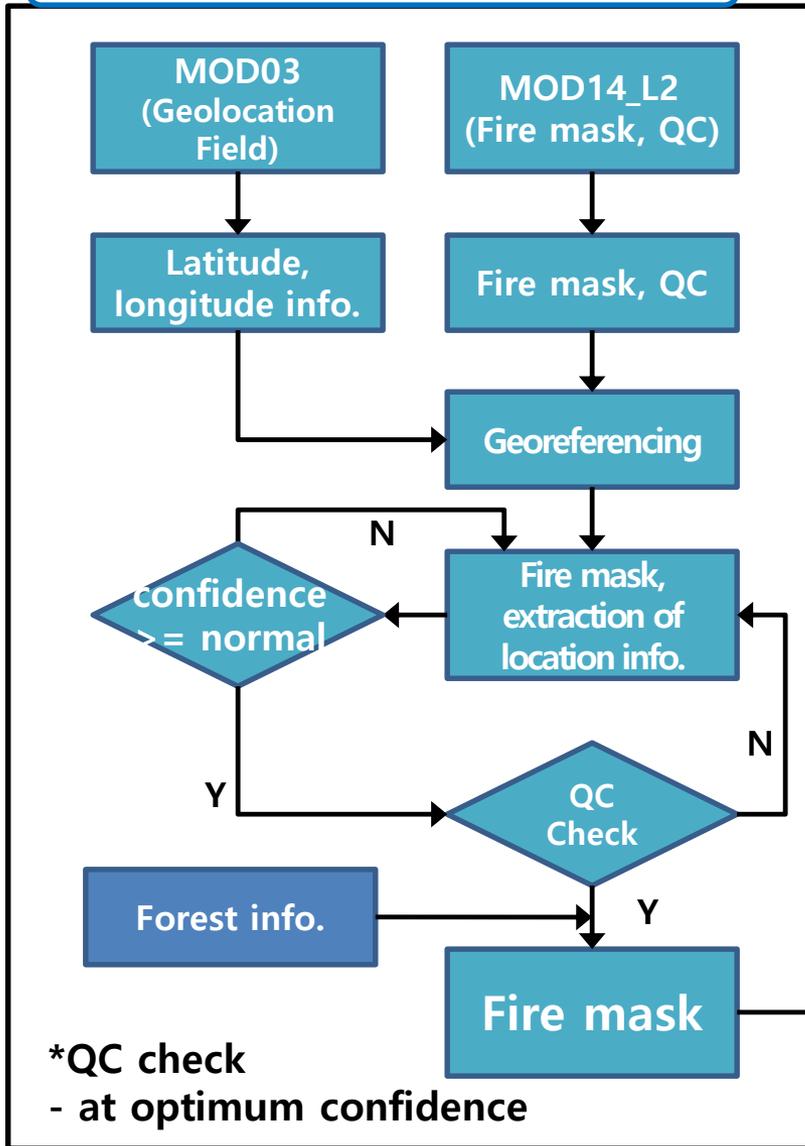
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Materials and Methods: Image data processing flowchart

✓ Processing flowchart of MOD14

Primary 2nd correction





Materials and Methods: MODIS14 Layer Table (Product, QC)

✓ MODIS14 Fire Mask Product

Classes
0 not processed (missing input data)
1 not processed (obsolete; not used in post-launch product)
2 not processed (other reason)
3 water
4 cloud
5 no fire
6 unknown
7 fire (low confidence)
8 fire (nominal confidence)
9 fire (high confidence)

❖ Selection of materials

- Nominal confidence
- High confidence

❖ QA Flag

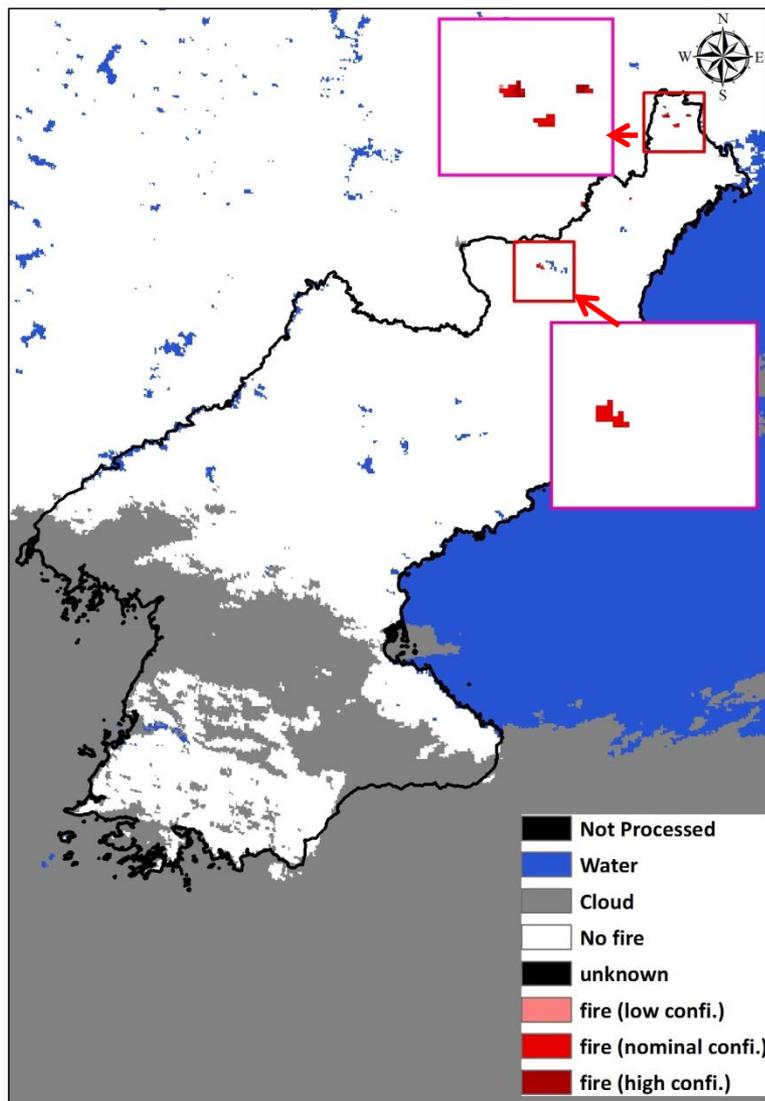
- Optimum confidence
- Less than optimum confidence

✓ QA Flag (32-bit)

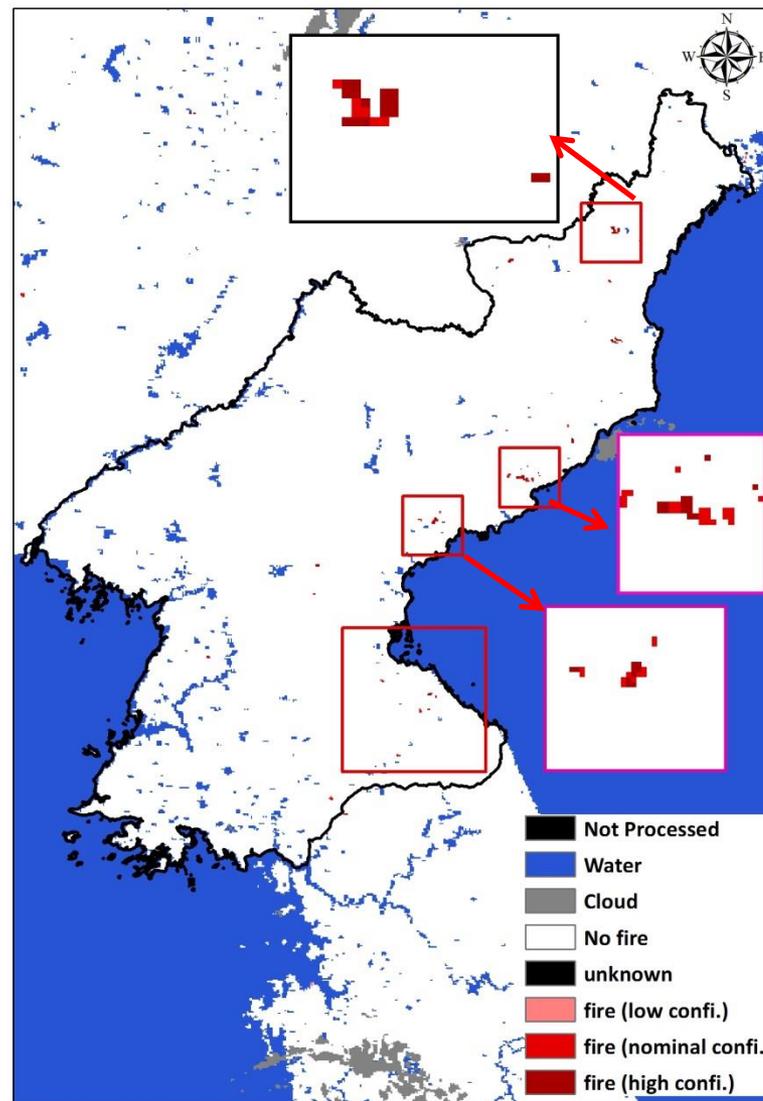
Bit No.	Parameter Name	Bit Comb.	Algorithm_QA
0-1	MODLAND QA bits	00	Fire/no-fire determined at optimum confidence
		01	Fire/no-fire determined at less than optimum confidence
		10	No determination made due to cloud cover
		11	No determination made due to other reason(s)
2	3.9 micron high-gain flag	0	band 21 used
		1	band 22 used
3	Atmospheric correction	0	Not performed
		1	Performed
4	Day/night algorithm	0	Night
		1	Day
5	Potential fire pixel	0	No (if no, remaining QA fields except bit 23 are not set)
		1	Yes
6	Spare (set to zero)	0	Spare
7-10	Background window size parameter, R	R = 0	Unable to characterize background
		R > 0	Background characterized with (2R+1) by (2R+1) window
11	360 K T21 test	0	Fail
		1	Pass
12	DT relative test	0	Fail
		1	Pass
13	DT absolute test	0	Fail
		1	Pass
14	T21 relative test i	0	Fail
		1	Pass
15	T31 relative test ii	0	Fail
		1	Pass



Key results: example of MODIS14 fire mask



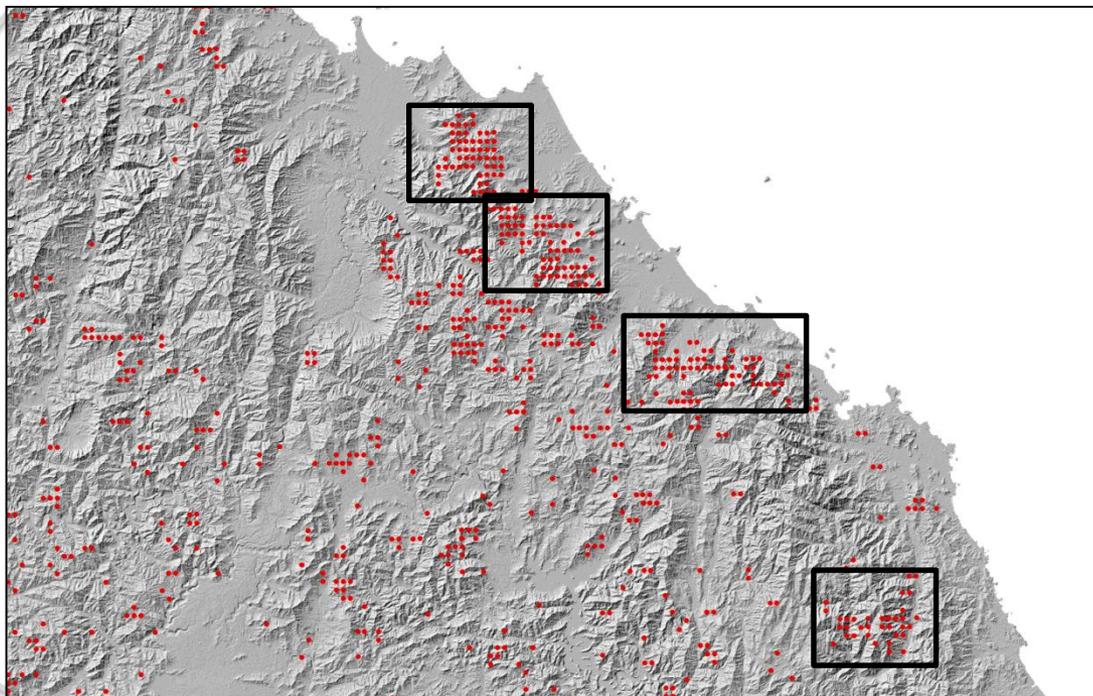
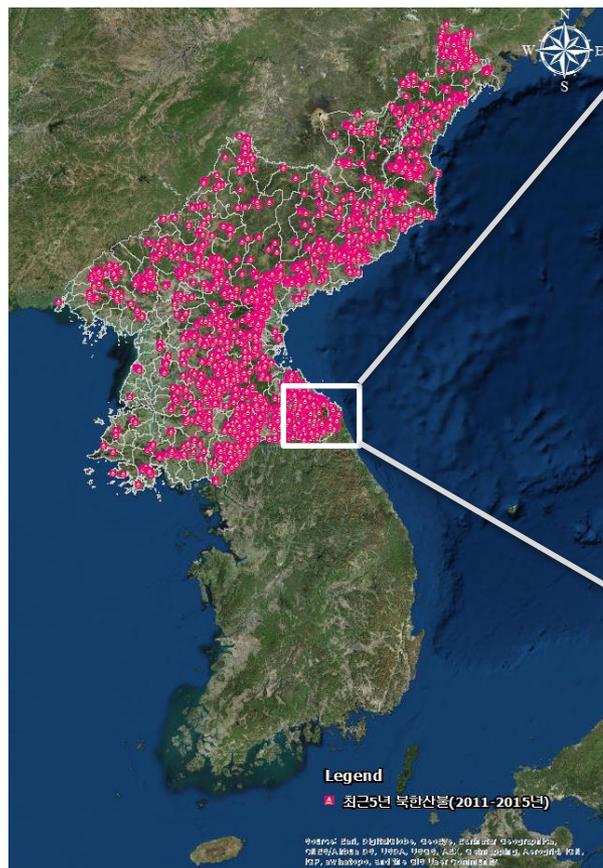
April 29, 2012



April 27, 2015



Key results: Forest fire(FF) spots DB for the inaccessible area



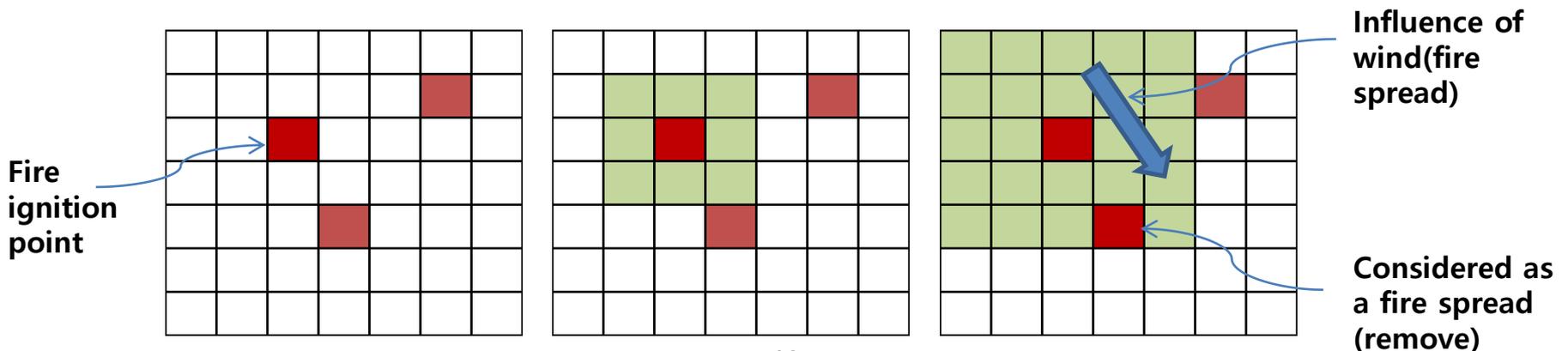
- ❖ Total 3,637 fire spot points
- Period : 2011~2015 (5yrs)



Key results: Hypothesis for problem solving

[Hypothesis for extraction of fire spot points from MOD-14 Product]

- ① Consider fire spotting at the time of the first detection when a forest fire was detected continuously at a particular pixel as a fire ignition point and occurrence time
- ② When a fire spot is detected at different times in the same pixel, it is regarded as an individual forest fire. However, apply only when the ignition time differs by more than 5 days
- ③ Identify whether forest fires have spread by 4 days after the ignition time, centered on ignition points
 - Remove fire spotting after setting 3 x 3 pixel area after ignition
 - After 2 days, check 5x5 pixel area
 - Identification of data after cloud data
- ④ Removal of fire spotting in the same forest area using wind UV vector and wind direction

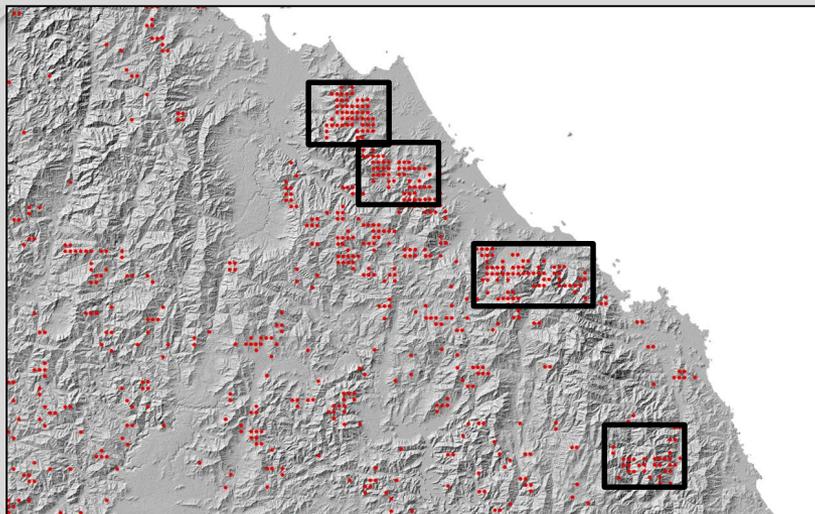
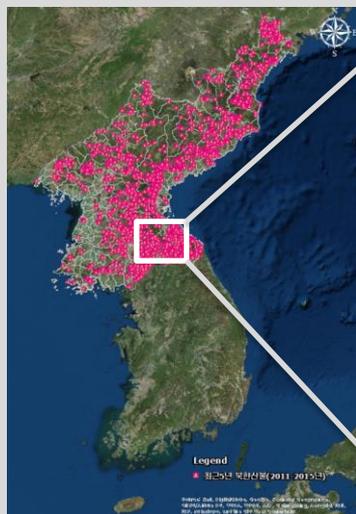




Key results: Reanalysis of fire spots by hypothesis

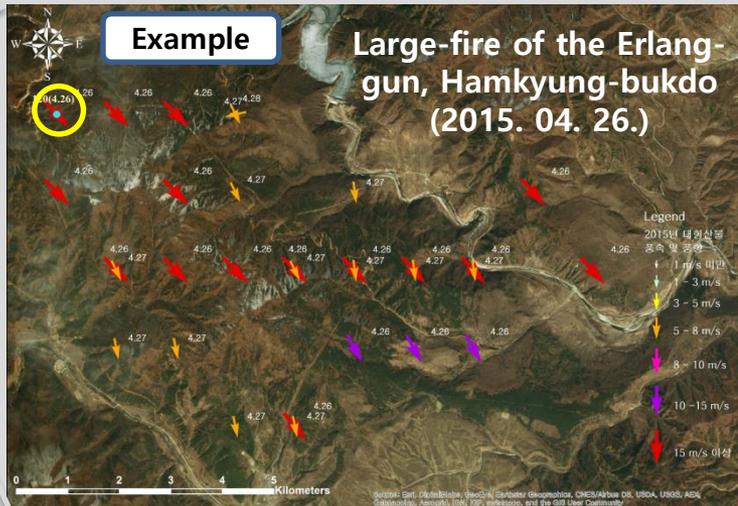
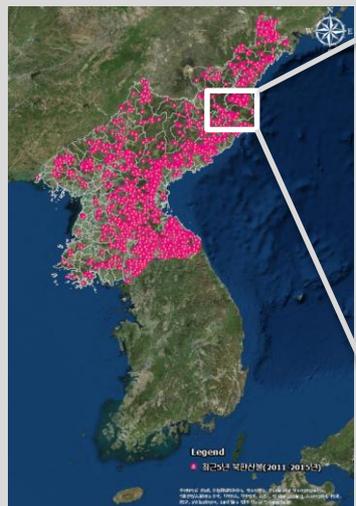
[Before reanalysis]

❖ (5yrs) A total of 3,637 fire spot points



[Reanalysis]

❖ (5yrs) Extracting a total of 1,469 fire spot points



[Consideration]

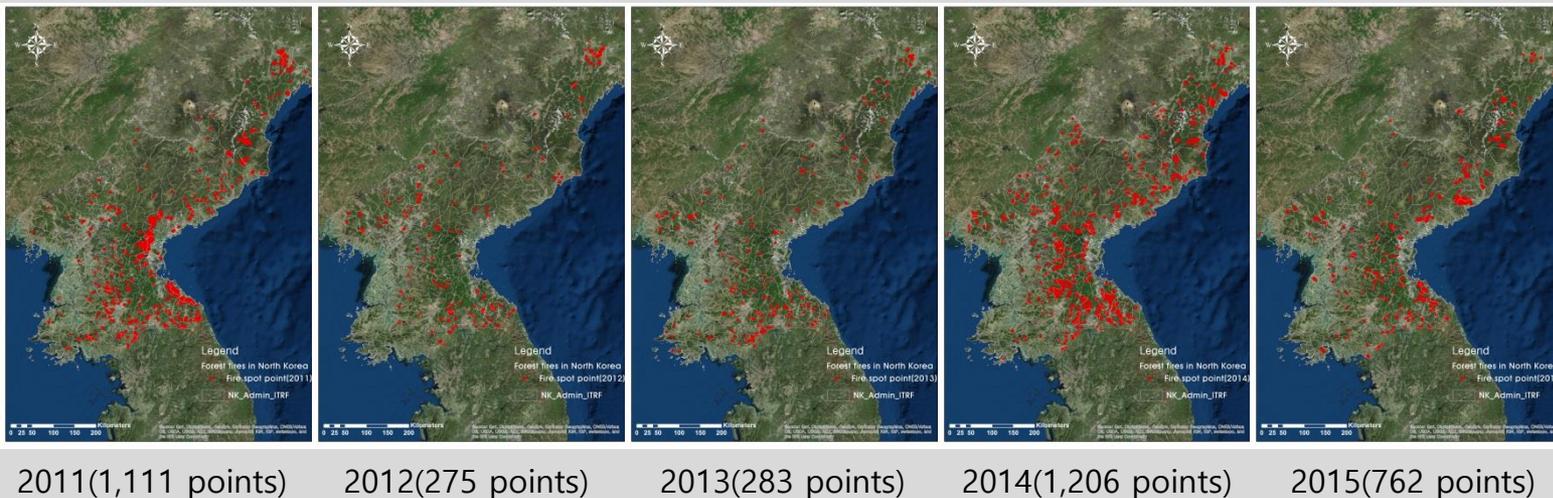
- FF detection (April 26) → Fire spread (April 27)
- WSmean : 5.0~30.0m/s
- WD : NW
- ※ Ignition point estimation considering detection time and WS/WD



Key results: Reanalysis of fire spots by hypothesis

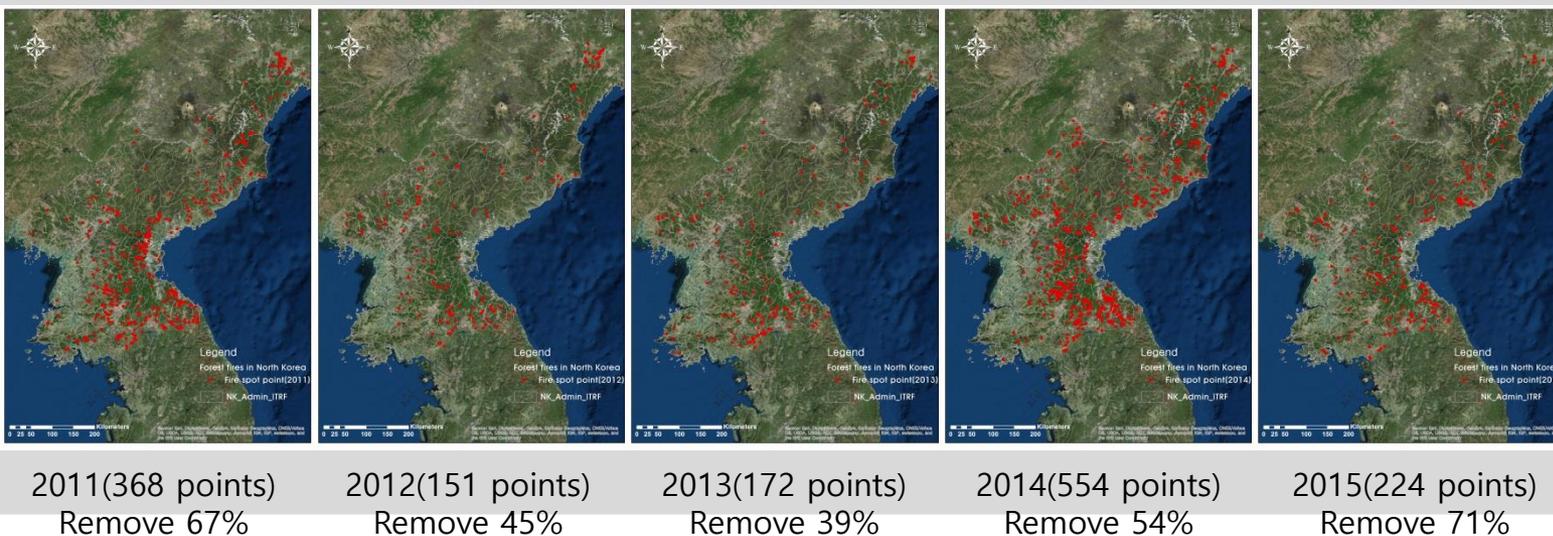
[Before reanalysis]

❖ (5yrs) A total of 3,637 fire spot points



[Reanalysis]

❖ (5yrs) Extracting a total of 1,469 fire spot points

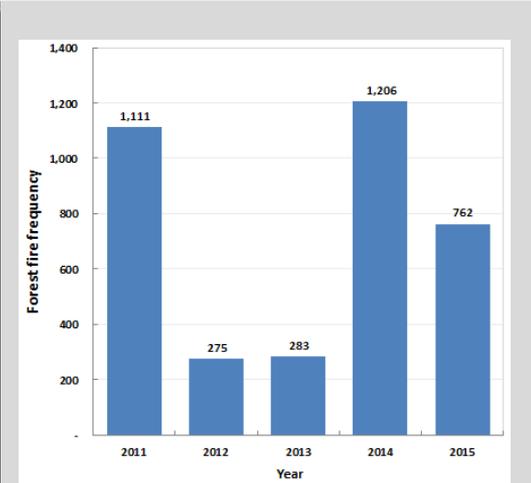
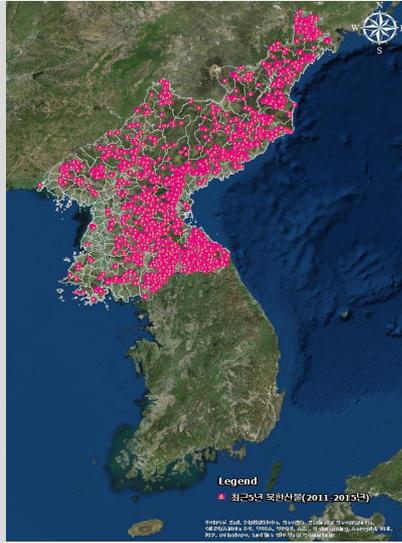




Key results: Reanalysis of fire spots by hypothesis

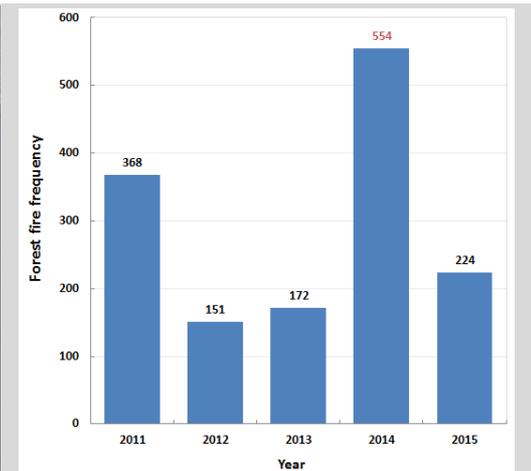
[Before reanalysis]

❖ (5yrs) A total of 3,637 fire spot points



[Reanalysis]

❖ (5yrs) Extracting a total of 1,469 fire spot points



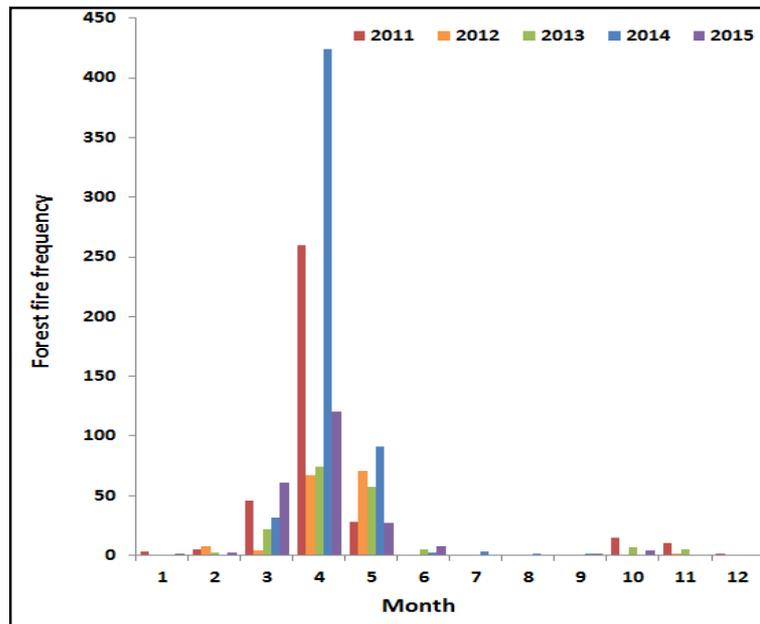
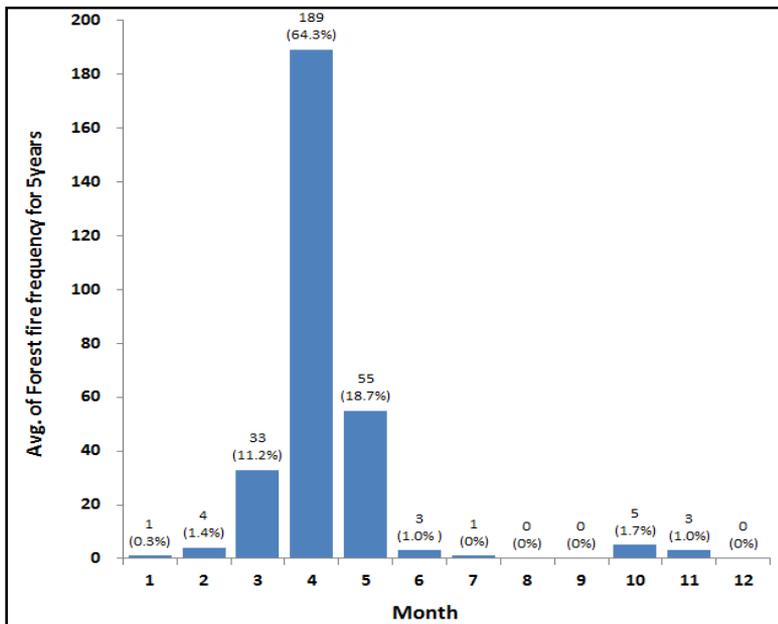
Removes about 60% of duplicate fire spot points



Key results: Monthly FF frequency for reanalysis data

Year	Fires	%
2011	368	25.1
2012	151	10.3
2013	172	11.7
2014	554	37.7
2015	224	15.2
Total	1,469	100.0

M/Y	2011		2012		2013		2014		2015	
1	3	0.8%	0	0.0%	0	0.0%	0	0.0%	1	0.4%
2	5	1.4%	8	5.3%	2	1.2%	0	0.0%	2	0.9%
3	46	12.5%	4	2.6%	22	12.8%	32	5.8%	61	27.2%
4	260	70.7%	67	44.4%	74	43.0%	424	76.5%	120	53.6%
5	28	7.6%	71	47.0%	57	33.1%	91	16.4%	27	12.1%
6	0	0.0%	0	0.0%	5	2.9%	2	0.4%	8	3.6%
7	0	0.0%	0	0.0%	0	0.0%	3	0.5%	0	0.0%
8	0	0.0%	0	0.0%	0	0.0%	1	0.2%	0	0.0%
9	0	0.0%	0	0.0%	0	0.0%	1	0.2%	1	0.4%
10	15	4.1%	0	0.0%	7	4.1%	0	0.0%	4	1.8%
11	10	2.7%	1	0.7%	5	2.9%	0	0.0%	0	0.0%
12	1	0.3%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Total	368	100.0%	151	100.0%	172	100.0%	554	100.0%	224	100.0%



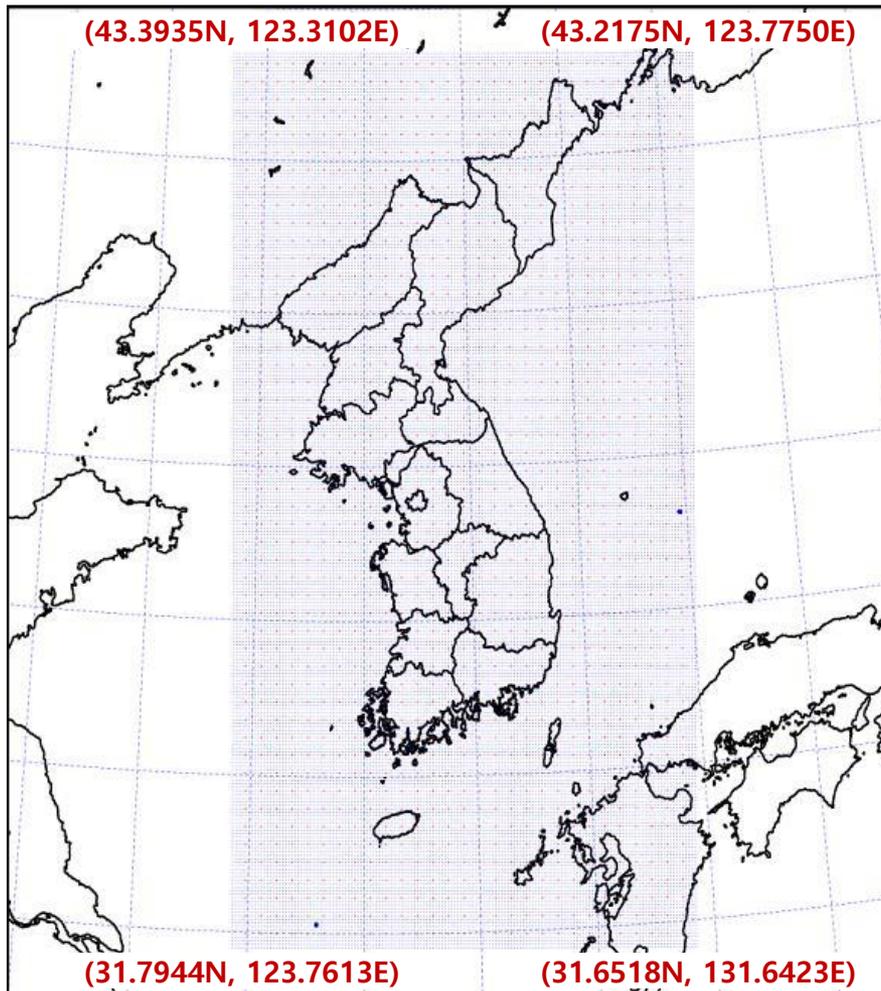


Key results

- 2 Establishment of weather database in forest fire area
 - ➔ Development of Daily Weather Index (DWI) model
-



Materials and Methods: 5km digital weather data of KMA

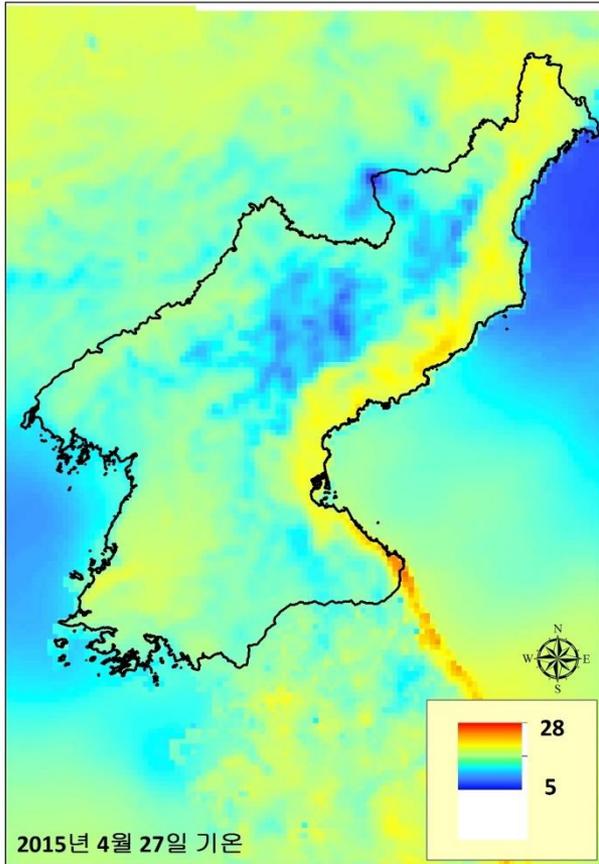


- ❖ Analysis data : 5km DW data of KMA
 - Period : 2011~2015 (5yrs)
- ❖ Mesh info. of KMA DW data
 - Grid interval : 5km
 - Grid # : EW149 × SN 253 → 37,697
 - Total grid distance : EW 745km, SN 1,265km
 - Standard grid point : (43, 136) / (38.0N, 126.0E)

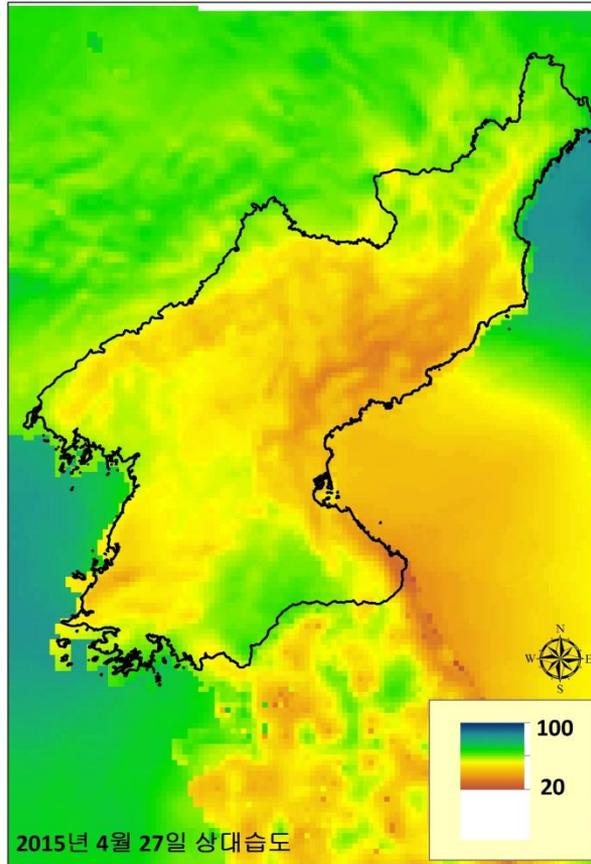


Key results: Weather database(5km grid) of fire spot points

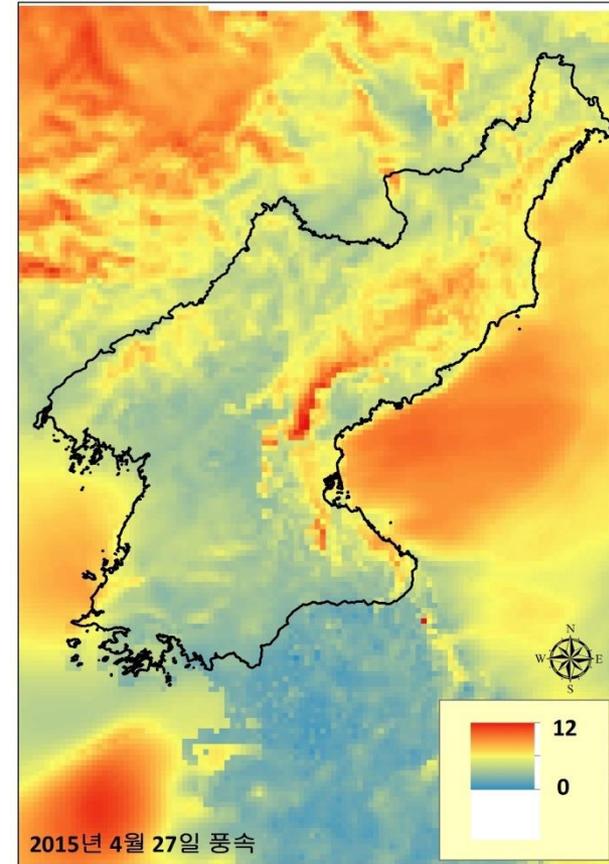
Temperature



Relative humidity

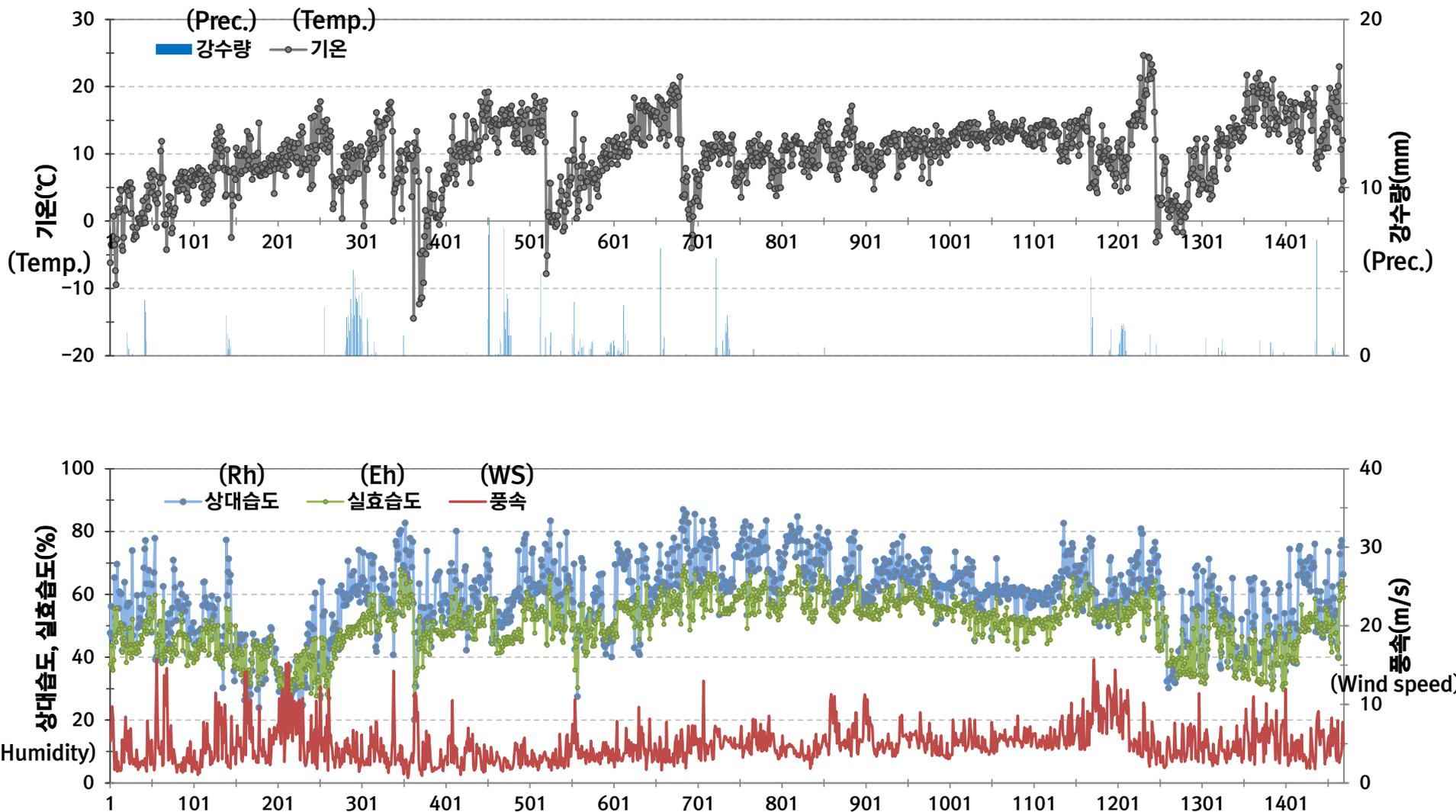


Wind speed





Key results: Weather database(5km grid) of fire spot points





Key results: Development of daily weather index model

☑ Daily weather index (DWI) model

- Logistic Regression
- Weather variables : temp.(mean, max, min), relative humidity(mean, min), effective humidity, wind speed(mena, max), precipitation

$$p = \frac{\exp(\beta_0 + \beta_1 X_1 + \dots + \beta_j X_j)}{1 + \exp(\beta_0 + \beta_1 X_1 + \dots + \beta_j X_j)}$$

Estimated Correlation Matrix								
parameter	intercept	T1D_max	RH1D_min	EH1D_avg	T1D_avg	T1D_min	RH1D_avg	WS1D_max
intercept	1.0000**	-0.1104	0.3213	-0.4296	-0.0536	0.2036	-0.2282	0.1234
T1D_max	-0.1104**	1.0000	0.2491	0.0518	-0.9312	0.6922	-0.2572	0.0026
RH1D_min	0.3213**	0.2491	1.0000	-0.1107	-0.1490	-0.0208	-0.6791	0.0017
EH1D_avg	-0.4296**	0.0518	-0.1107	1.0000	-0.0890	0.1177	-0.5346	-0.0738
WS1D_avg	-0.4152**	0.0165	-0.1965	0.0848	0.0574	-0.1194	0.2095	-0.8399
T1D_avg	-0.0536**	-0.9312	-0.1490	-0.0890	1.0000	-0.8900	0.2274	-0.0499
T1D_min	0.2036**	0.6922	-0.0208	0.1177	-0.8900	1.0000	-0.1437	0.0738
RH1D_avg	-0.2282**	-0.2572	-0.6791	-0.5346	0.2274	-0.1437	1.0000	-0.0469
WS1D_max	0.1234**	0.0026	0.0017	-0.0738	-0.0499	0.0738	-0.0469	1.0000

** p<0.01



Key results: Development of daily weather index model

Result of the logistic regression analysis

– Sample Number : 10,283 (fire spot points of the fire day, 3 days before and after the non fire days)

Response Profile	
Fire	Total Frequency
0	8,814
1	1,469
Probability modeled is Fire = '1'	
-2 Log Likelihood	8,350.885
χ^2	1,207.6659
% predict value	66.6

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-2.7425	0.2587	112.3371	<.0001
T1D_max	1	0.0905	0.0247	13.4266	0.0002
RH1D_min	1	-0.0517	0.00563	84.1784	<.0001
EH1D_avg	1	0.0334	0.00657	25.8035	<.0001
WS1D_avg	1	0.1283	0.0273	22.1316	<.0001
T1D_avg	1	-0.0664	0.0444	2.2346	0.1349
T1D_min	1	0.0116	0.0230	0.2545	0.6139
RH1D_avg	1	-0.00507	0.00611	0.6909	0.4059
WS1D_max	1	-0.00771	0.0140	0.3035	0.5817

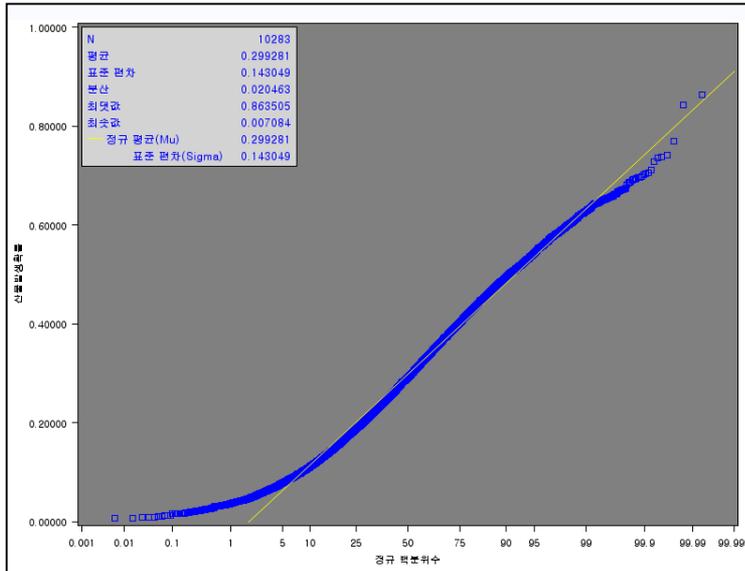
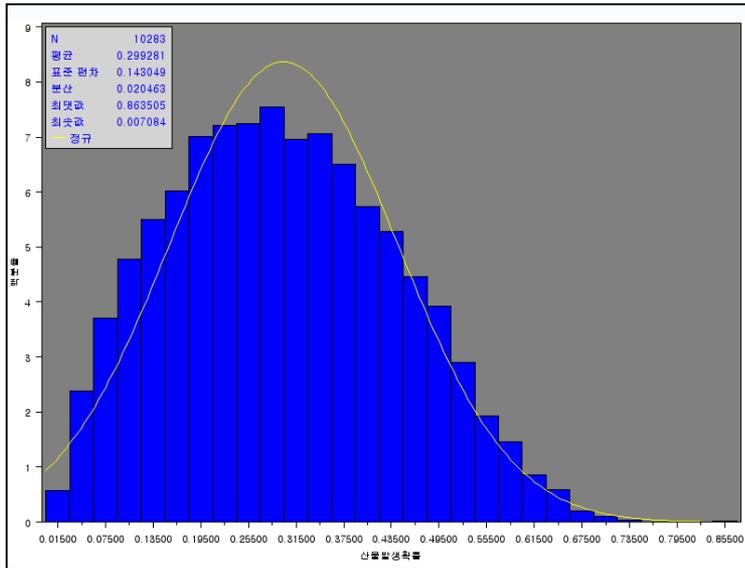
* p<0.01

DWI model of DPRK

$$[1 + \exp\{-(2.7425 + (0.0905 * T_{max}) - (0.0517 * RH_{min}) + (0.0334 * EH) + (0.1283 * WS_{avg}))\}]^{-1}$$



Key results: The probability interval of DWI model in DPRK



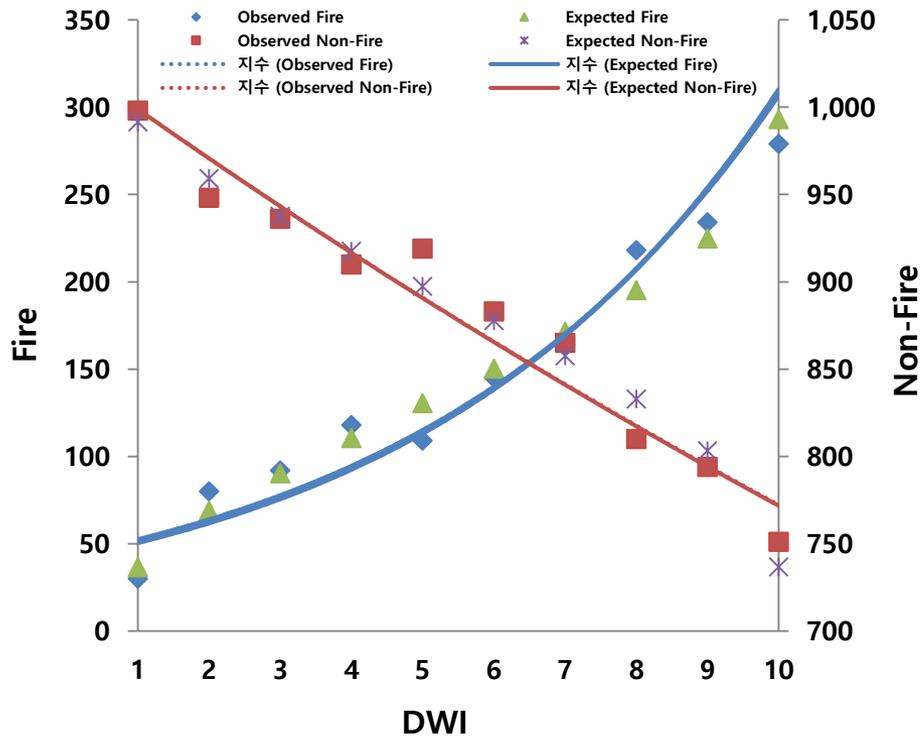
Distribution analysis : FF occurrence probability	
N	10,283
Mean	0.29928
Max	0.86350
Min	0.00708
Standard deviation	0.14305
Dispersion	0.02046
Avg. standard error	0.00141

Interval ratio	DWI	Estimated probability interval
10%	1	[.00000~.11138]
20%	2	[.11139~.16559]
30%	3	[.16560~.21032]
40%	4	[.21033~.25141]
50%	5	[.25142~.29238]
60%	6	[.29239~.33452]
70%	7	[.33453~.37828]
80%	8	[.37829~.43005]
90%	9	[.43006~.49471]
100%	10	[.49472~1.0000]



Key results: Verification of the DWI model in DPRK

✍ The frequency of fire day and non-fire day by DWI model



DWI	Observed Fire	Expected Fire	Observed Non-Fire	Expected Non-Fire
1	30	36.51	998	991.49
2	80	68.88	948	959.12
3	92	90.42	936	937.58
4	118	110.54	910	917.46
5	109	130.57	919	897.43
6	145	150.24	883	877.76
7	164	171.45	865	857.55
8	218	195.23	810	832.77
9	234	224.84	794	803.16
10	279	293.20	751	736.80



Key results

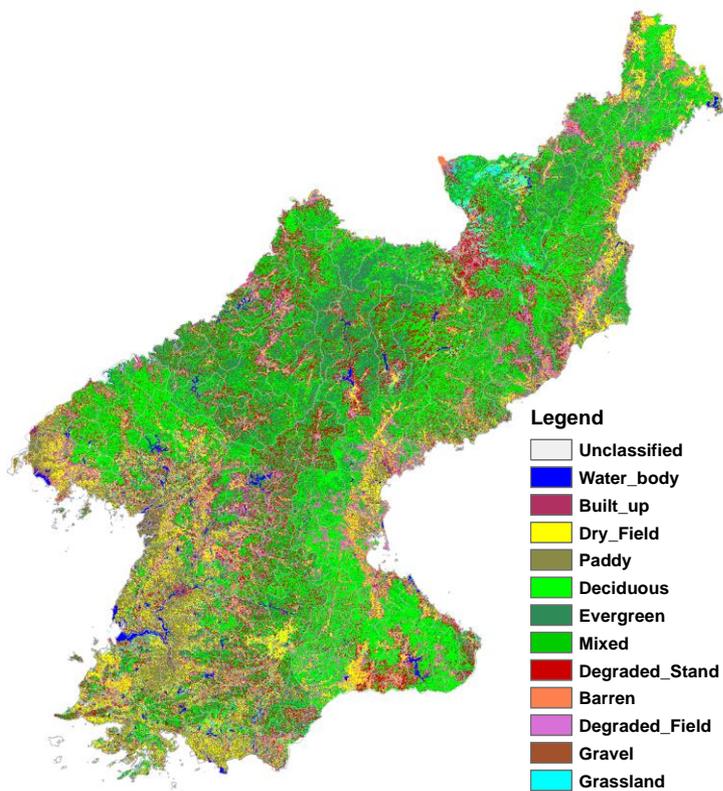
- 3 Establishment of forest map database in DPRK
 - ➔ Development of Fuel Model Index (FMI) model
-



Key results: Forest type map in DPRK

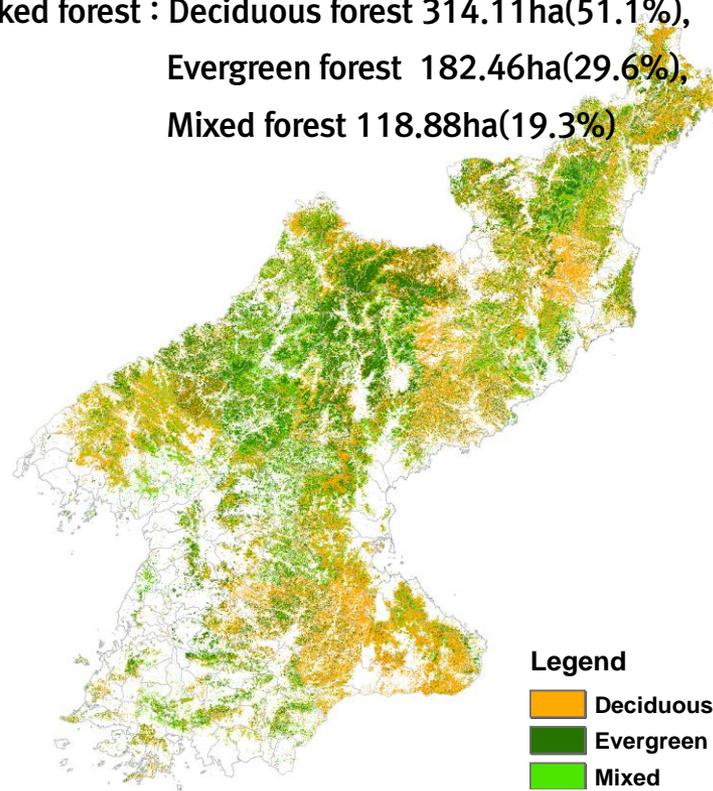
❖ Data : 66 SPOT images(10m resolution)

- Satellite images from 2004 to 2008
- Classification : ISODATA



❖ Results

- Forest area : Approximately 8.98 million ha, 75.45% of DPRK's land area
 - Stocked forest 6.15 mil. ha / Unstocked forest 2.83 mil. ha
- Stocked forest : Deciduous forest 314.11ha(51.1%), Evergreen forest 182.46ha(29.6%), Mixed forest 118.88ha(19.3%)



[Data source] National Institute of Forest Science(NIFoS), 2008



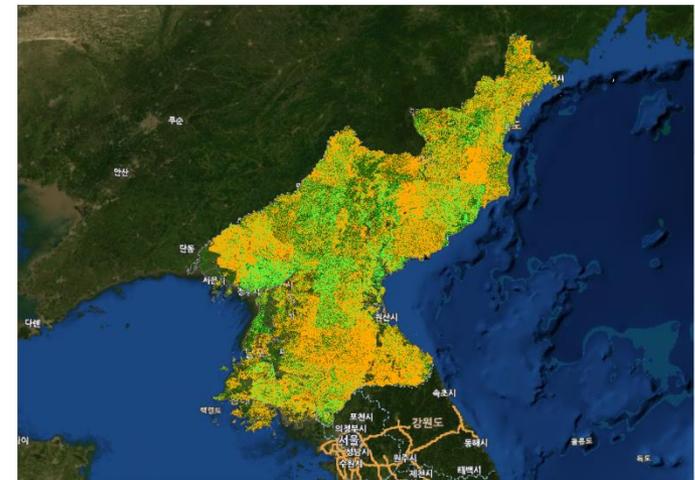
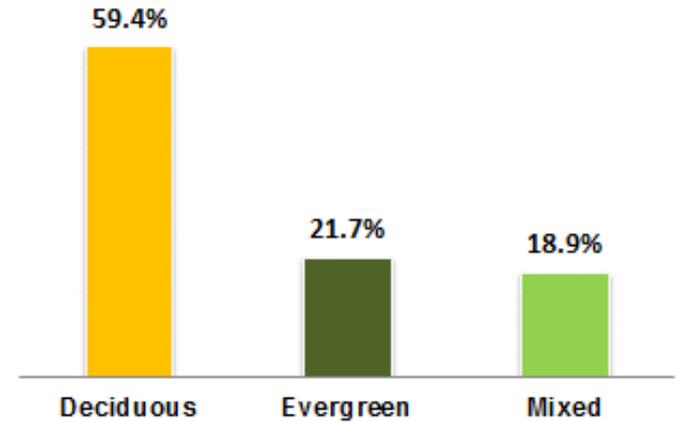
Key results: Fuel Model Index(FMI)

❖ Forest type characteristics of forest fire area in DPRK

- **Deciduous forest 59.4%, Evergreen forest 21.7%, Mixed forest 18.9%**

* (ROK) Evergreen 69.0%, Mixed 16.7%, Deciduous 14.3%

Index	Danger rating	Fuel Model Index
1	Low	-
2		-
3	↑	Mixed
4		Evergreen
5	Moderate	-
6		-
7		-
8	↓	-
9		-
10	High	Deciduous



FMI map



Key results

4

Establishment of topographic information in DPRK

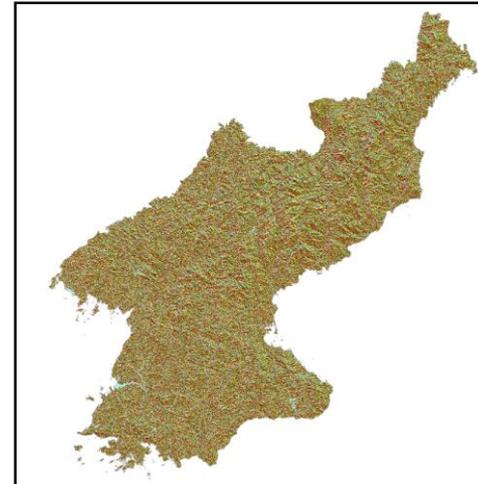
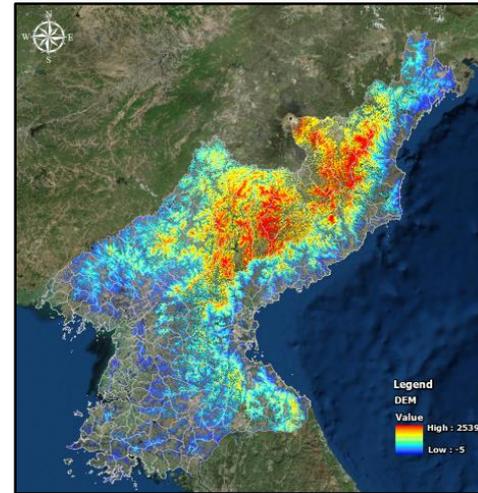
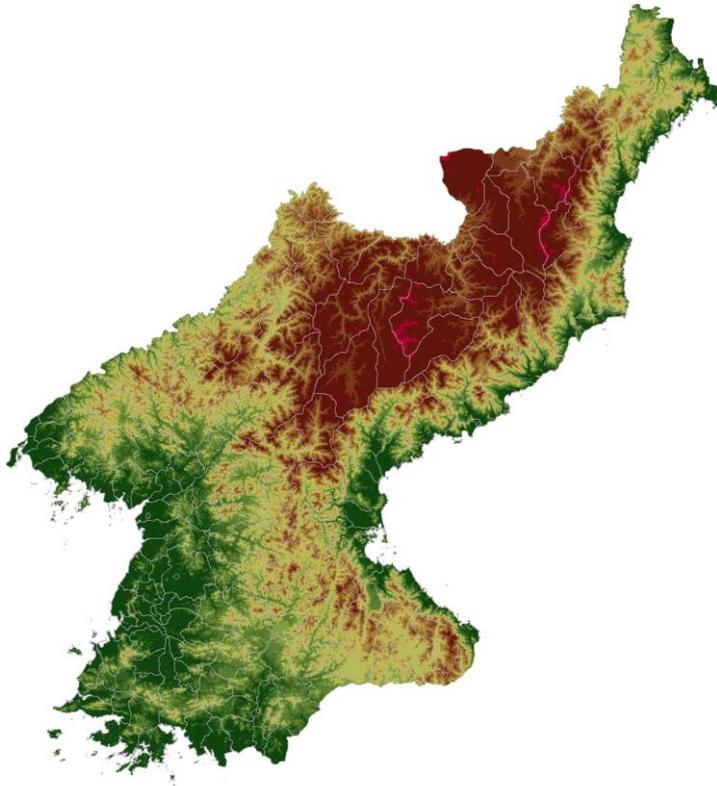
➔ Development of Topography Model Index (TMI) model



Materials and Methods: Topographic info. in DPRK

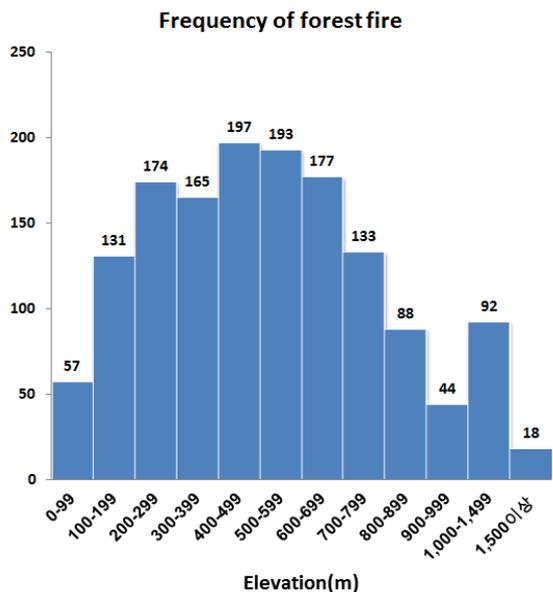
❖ Analysis data : 1" DEM(30m grid)

– Extraction info. : elevation and aspect distribution map





Key results: Topography Model Index(TMI)

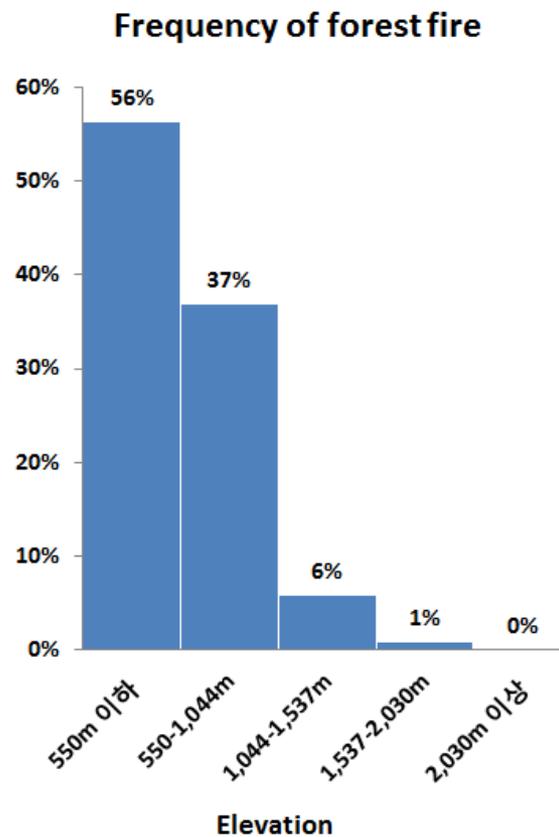


mean(μ) : 796m, Max : 2,539m, S.D.(δ) : 493m

Intervals	Elevation	Fire freq.	Ratio
$x \leq \mu - 1/2 \delta$	Less than 550m	828	56%
$\mu - 1/2 \delta < x \leq \mu + 1/2 \delta$	550-1,044m	542	37%
$\mu + 1/2 \delta < x \leq \mu + 3/2 \delta$	1,044-1,537m	85	6%
$\mu + 3/2 \delta < x \leq \mu + 5/2 \delta$	1,537-2,030m	14	1%
$\mu + 5/2 \delta < x$	More than 2,030m	0	0%
Total		1,469	100%

❖ Results

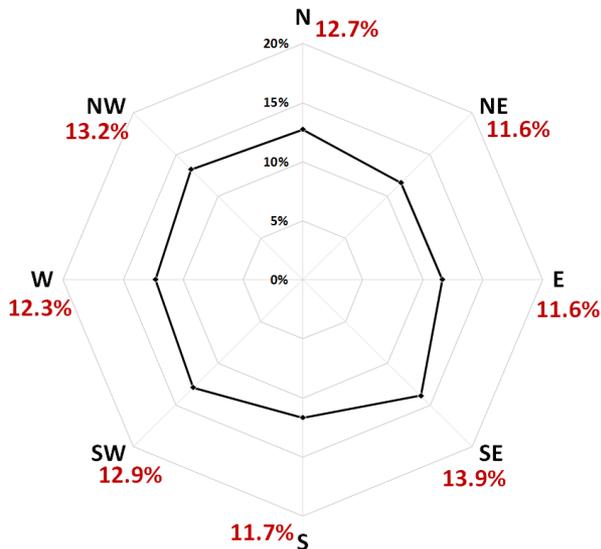
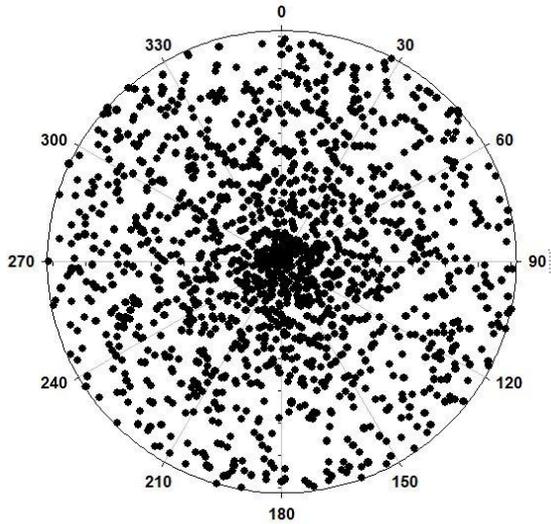
- (Freq. analysis) extraction of altitude Info. of fire spot points in forest area
 - 1,469 fire spot points
 - It is divided into 5 classes using the average of the altitude and the standard deviation.





Key results: Topography Model Index(TMI)

Distribution of 1,469 hot spots by aspect



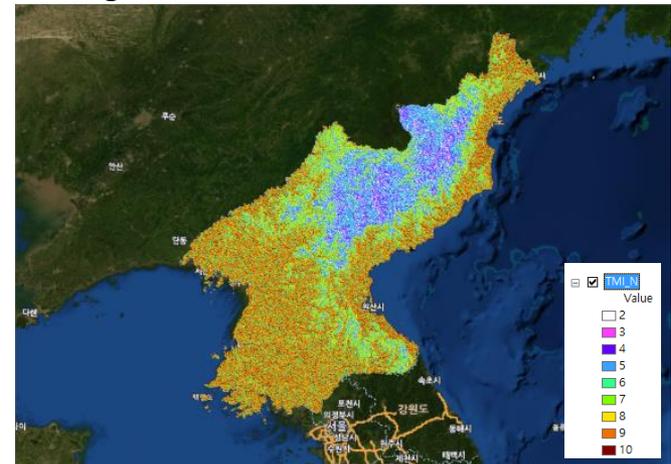
❖ Results

- (Freq. analysis) extraction of aspect Info. of fire spot points in forest area

- 1,469 fire spot points
- Eight aspect analysis of fire spot points

Index	Danger rating	Topography Model Index	
		Aspect	Elevation
0.5	Low		≥ 1,537m
1.0		NE/E/S	1,044-1,537m
1.5	↑		
2.0		W	
2.5	Moderate		
3.0		SW/N	
3.5		NW	550-1,044m
4.0	↓		
4.5			
5.0	High	SE	550m≤

TMI map





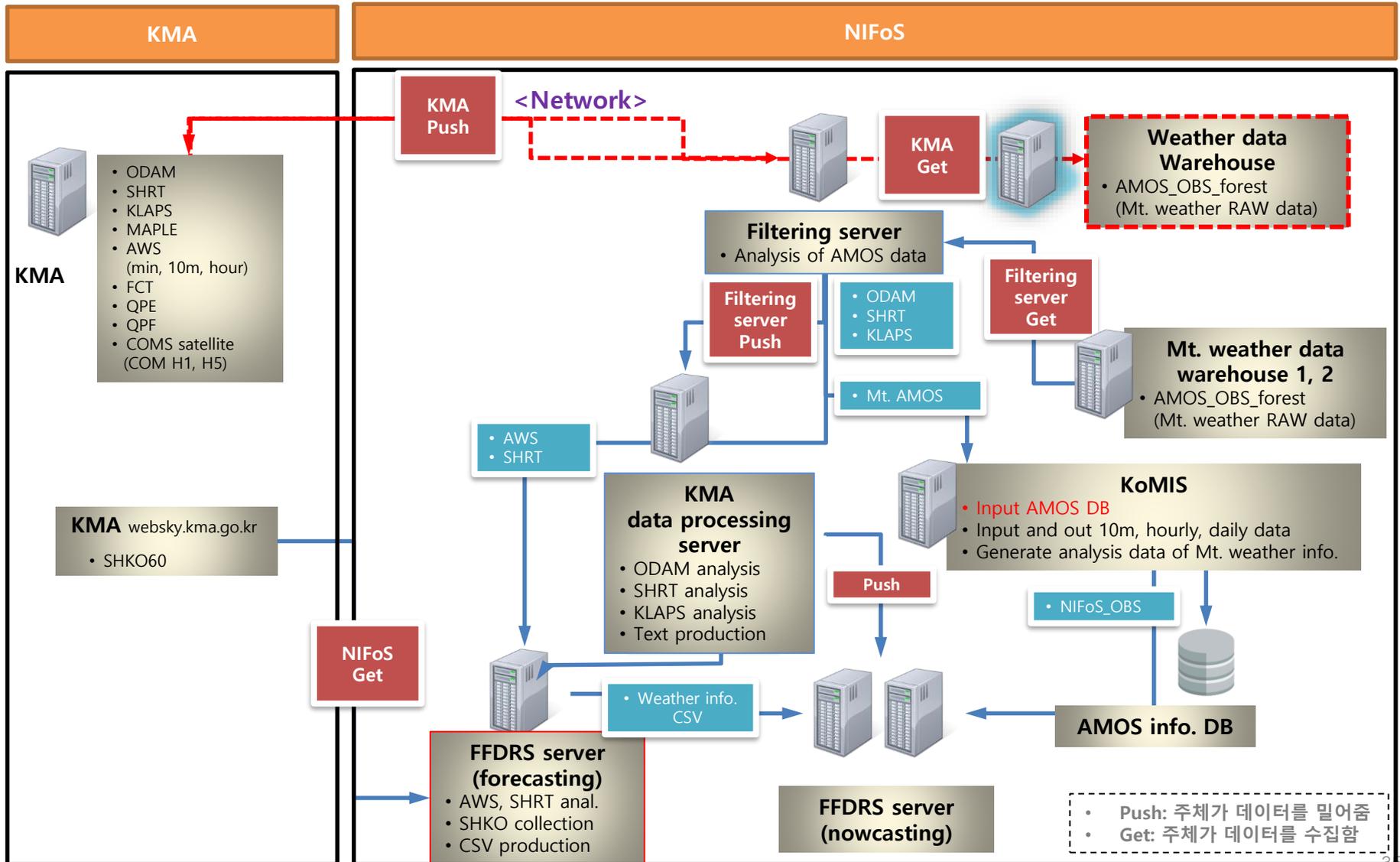
Key results

5 Verification of the statistical model by case study

➔ Development of forest fire danger rating system(FFDRS) in DPRK

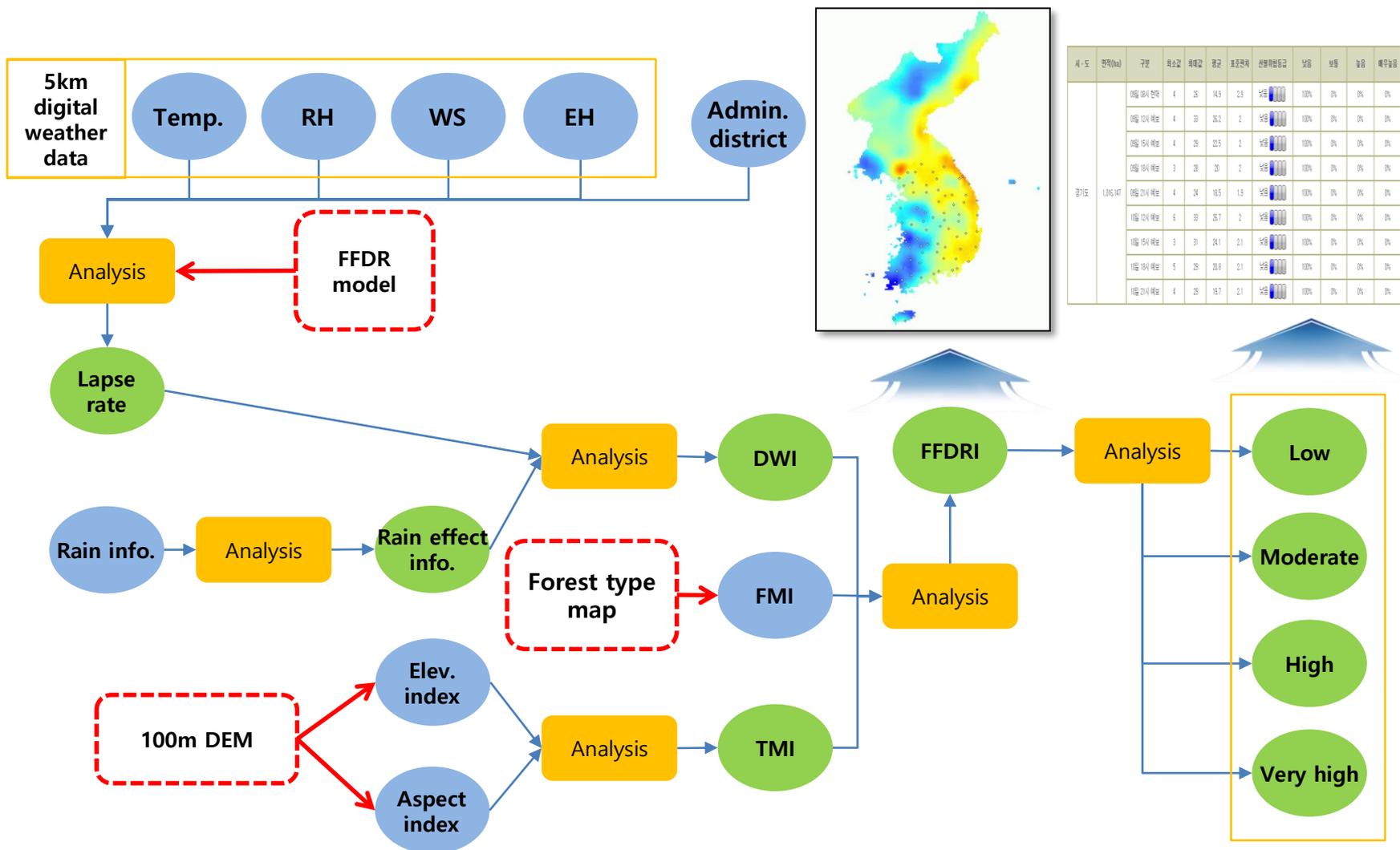


Real-time weather info. sharing system



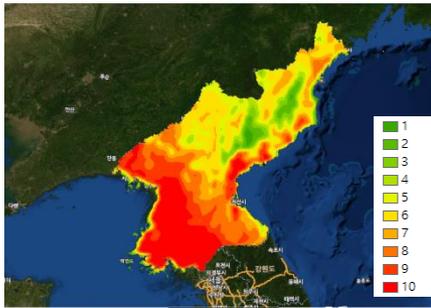


Analysis flow chart for processing FFDR I

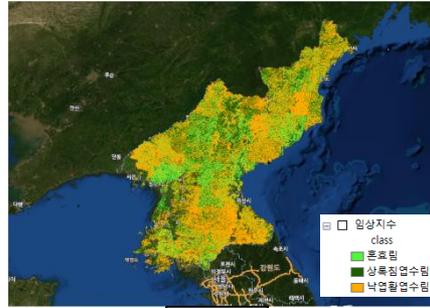




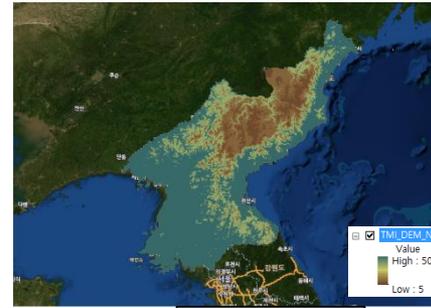
Automation of FFDRI Process Model



DWI



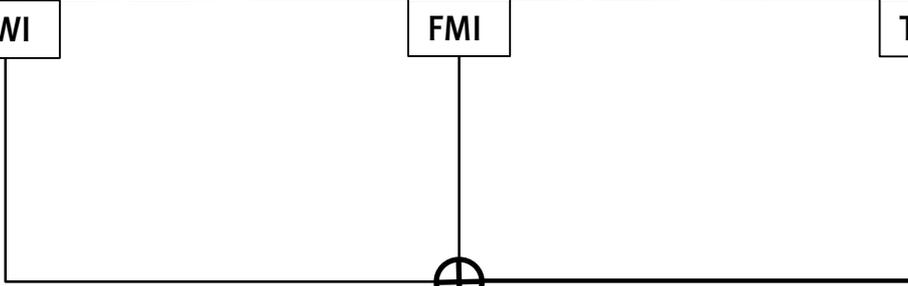
FMI



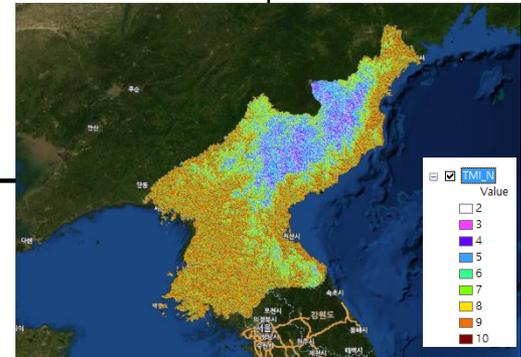
TMI_Elev.



TMI_Aspect

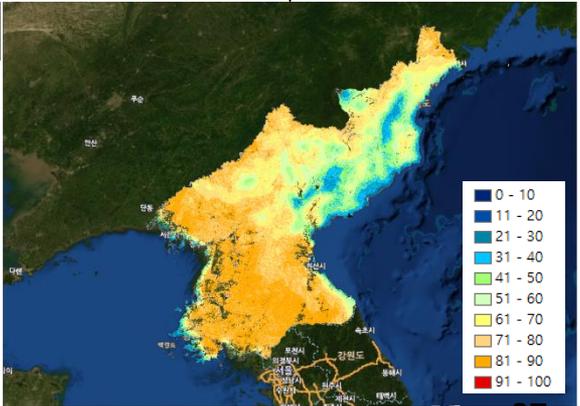


$$\sum_{k=0}^n$$



TMI

Fire Danger Rating Index





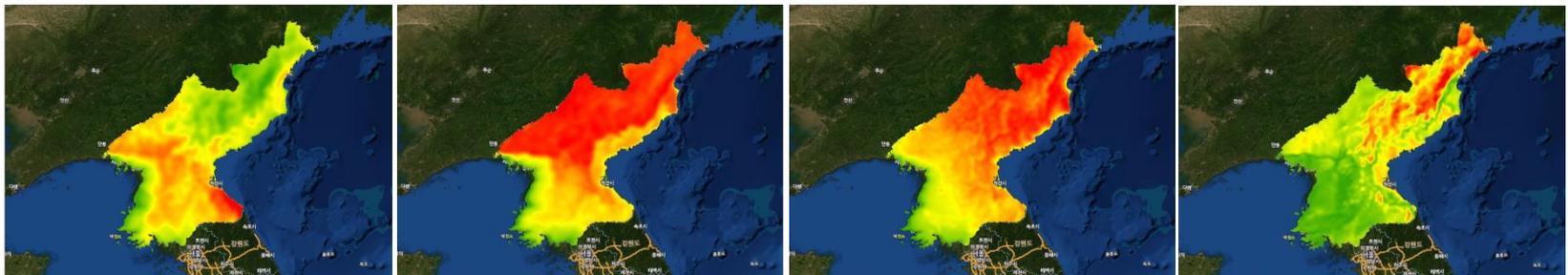
Simulation of actual FF case of statistical model (Case Study)

2014 yr (DD)	(MM)	3	4	5	6	7	8	9	Fires
1		1	5	19					25
2			15	4					19
3				19					19
4			1	3					4
5	2								2
6			9	21	1				31
7			5						5
8	1		6						7
9			21						21
10			3	5					8
11			36			1			37
12			9			1	1		11
13			16			1		1	18
14	1		8		1				10
15	1		51						52
16			29						29
17			2	1					3
18			27	2					29
19	1		2						3
20			6	4					10
21	1		3						4
22	4		26	3					33
23	2		22	2					26
24	2		28						30
25			70						70
26	6		1						7
27	4		1	1					6
28	6								6
29			15	5					20
30			7						7
31				2					2
Fires	32		424	91	2	3	1	1	554

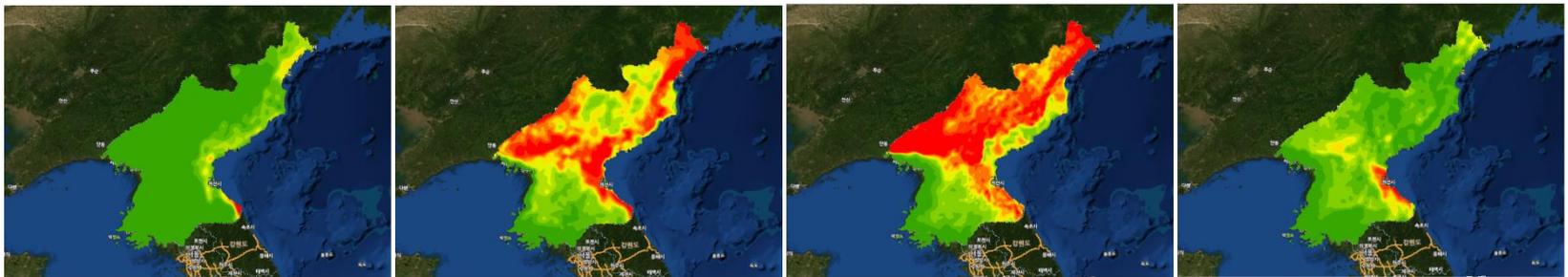
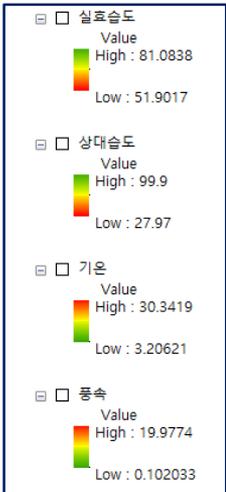


Simulation of actual FF case of statistical model (Case Study)

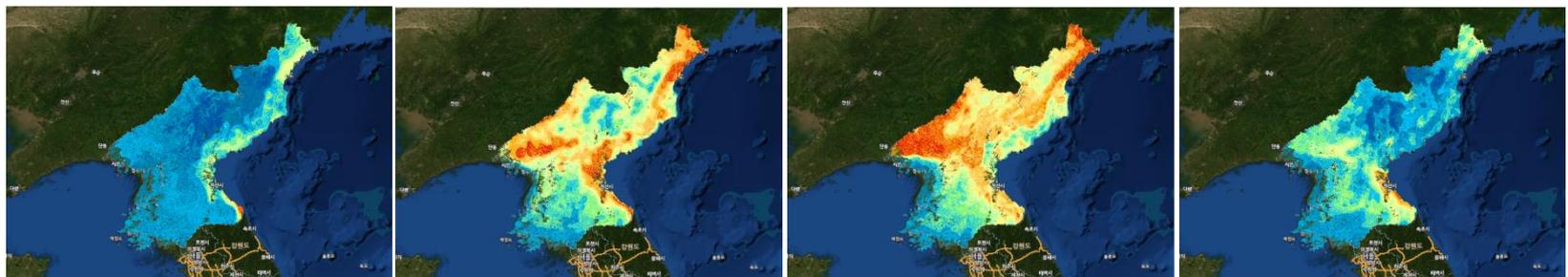
[April 15, 2017]



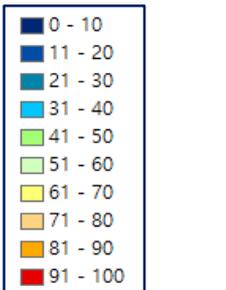
15hr, Temp./RH/EH/WS



Daily Weather Index(DWI) 09hr/12hr/15hr/18hr



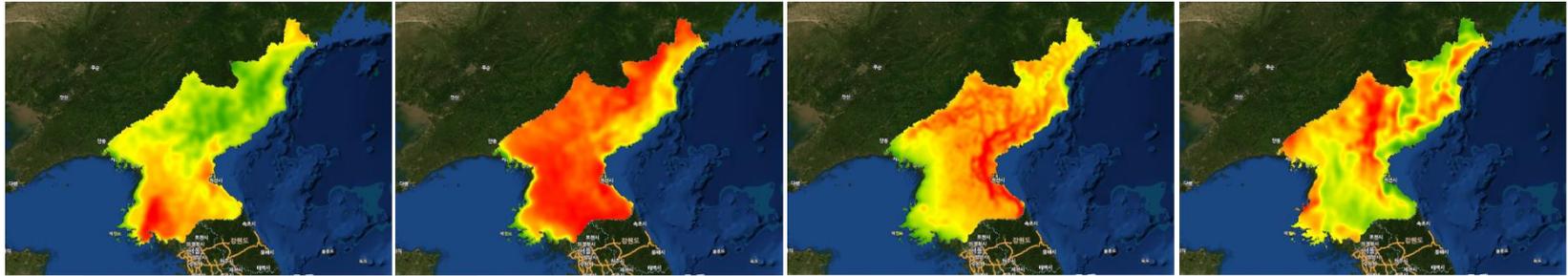
(FFDRI) 09hr/12hr/15hr/18hr



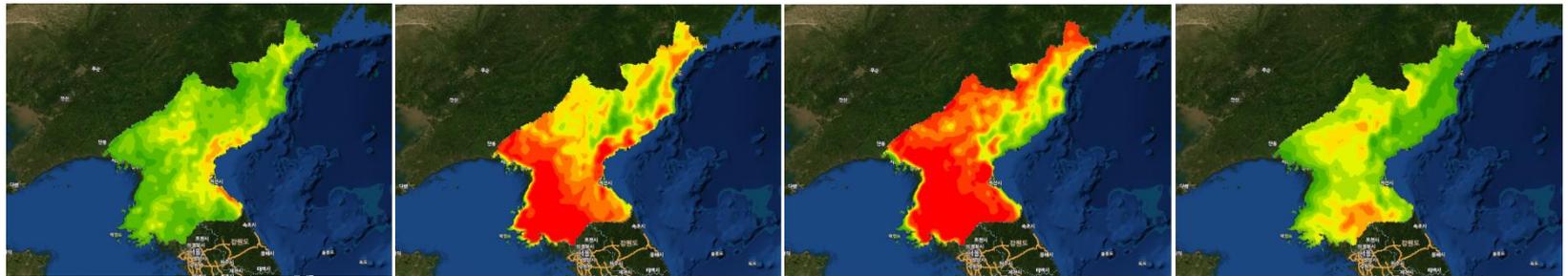
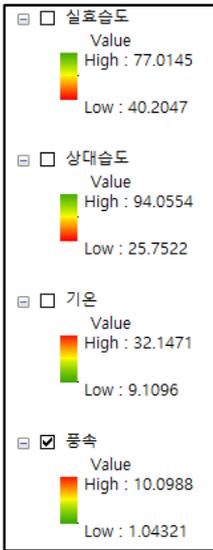


Simulation of actual FF case of statistical model (Case Study)

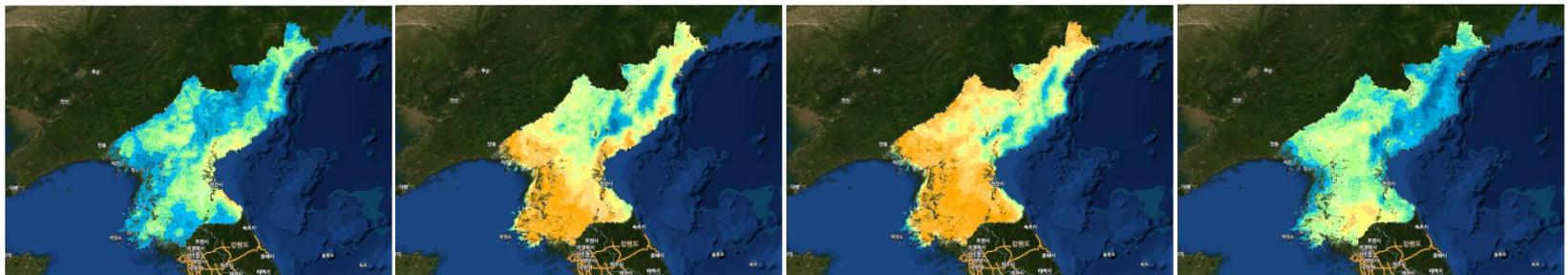
[April 25, 2017]



15hr, Temp./RH/EH/WS



Daily Weather Index(DWI) 09hr/12hr/15hr/18hr

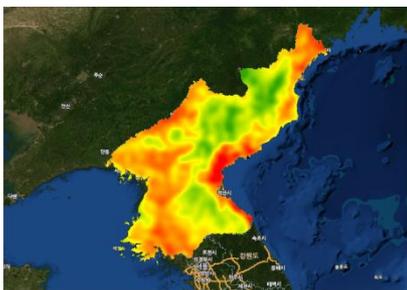


(FFDRI) 09hr/12hr/15hr/18hr

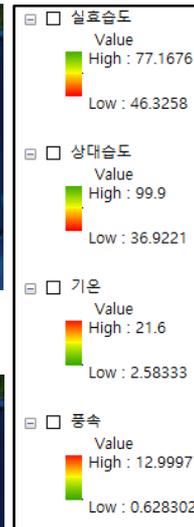
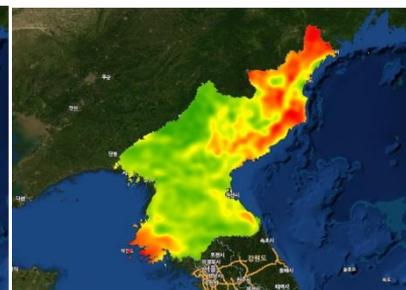
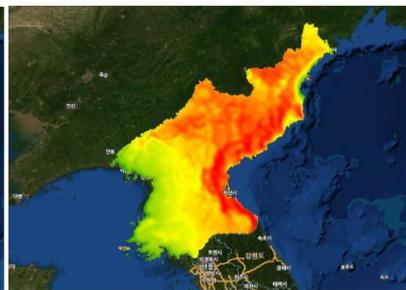
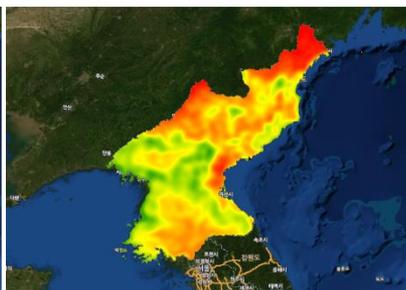


Simulation of actual FF case of statistical model (Case Study)

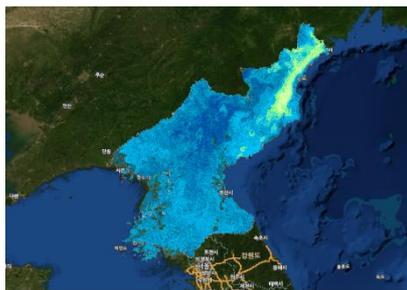
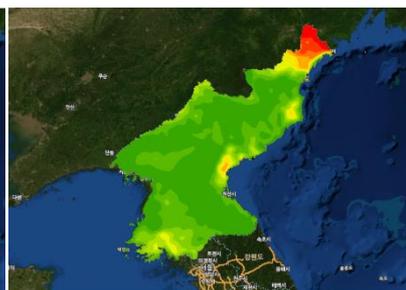
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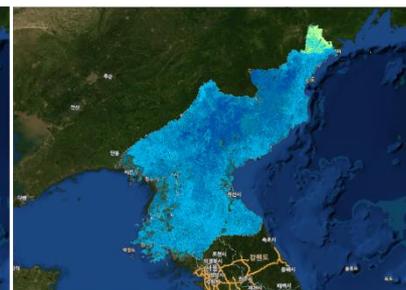
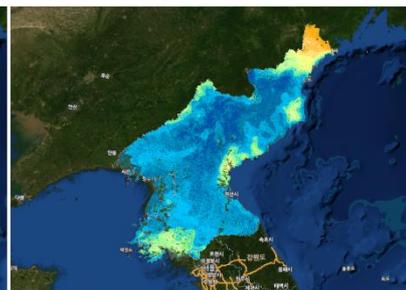
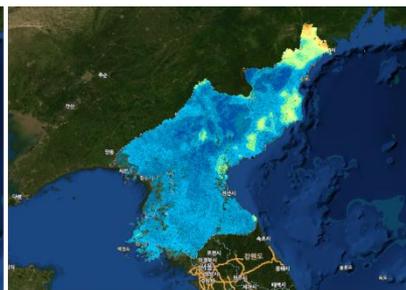
15hr, Temp./RH/EH/WS



Daily Weather Index(DWI) 09hr/12hr/15hr/18hr



(FFDRI) 09hr/12hr/15hr/18hr



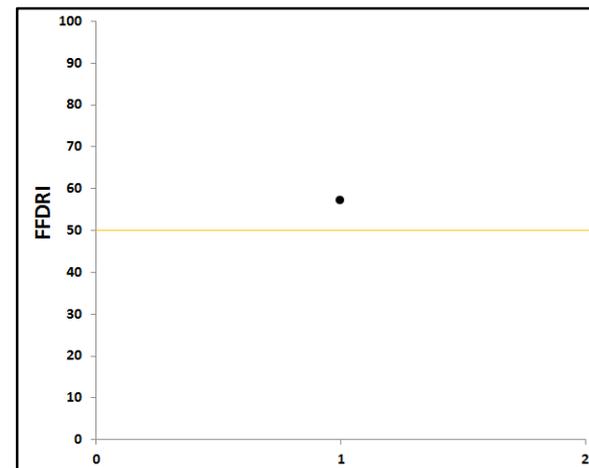
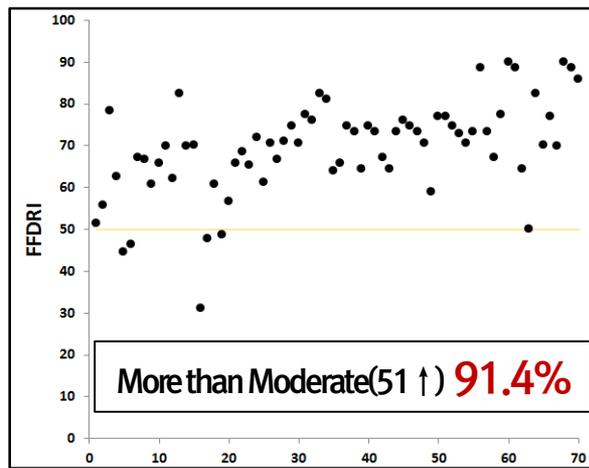
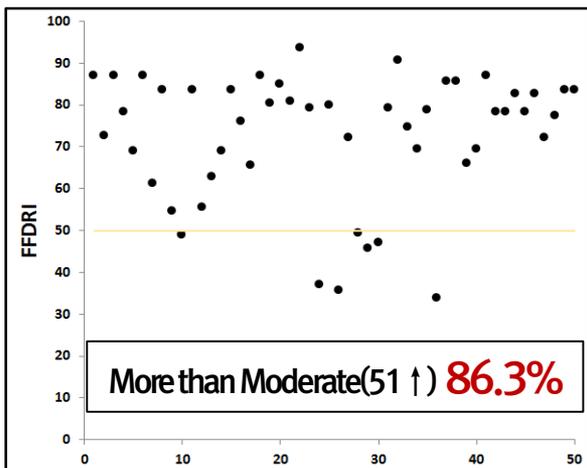
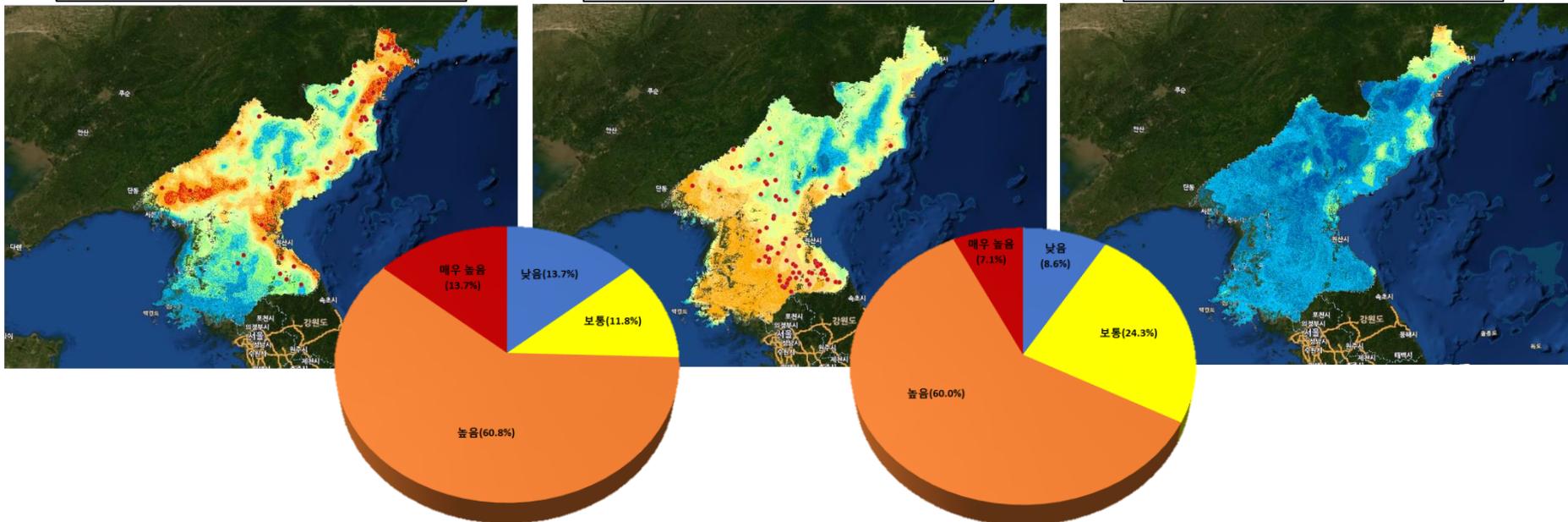


Simulation of actual FF case of statistical model (Case Study)

April 15, 2014(51 forest fires)

April 25, 2014(70 forest fires)

April 27, 2014(1 forest fire)





Development of FFDRS in DPRK

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현재실황 : 2017년 10월 29일 15시 30분 발표

[행정구역도](#)
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[항공사진](#)

현재 산불위험지수

지역	등급	지수
전국		17.4
자강도		15.9
함경북도		17.4
함경남도		16.5
황해북도		18.3
황해남도		18.4
개성		17.5
강원도		19.1
평안북도		18.1
평안남도		16.9

소속기관 바로가기 이동

관련사이트 바로가기 이동

[02455] 서울특별시 등대문구 회기로 57 국립산림과학원 산림보전부 기후변화연구센터 대표전화: 02-961-2683, FAX: 02-961-2914

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FFDRI

Thank you for attention!

