Impact Assessment on Temperate Fruits using High-Definition Digital Climate Maps under Projected Climate Change in Korea
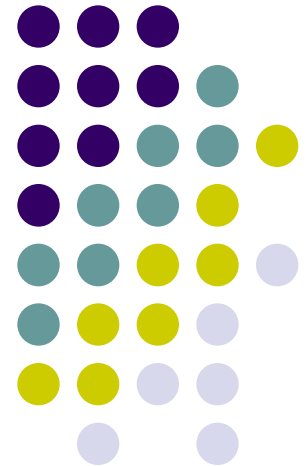
Jin-Hee Kim*, Soo-Ock Kim*, Jin I. Yun**, Byong-Lyol Lee*

* National Center for AgroMeteorology
** Kyung Hee University
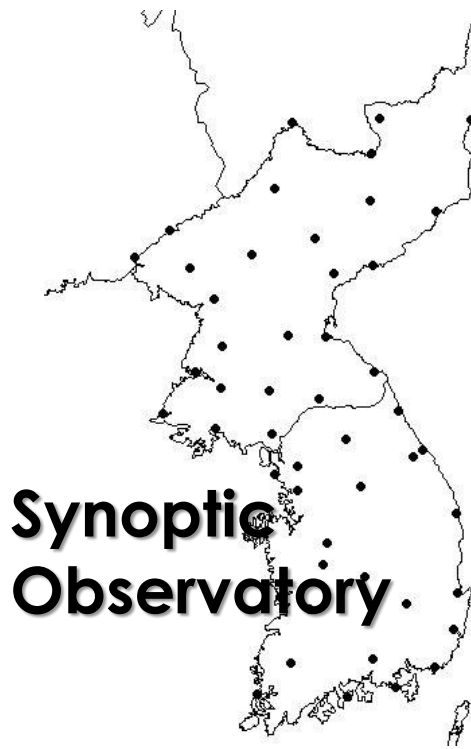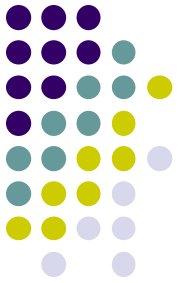Republic of Korea

Contents

I.   High Definition DCM

II. Derived DCMs

III. Applied DCMs

    - case study

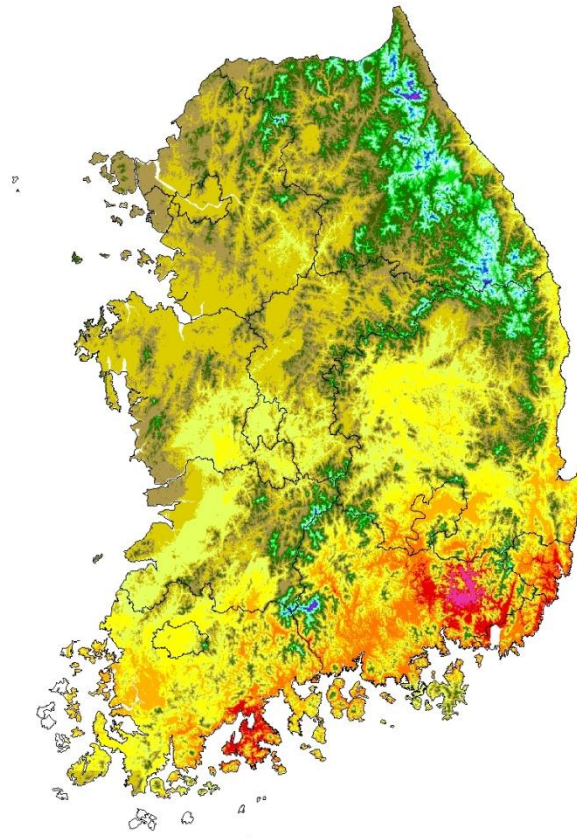   - impact assessment

I. High Definition DCM

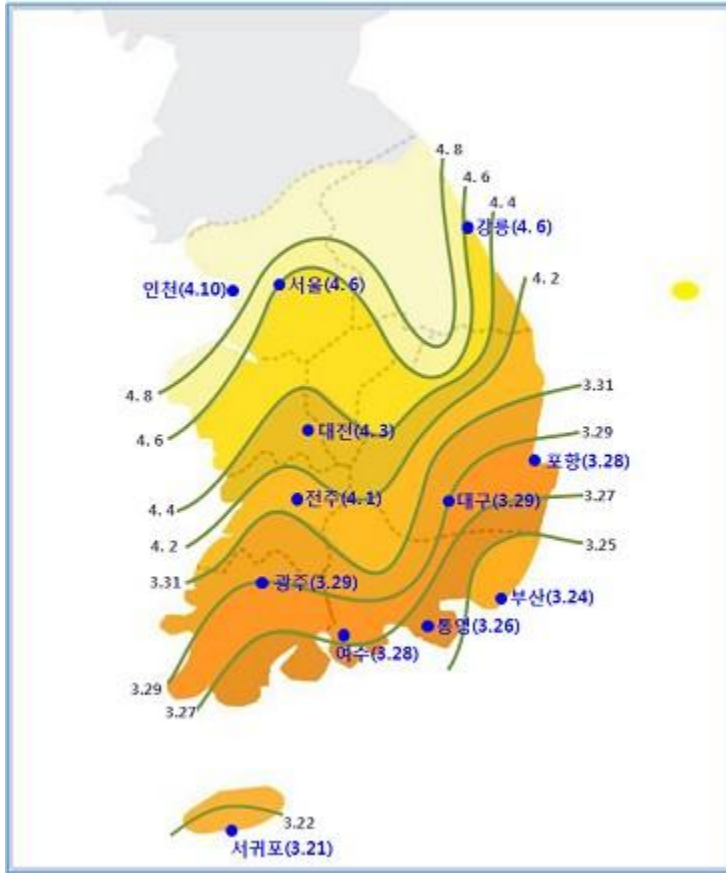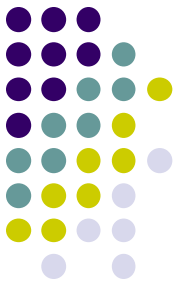**Synoptic Observatory**

Synoptic Climate Map

AWS

Limited optimal condition

I. High Definition DCM
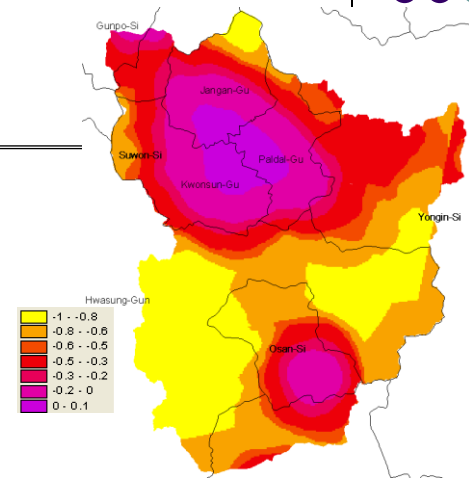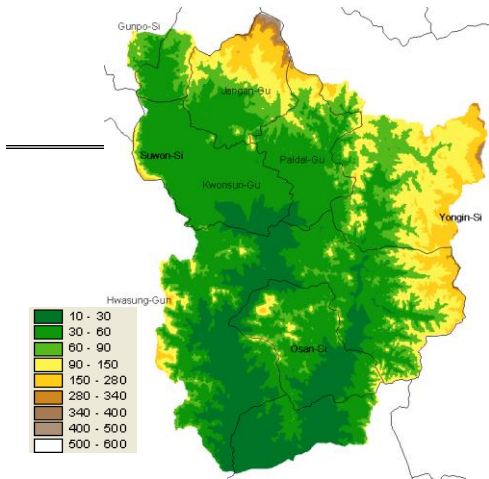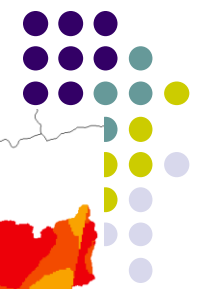
Estimation of Site-specific Climates

- **Site-specific climates : Micro climate, Local climate**
- **Geospatial climatology : Estimation of site-specific climate (deviation) from a given synoptic condition (mean) based on spatial data such as topography, vegetation, land cover etc.**

Synoptic Climate Map

Numerical-Empirical Model

Digital Climate Maps (DCM)

Altitude

Urban Effect

Synoptic Climate

Geospatial Climatology

Local Climate
(10~30m Grid)

Vegetation

Topoclimatic Effect

Legend (upper left):
10 - 30
30 - 60
60 - 90
90 - 150
150 - 280
280 - 340
340 - 400
400 - 500
500 - 600

Legend (upper right):
-1 - -0.8
-0.8 - -0.6
-0.6 - -0.5
-0.5 - -0.3
-0.3 - -0.2
-0.2 - 0
0 - 0.1

Legend (lower left):
Waters
Urban
Bare Ground
Swamp
Grassland
Forest
Farmland

Legend (lower right):
0 - 0.5
0.5 - 1.1
1.1 - 1.6
1.6 - 2.1
2.1 - 2.7
2.7 - 3.2
3.2 - 3.7
3.7 - 4.3
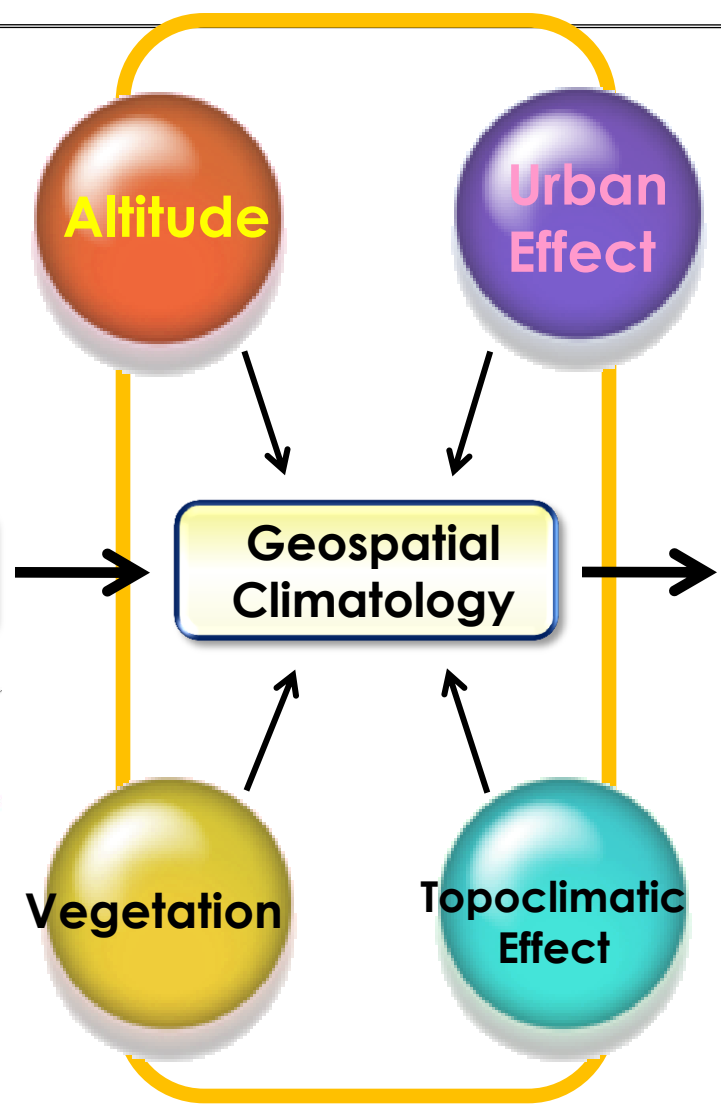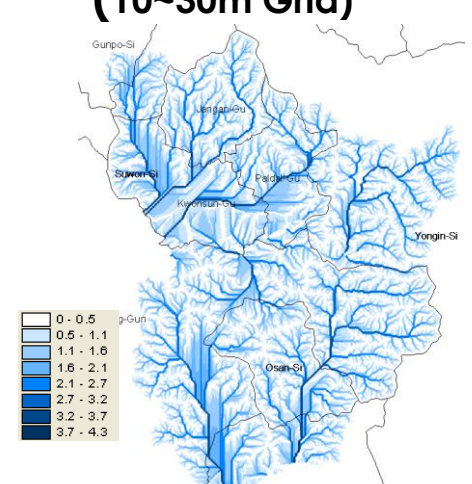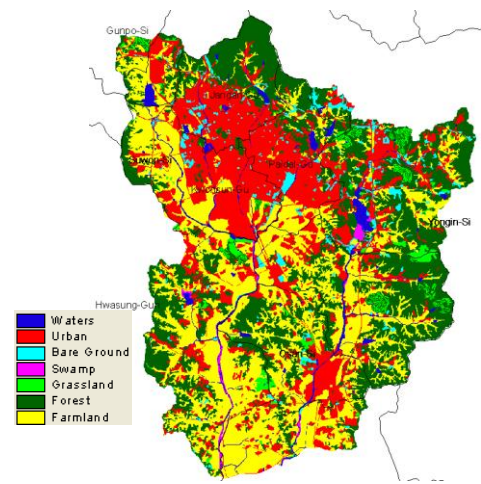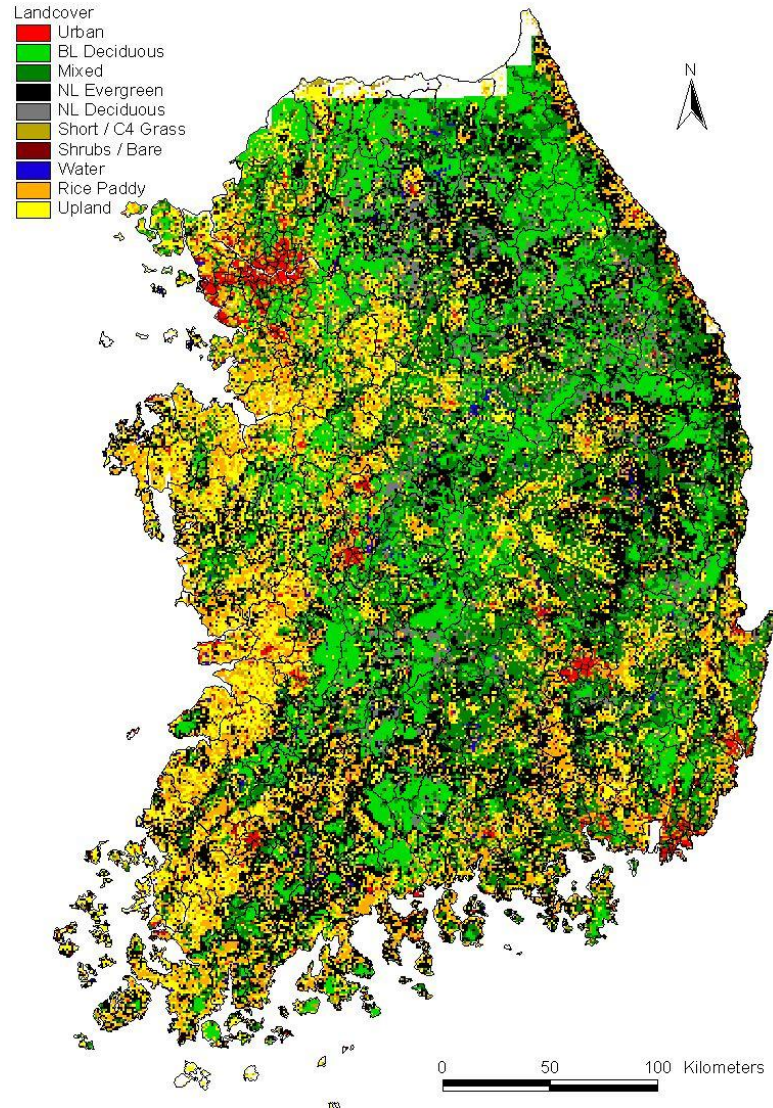
I. High Definition DCM

Topography and Geography
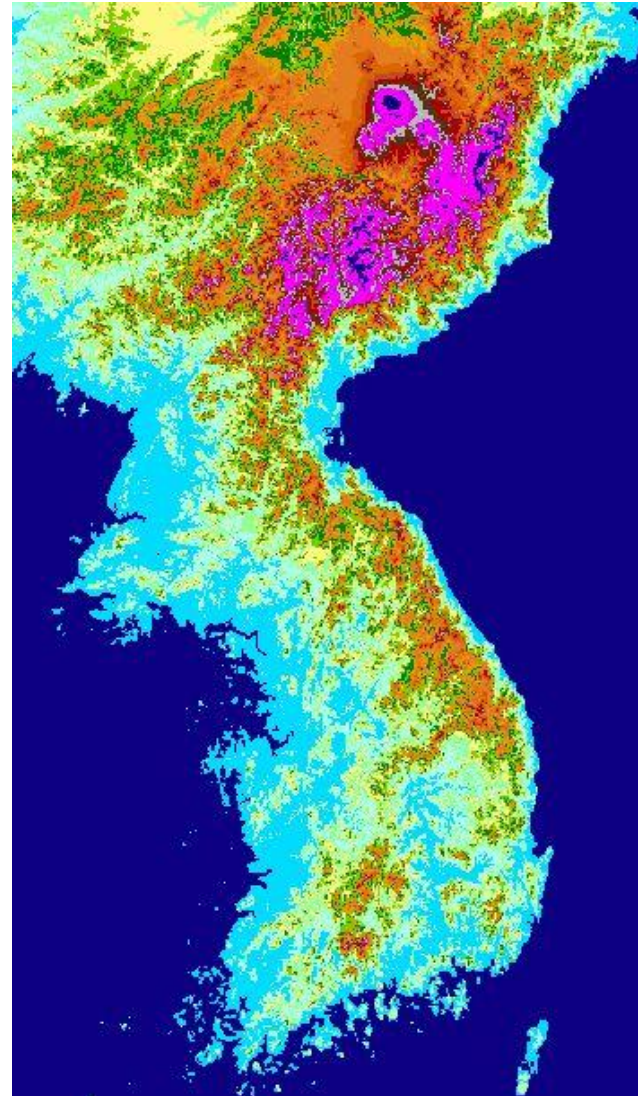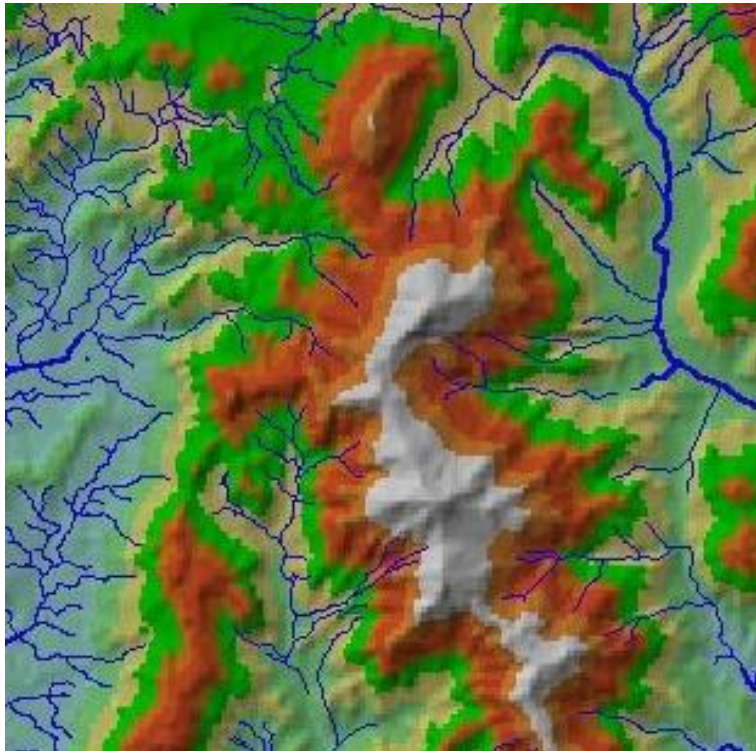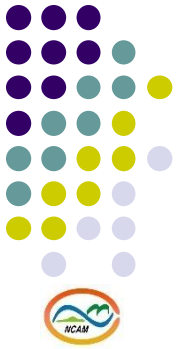
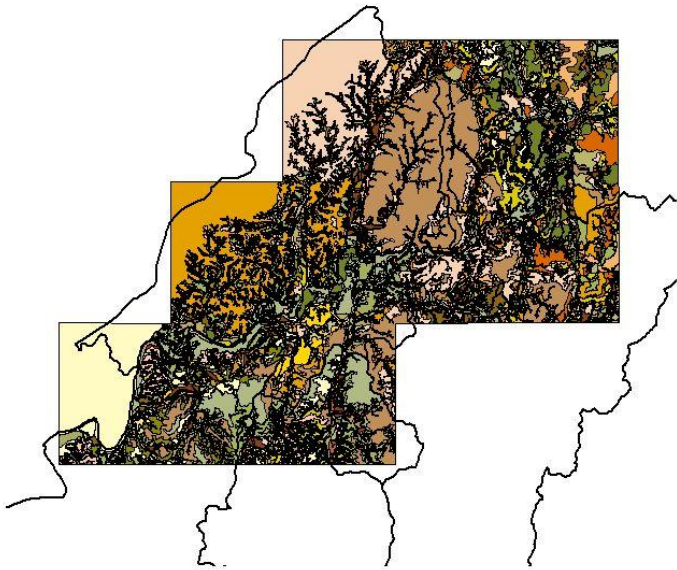# I. High Definition DCM

Land Cover and Land Use

Land Cover
- Urban
- Rice Paddy
- Upland
- Plastic House
- Orchards
- Other Crops
- Broadleaf
- Needleleaf
- Mixed Forest
- Grassland
- Barren
- Water

Landcover
- Urban
- BL Deciduous
- Mixed
- NL Evergreen
- NL Deciduous
- Short / C4 Grass
- Shrubs / Bare
- Water
- Rice Paddy
- Upland

0   50   100 Kilometers
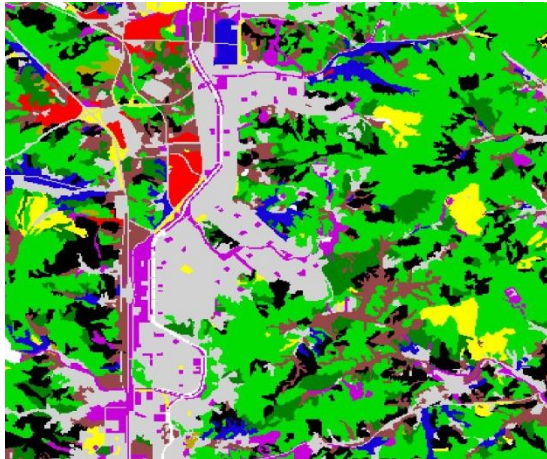
Soil

Sandy Loam
Loam
Silty Clay Loam
Clay Loam
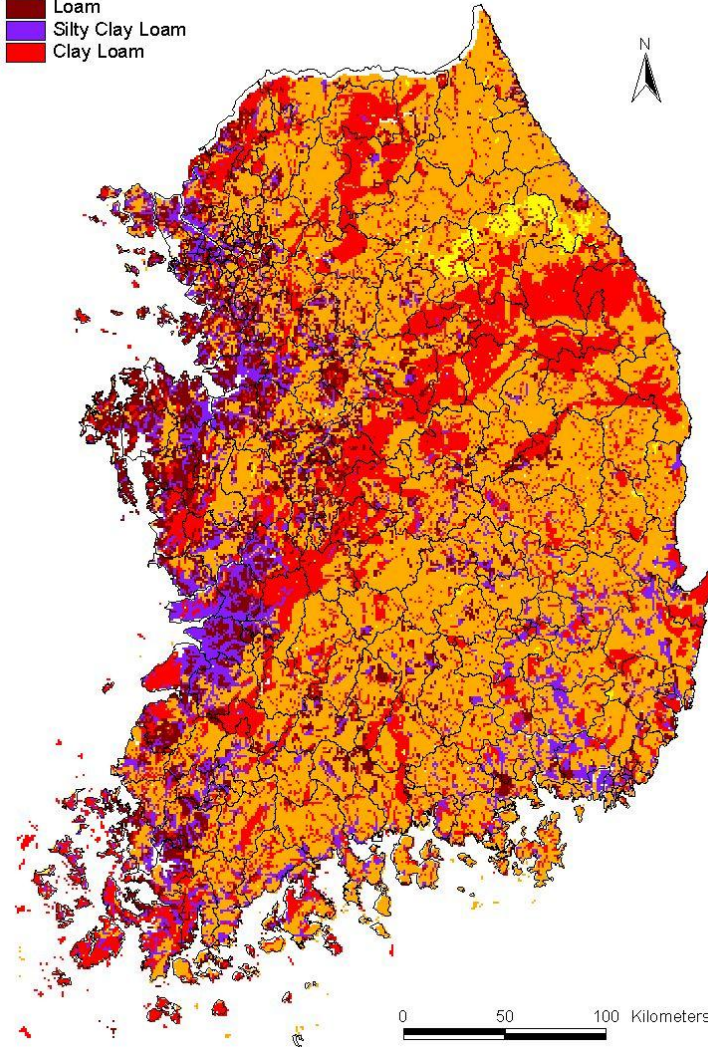
Digital Elevation Model

ELEVATION(m)
600 - 650
650 - 700
700 - 750
750 - 800
800 - 900
900 - 1000
1000 - 1100
1100 - 1200
1200 - 1300
1300 - 1500
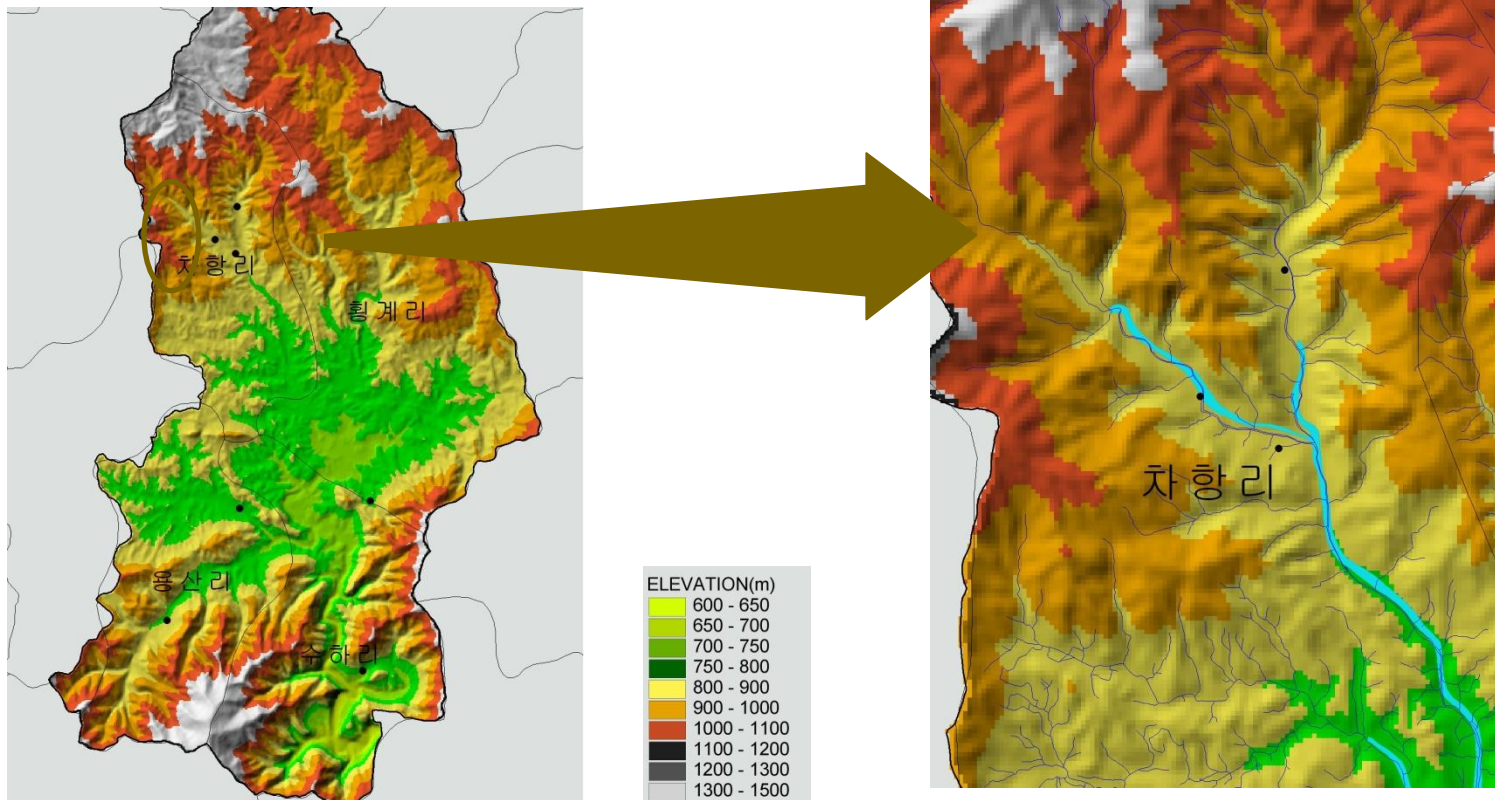
T101005DEM

I. High Definition DCM

Overheating Index of Jan. (normal)

OHI
- -0.4 - -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - 0
- 0
- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
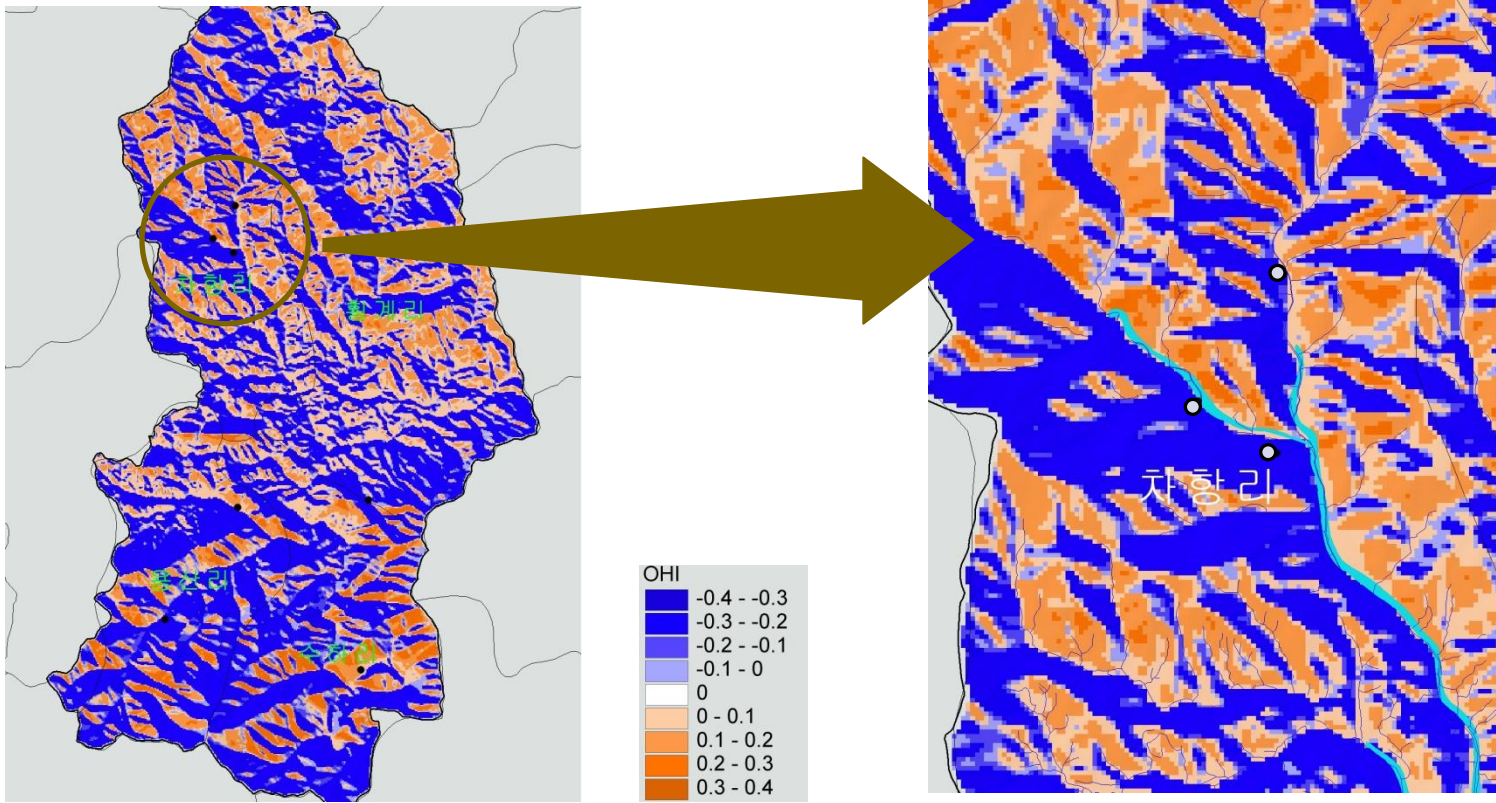
T101005OHI015

I. High Definition DCM

Monthly Max. Temp at Jan.

TEMPERATURE(C)
- -7 - -6
- -6 - -5
- -5 - -4
- -4 - -3
- -3 - -2
- -2 - -1
- -1 - 0
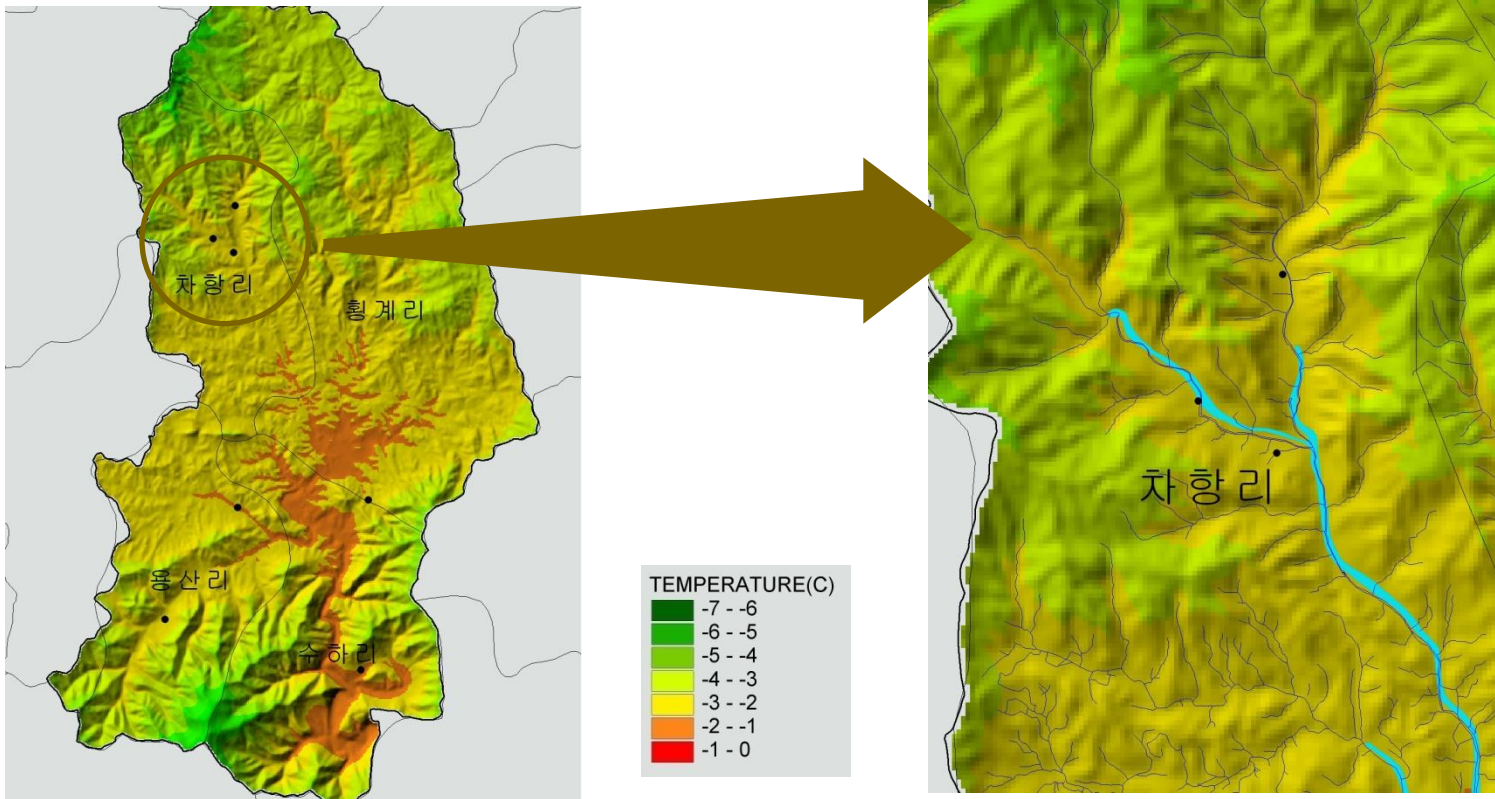
T101005tnu_01

I. High Definition DCM

Cold air drainage effect at Jan.

E2	
	0 - 0.5
	0.5 - 1
	1 - 1.5
	1.5 - 2
	2 - 2.5
	2.5 - 3
	3 - 3.5
	3.5 - 4

T101005E2_01

Monthly Min. Temp at Jan.

TEMPERATURE(C)
- -15 - -14
- -14 - -13
- -13 - -12
- -12 - -11
- -11 - -10
- -10 - -9
- -9 - -8
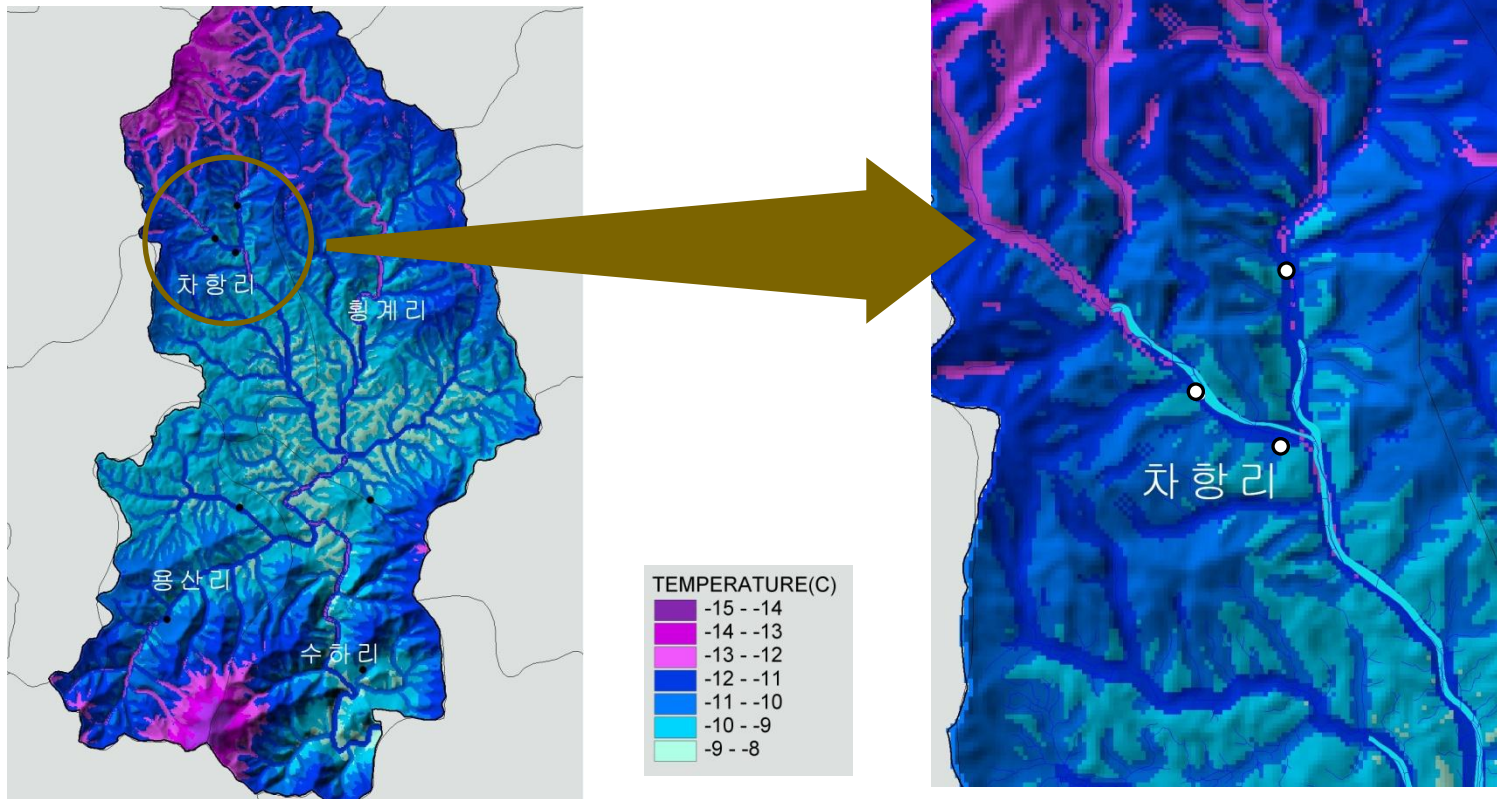
T101005tx_01

I. High Definition DCM

Temperature Distribution

Radiation

Legend:

- °ł żď
- Ŕúľ̈ö Áö
- ŔĎ»ç , MJ/m2
  - 2 - 3
  - 3 - 4
  - 4 - 5
  - 5 - 6
  - 6 - 7
  - 7 - 8
  - 8 - 9
  - 9 - 10
  - 10 - 11
  - 11 - 12
  - 12 - 13
  - 13 - 14
  - 14 - 15
  - 15 - 16
  - 16 - 17
  - 17 - 18
  - No Data

Rainfall

August, mm

- 0 - 80
- 80 - 180
- 180 - 220
- 220 - 250
- 250 - 270
- 270 - 290
- 290 - 320
- 330 - 390
- 390 - 630
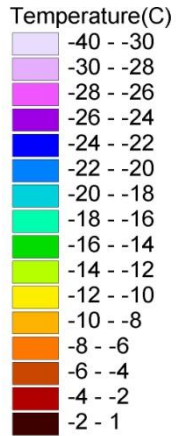- No Data
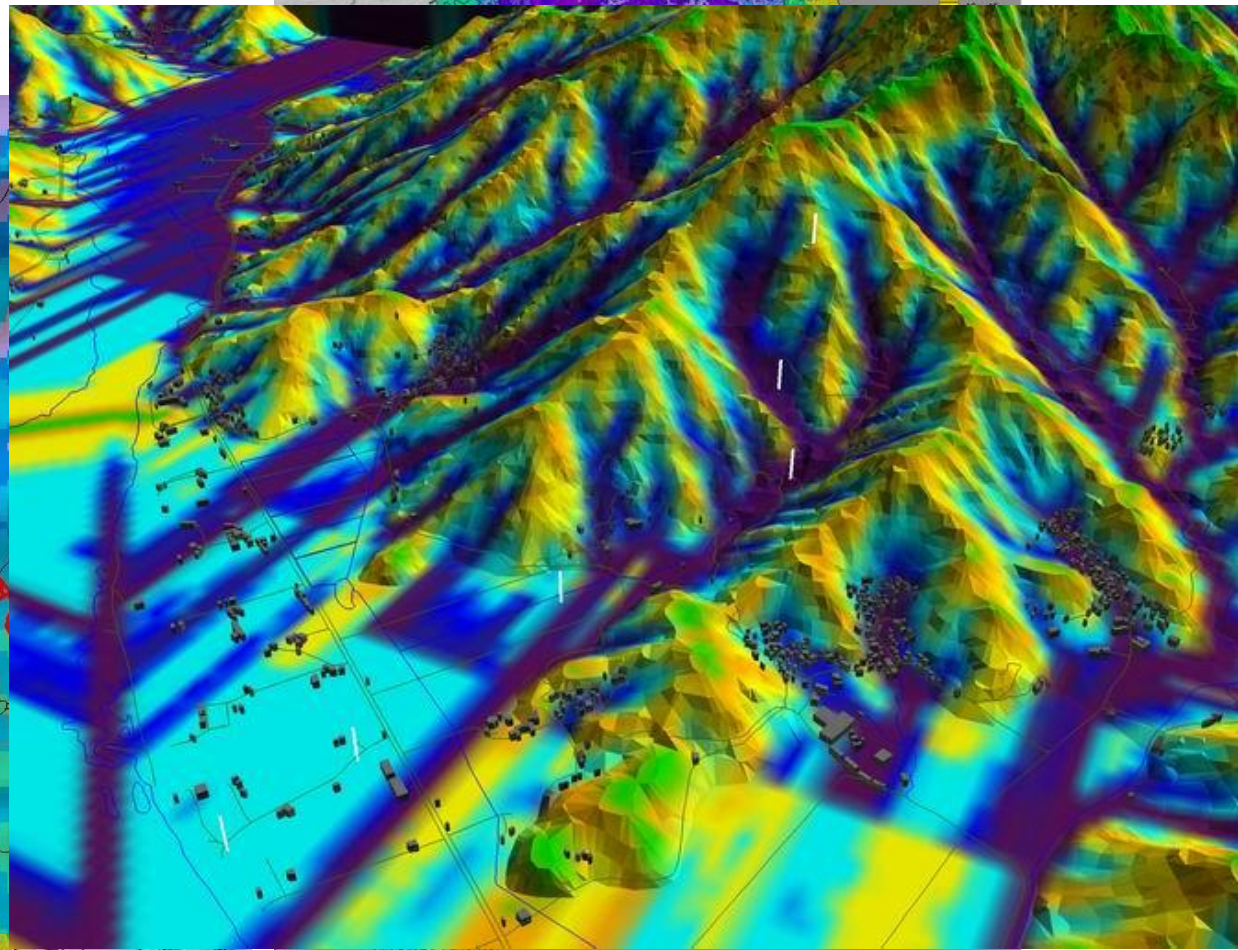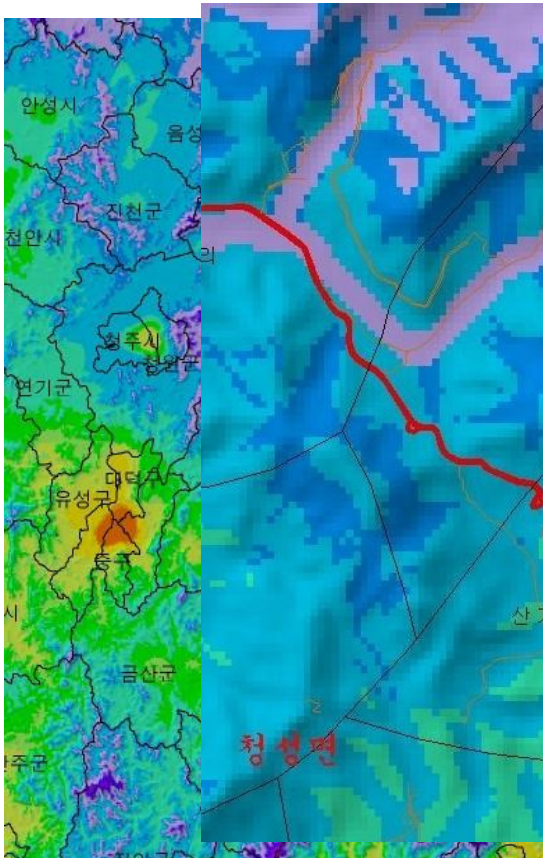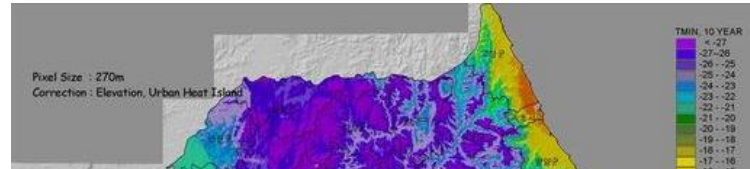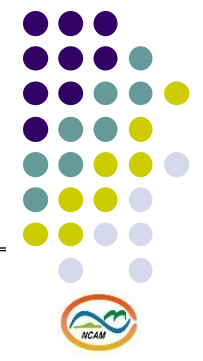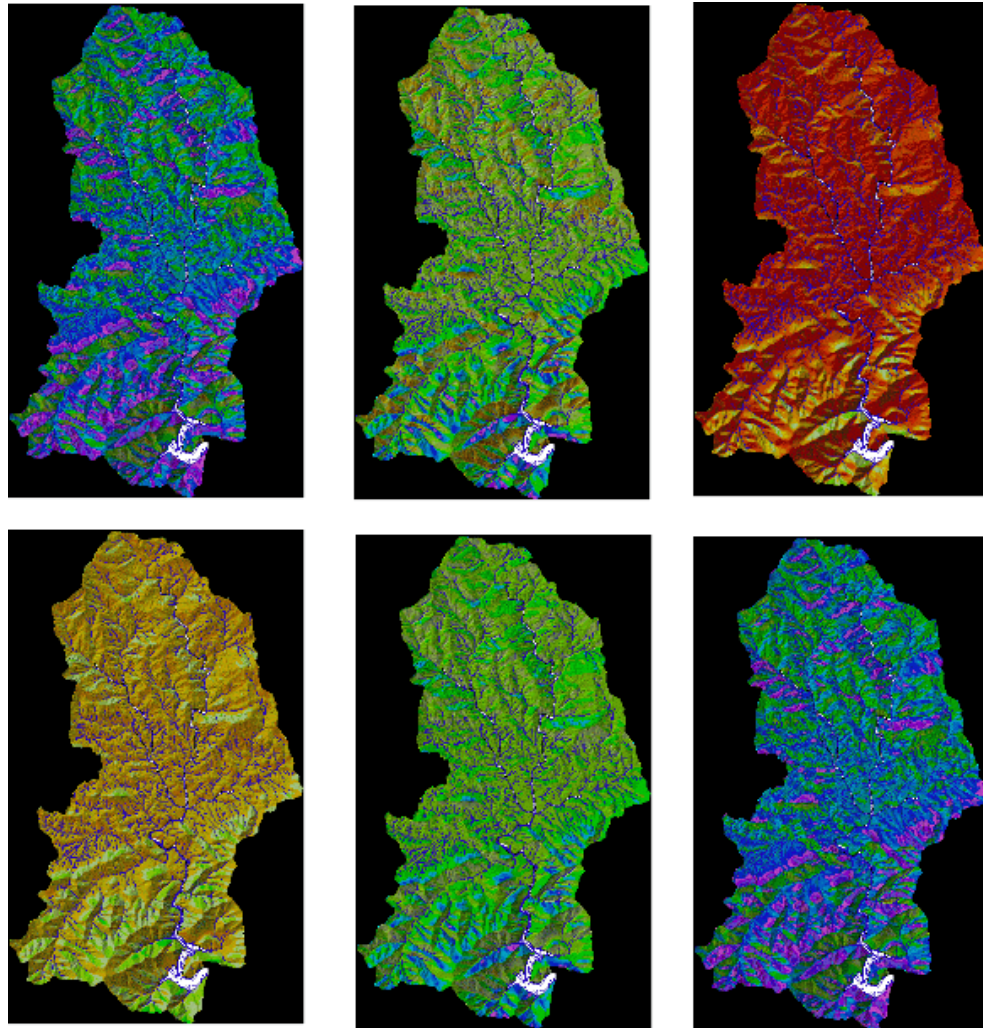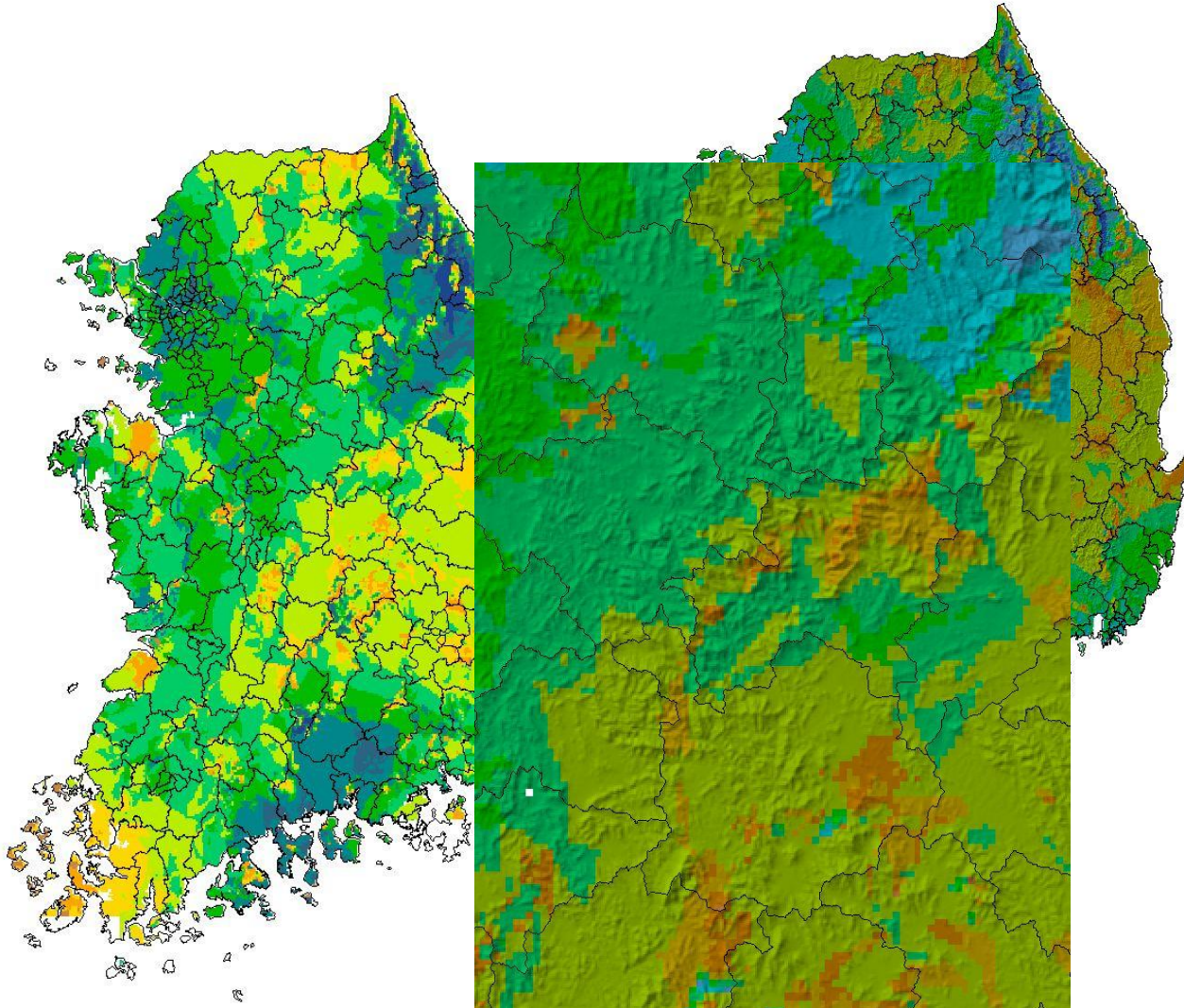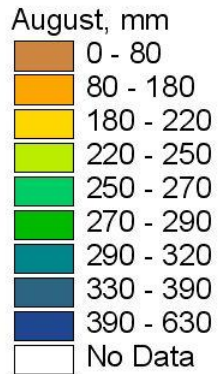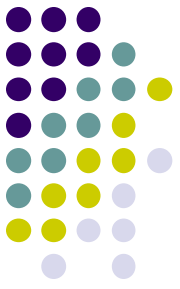
I. High Definition DCM

Field Calibration and Valdidation
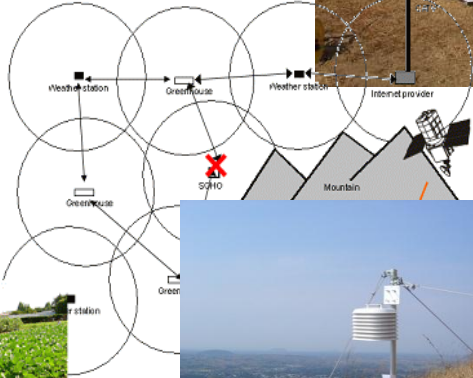
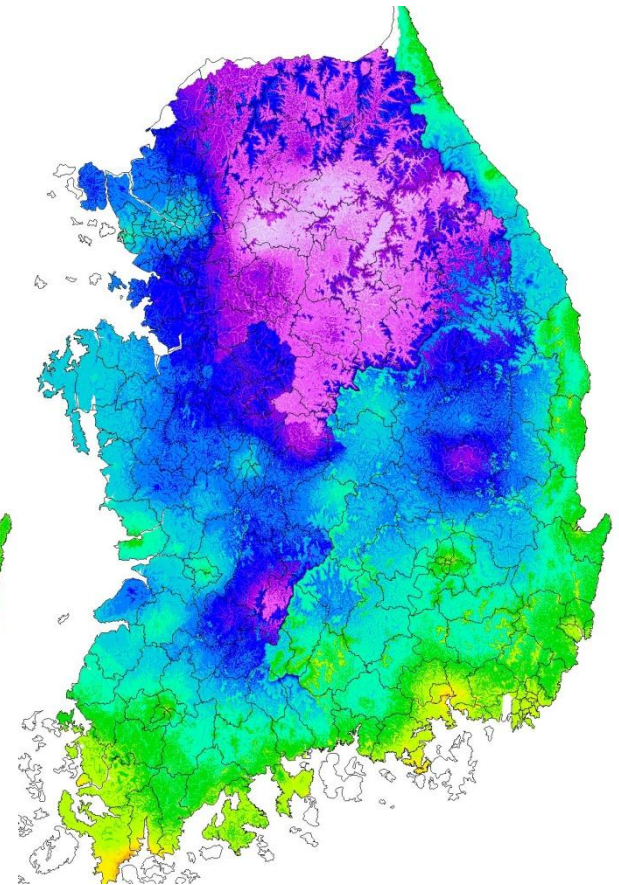# II. Derived DCMs

Extreme monthly min. temperature

Temperature(C)
-40 – -30
-30 – -28
-28 – -26
-26 – -24
-24 – -22
-22 – -20
-20 – -18
-18 – -16
-16 – -14
-14 – -12
-12 – -10
-10 – -8
-8 – -6
-6 – -4
-4 – -2
-2 – 1

1년   10년   30년

Seasonal solar radiations

계절일사량
- 150 - 300
- 301 - 450
- 451 - 600
- 601 - 750
- 751 - 900
- 901 - 1050
- 1051 - 1200
- 1201 - 1350
- 1351 - 1500
- 1501 - 1650
- 1651 - 1800
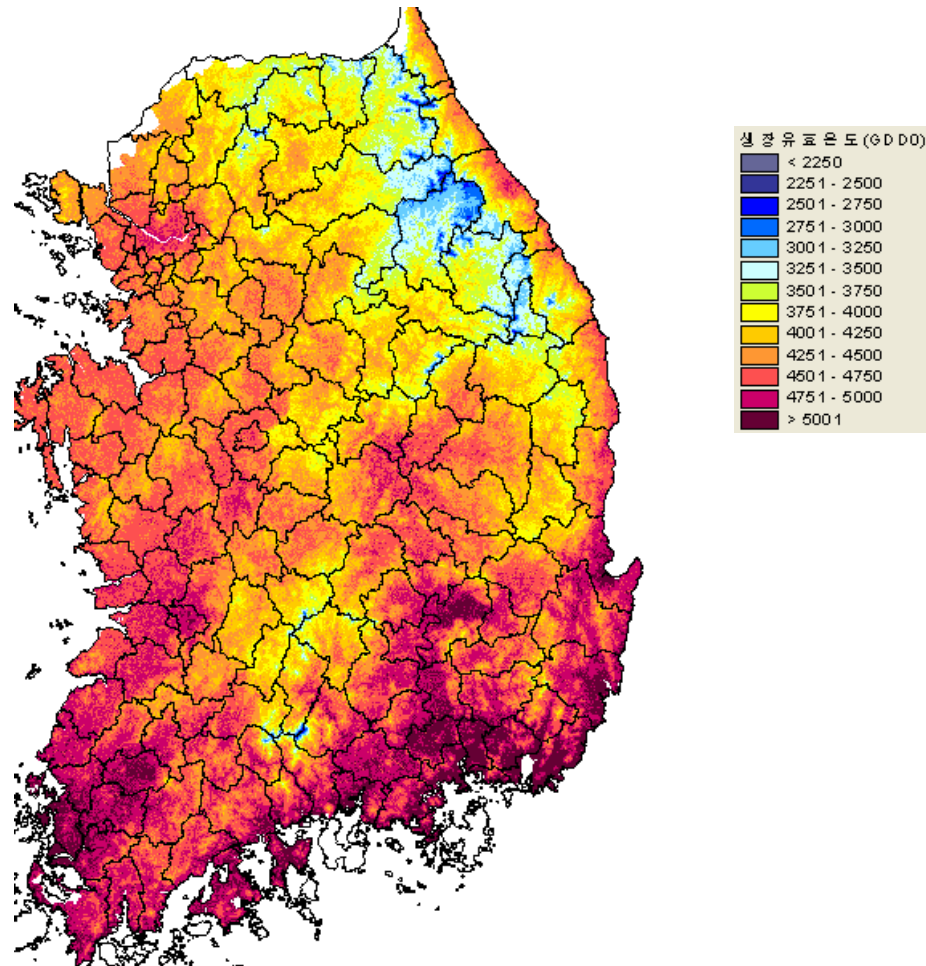- 1801 - 2000
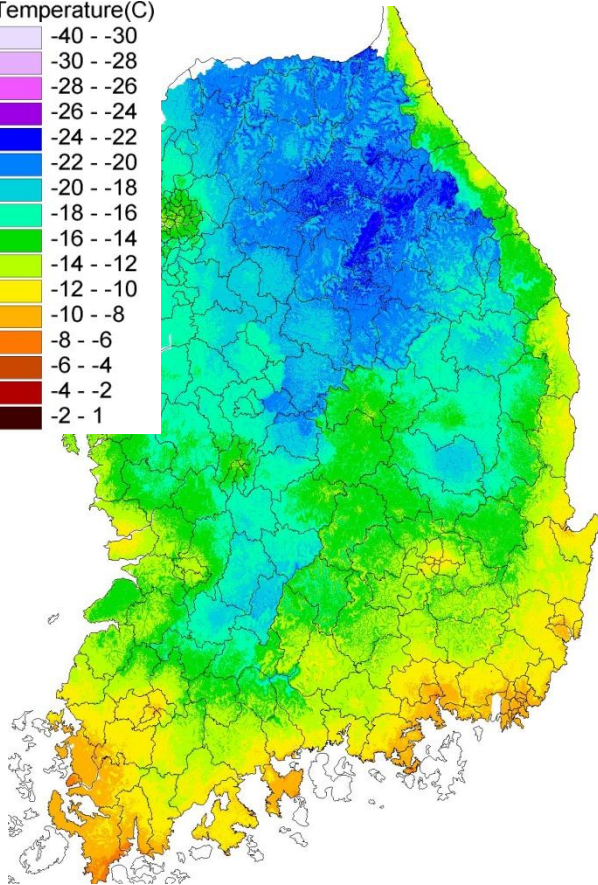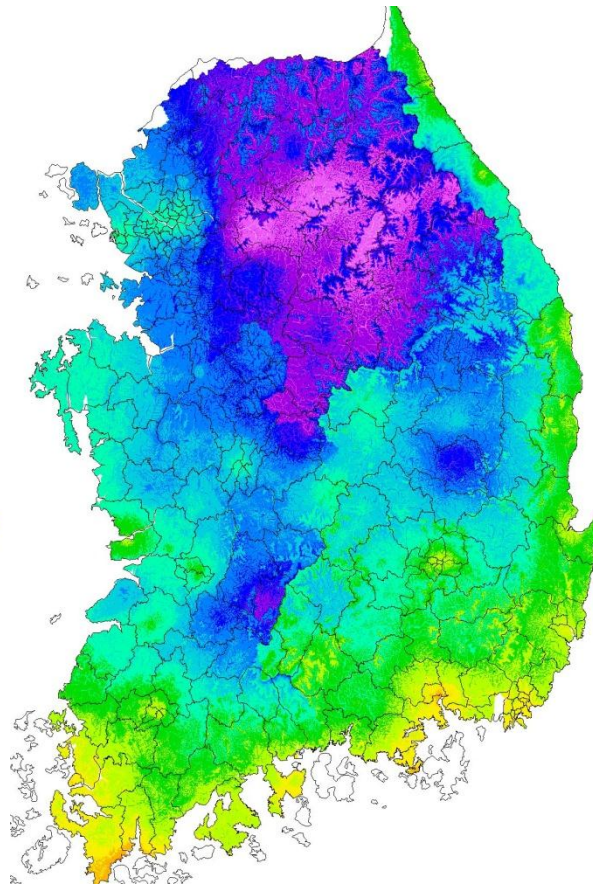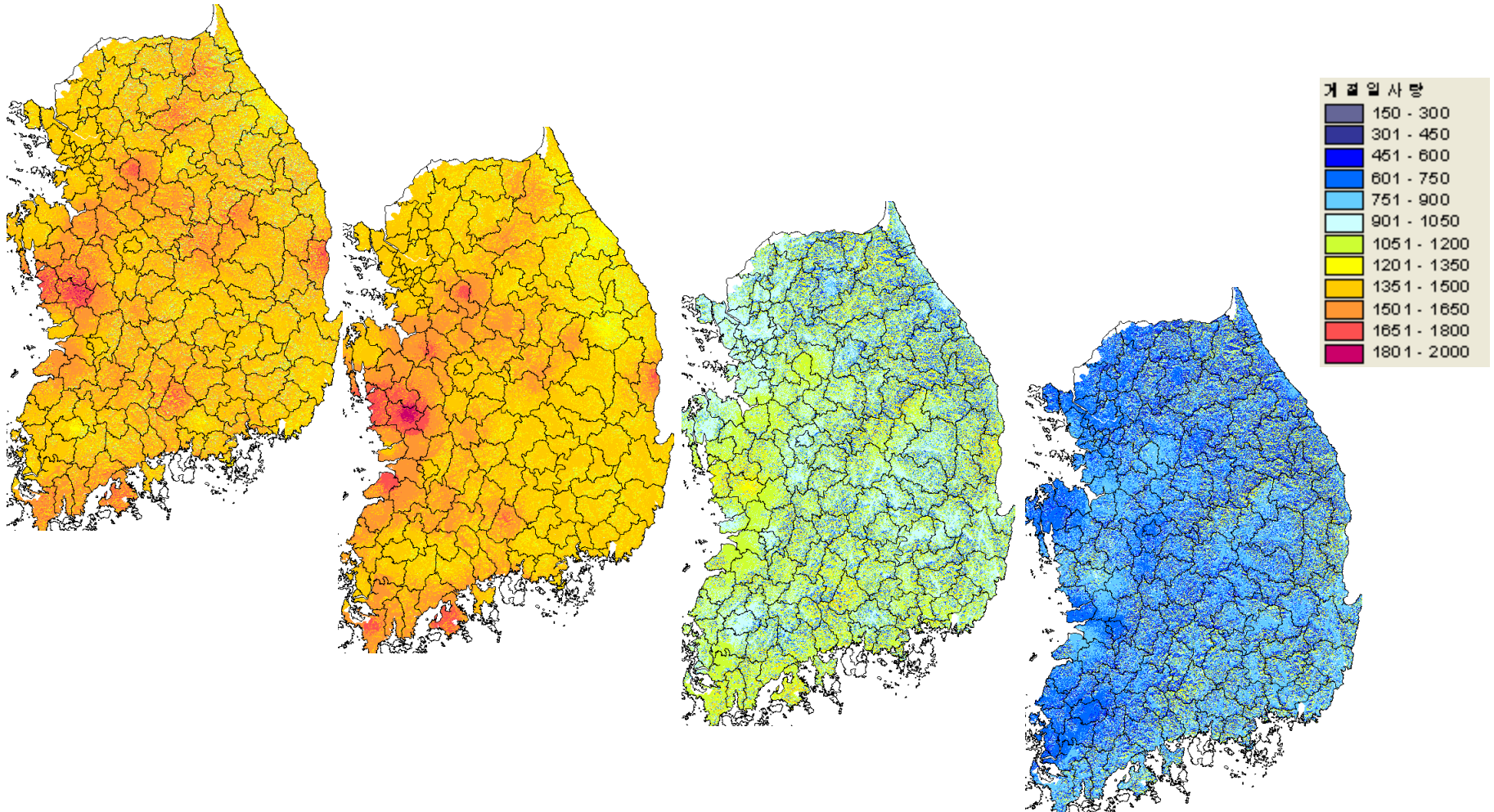
Biological temperature accumulation
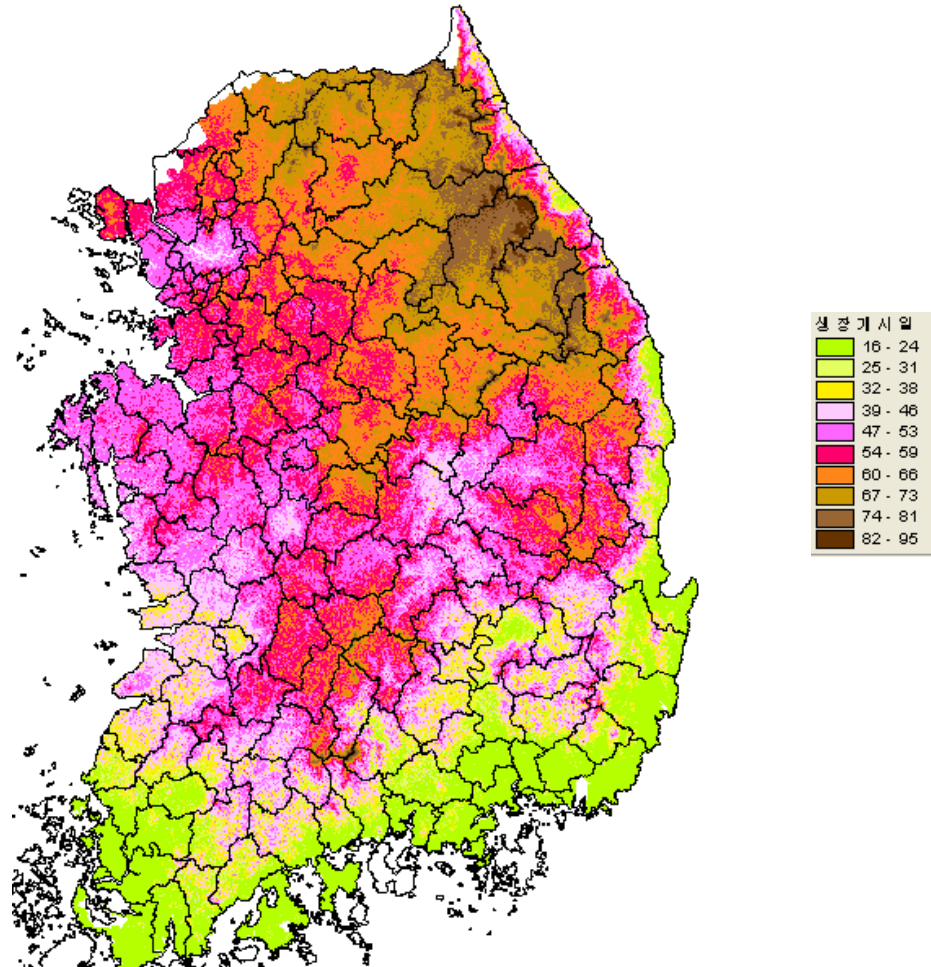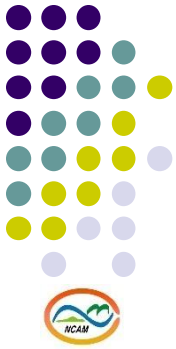
End day of biological growth
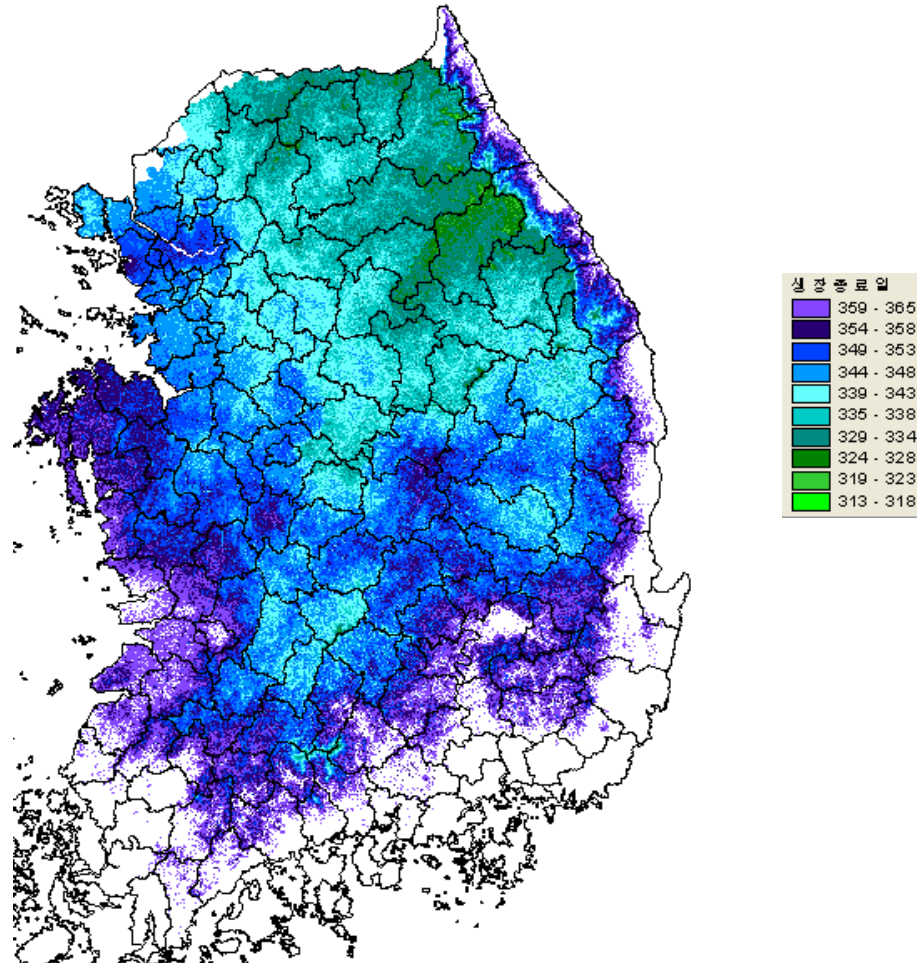
Growing Degree Days (GDD)

II. Derived DCMs

Optimum harvesting day
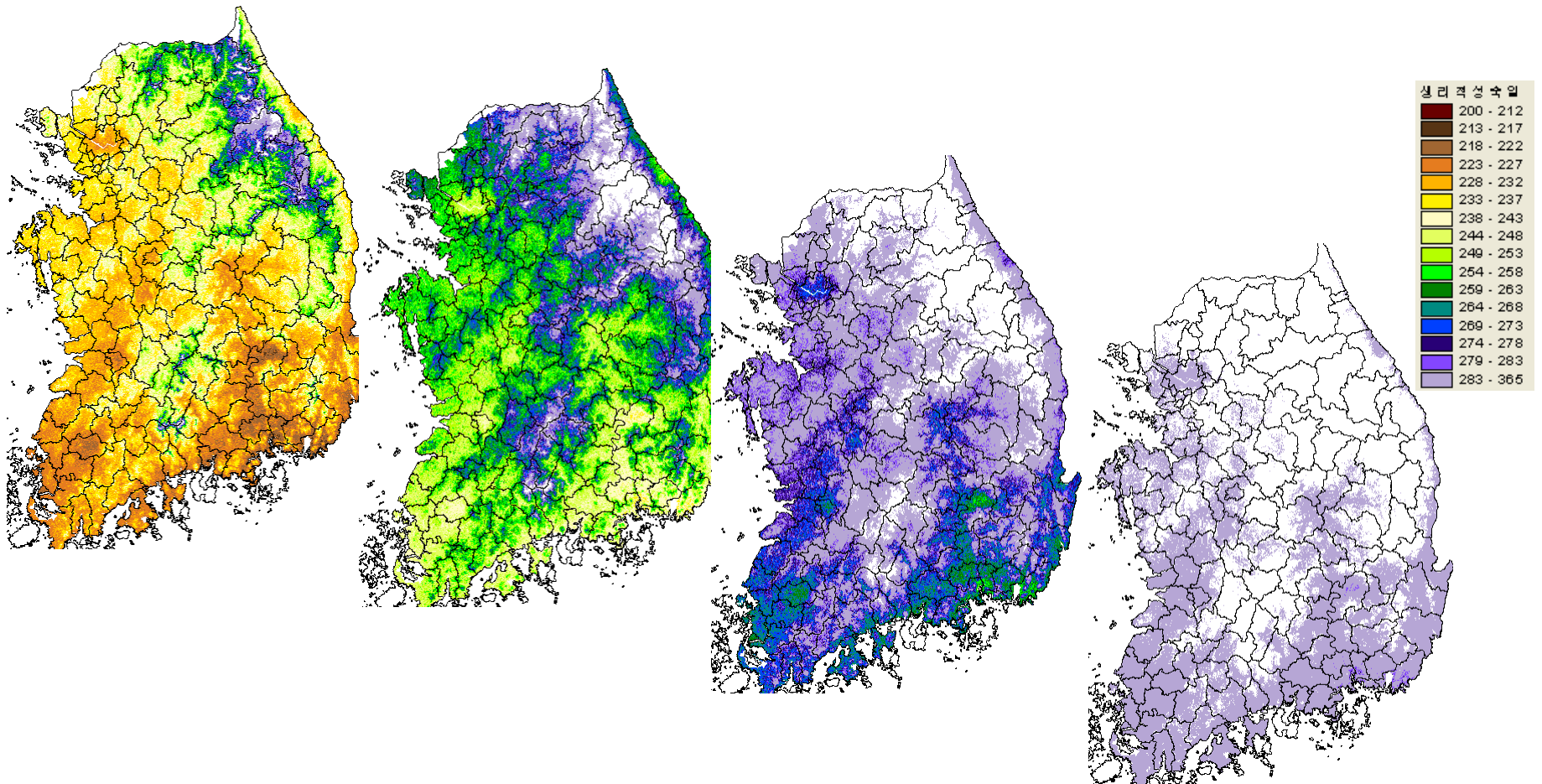
II. Derived DCMs

Phenology Prediction

Flowering

Phenology Monitoring
at every 200m altitude differences

[Climate Change Monitoring]
- 5 sites with different altitudes
- Management : basically same soil, crop, etc.
- Observations : phenology, growth, quality etc.
with long-term climate monitoring

80 m
200 m
350 m
500 m
700 m

<Annual Mean Temp. Distribution in Jeju>

[Case study of iAmNet prototype at Mt Hanra in Jeju with USN]

- Establishment of integrated monitoring system around Halla Mt. at nat'l level
  - Ag. Res. Center against GW, Env. Res. Res. Inst., World Nat. Treas. Heritage, Jeju province, Seoguipo-city
  - one site for weather, climate change, crop, ecosystem, environment, disaster for multiple purpose
- extended service after linking with existing wireless networks established in 2008

[Joint monitoring on plant phenology at different elevation for climate change monitoring in Jeju between KMA and RDA]

Current network

- Integration of total 50 nodes including USN-based AWSs 25('08), 9('07), and existing AWS 7, mesh node 9 under wireless mesh network
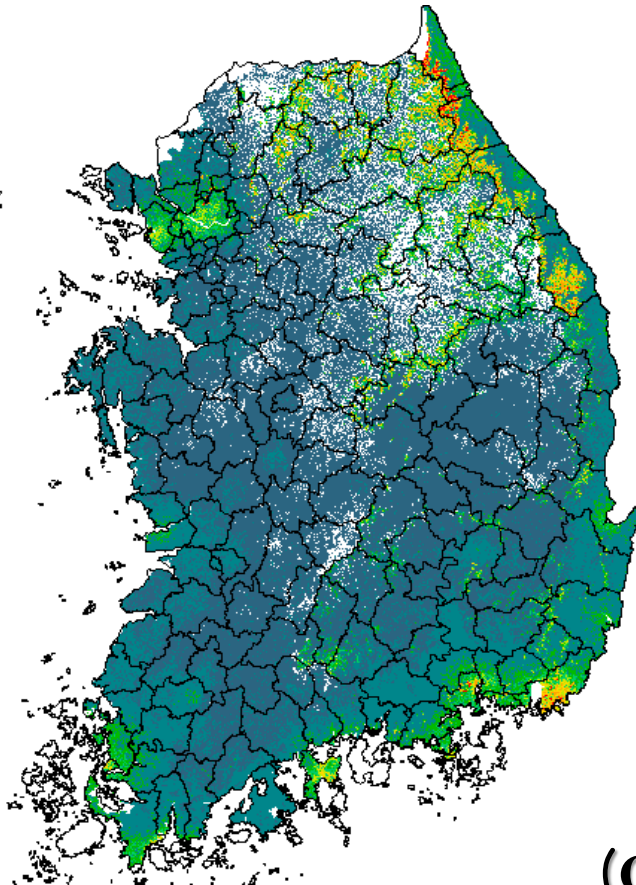

기상청   World Best 365

[USN based high density mesh network deployment for weather monitoring in Jeju]

AgroEcological zoning

dormancy depth

휴면심도
- -155
- -154 - -150
- -149 - -137
- -136 - -129
- -128 - -122
- -121 - -116
- -115 - -110
- -109 - -103
- -102 - 0

(Campbell Early : Grape)
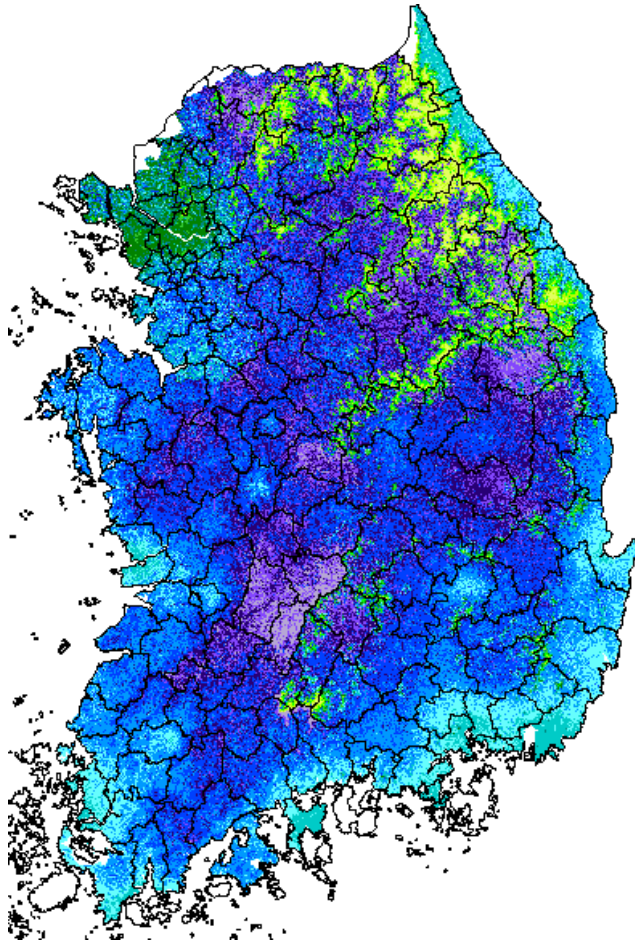
Self-dormancy breakout
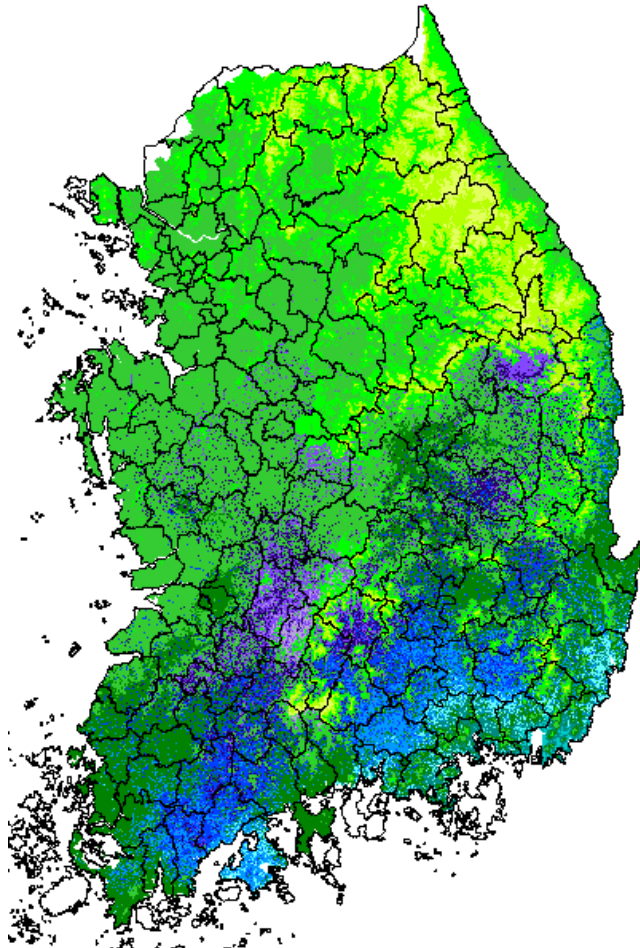
Forced-dormancy breakout
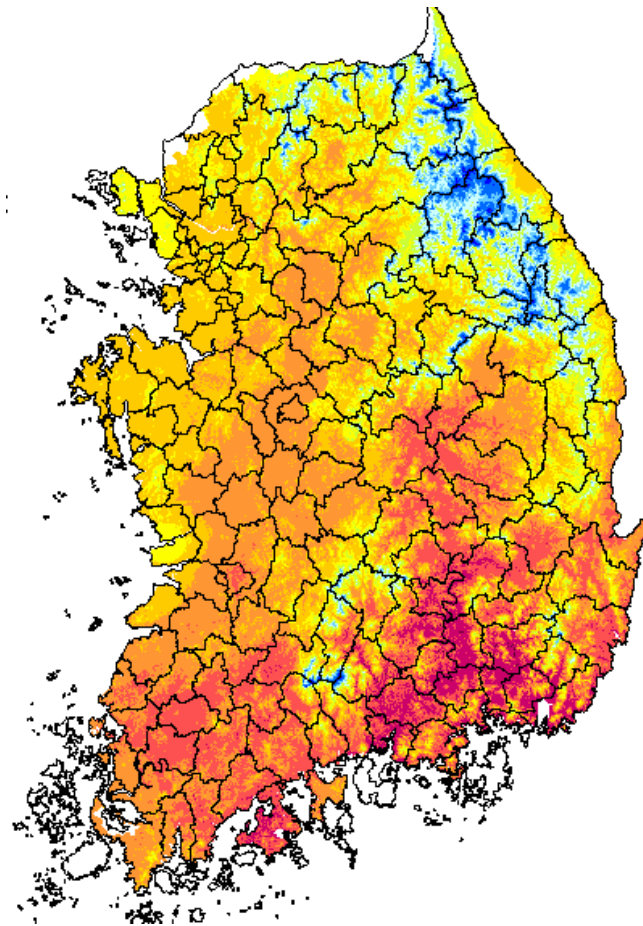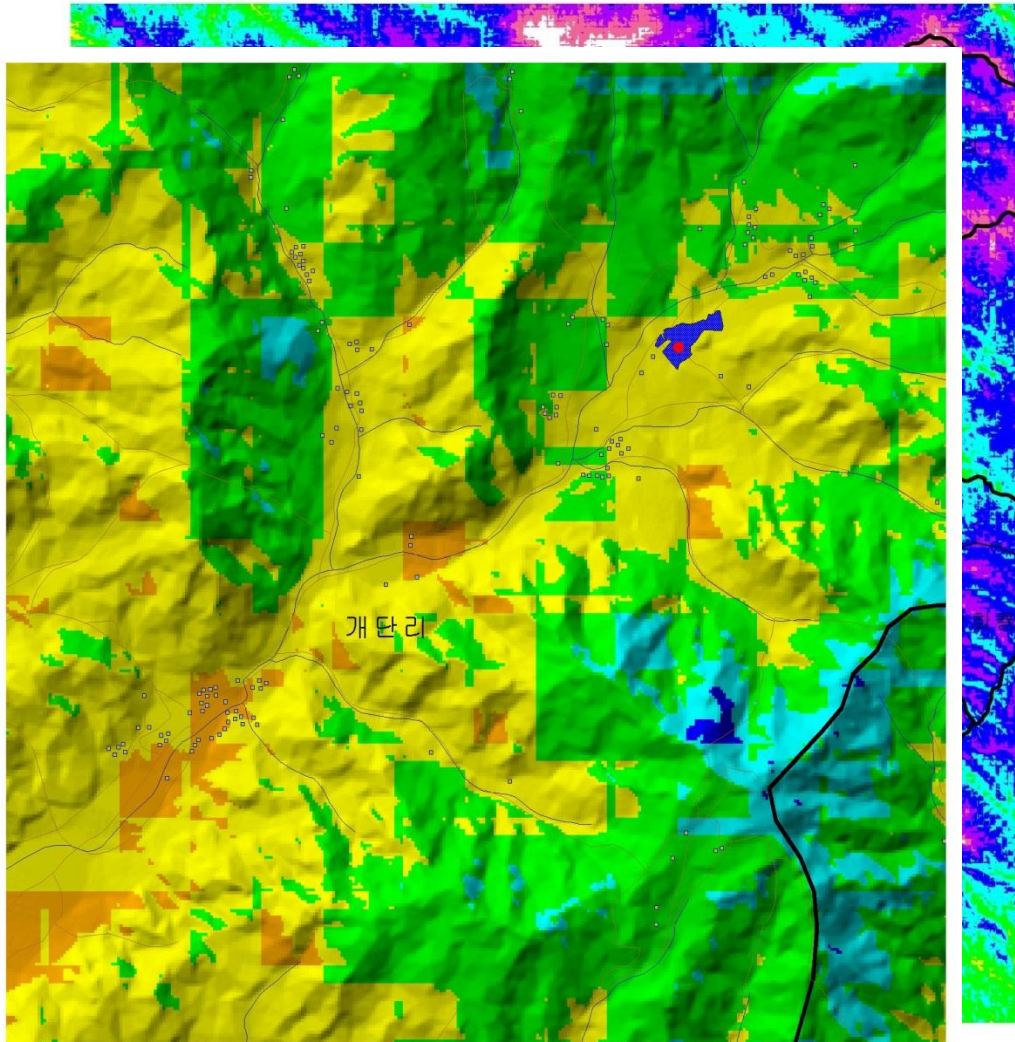
Bud breakout
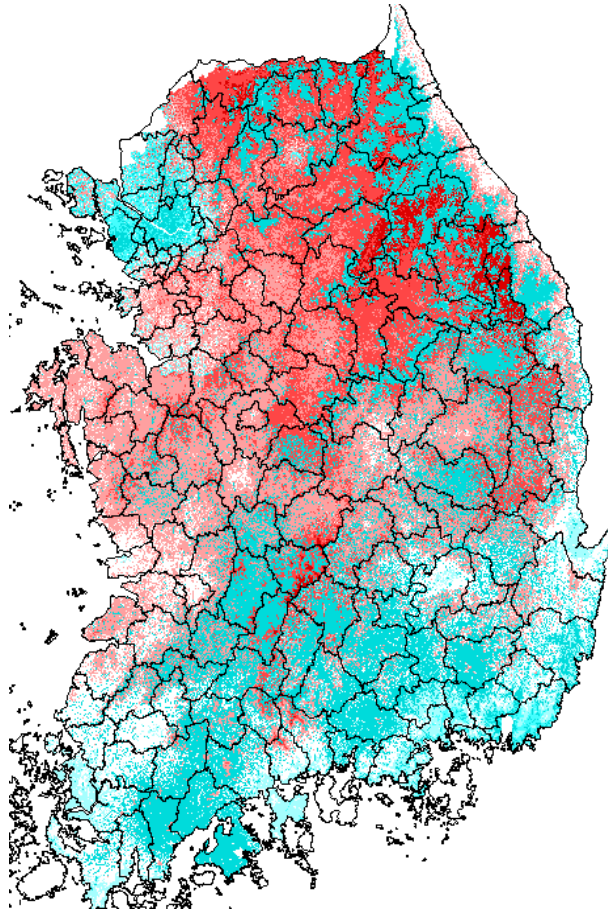
Cold tolerance period

Identification of optimal production zones

Apple 'Fuji' - Quality

- **L/D ratio: MaxT at Apr.~Jul.**
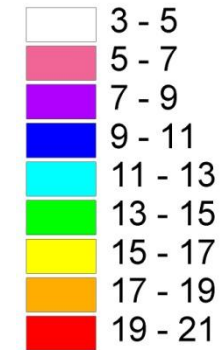- **Antocyanin: MeanT at Oct.**
- **Hunter a Value: "**

Identification of optimal production zones

Bonghwa

MaxT April

개단리

평년최고기온(4월)
- 3 - 5
- 5 - 7
- 7 - 9
- 9 - 11
- 11 - 13
- 13 - 15
- 15 - 17
- 17 - 19
- 19 - 21

0   0.5   1 Kilometers

Identification of optimal production zones

Bonghwa

MinT April

개단리

평년최저기온(4월)
- -5 - -3
- -3 - -1
- -1 - 0
- 0 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7

0   0.5   1   Kilometers
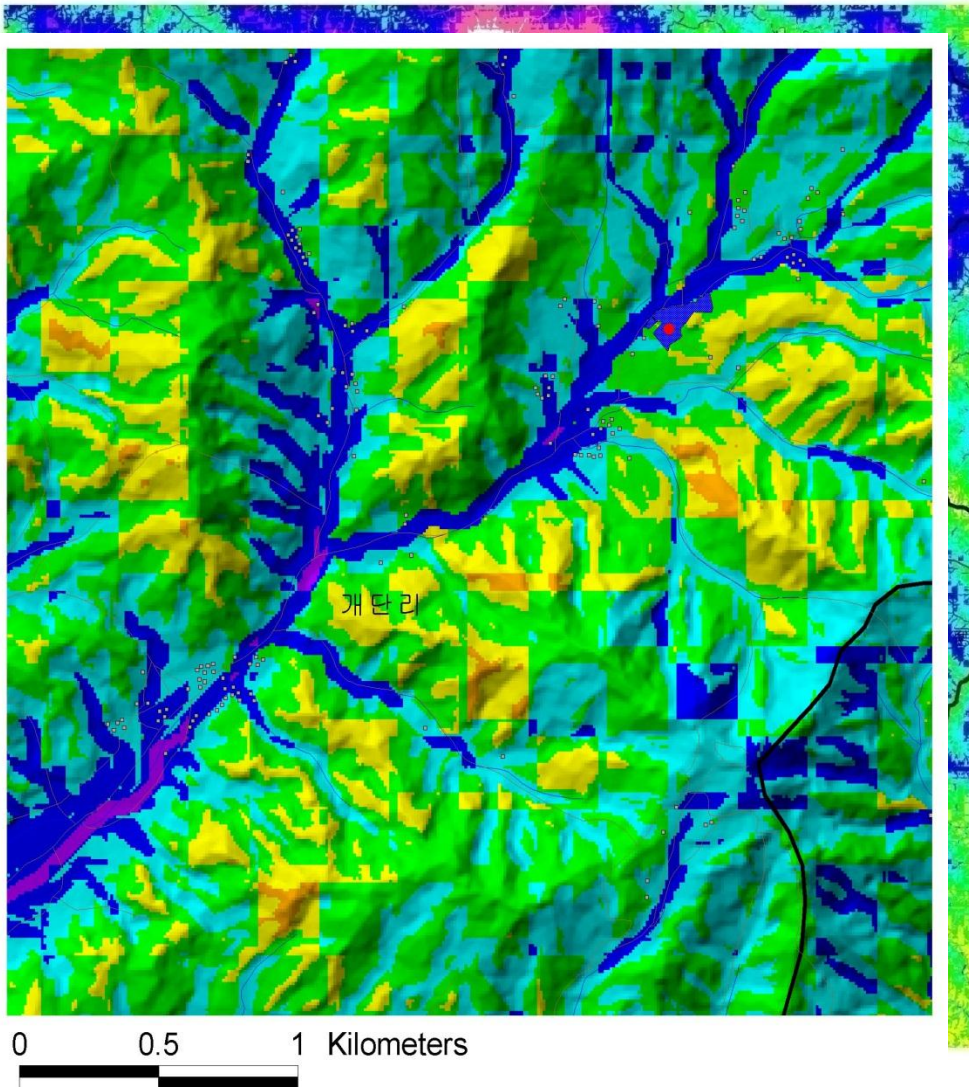
Identification of optimal production zones

L/D Ratio : 0.85 above

L/D Ratio(Fuji)
- 0 - 0.15
- 0.15 - 0.35
- 0.35 - 0.55
- 0.55 - 0.75
- 0.75 - 0.95
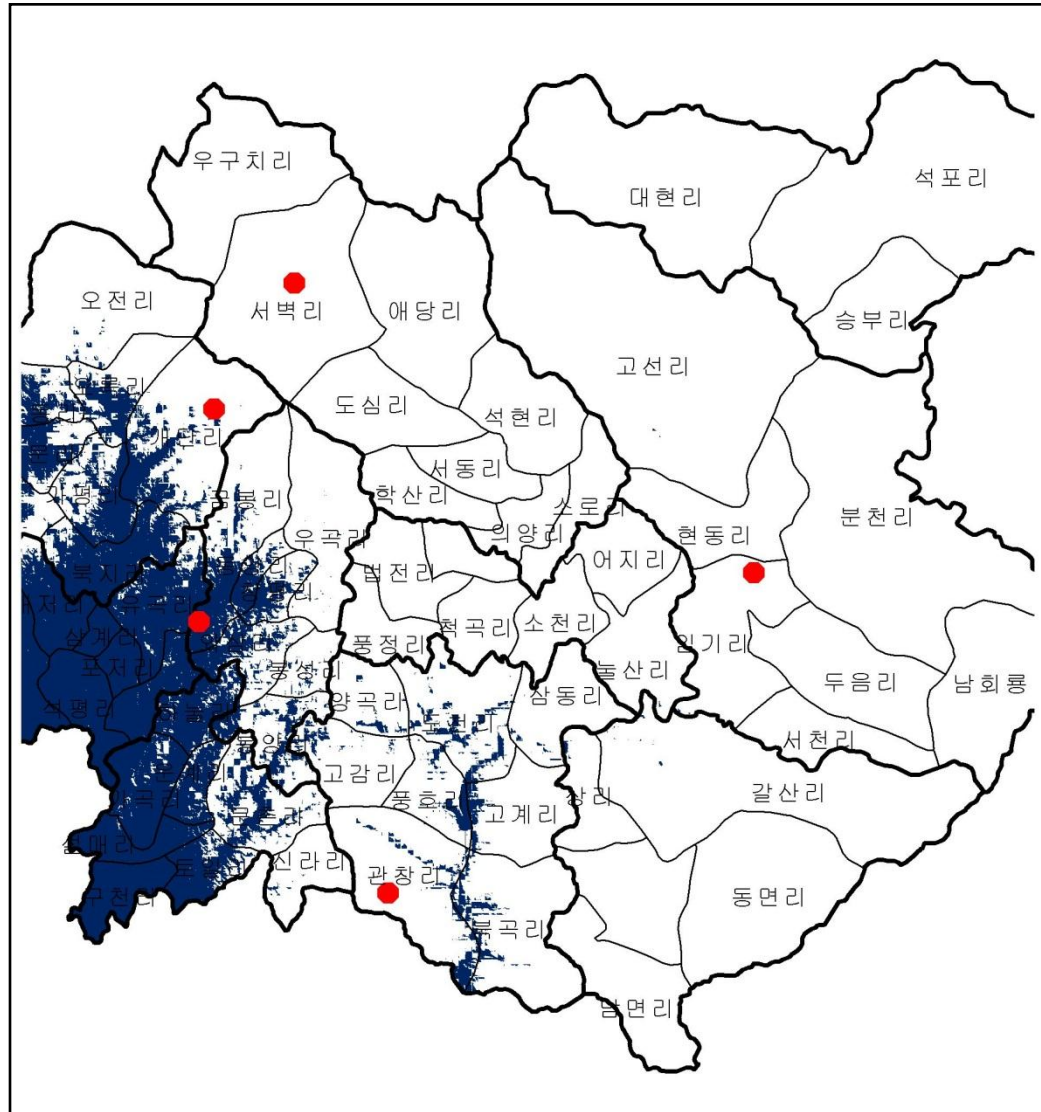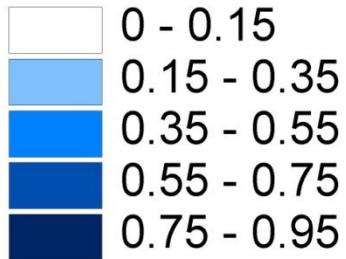
Identification of optimal production zones

**Hunter a value :
25 above**

Hunter a(Fuji)
- 0 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
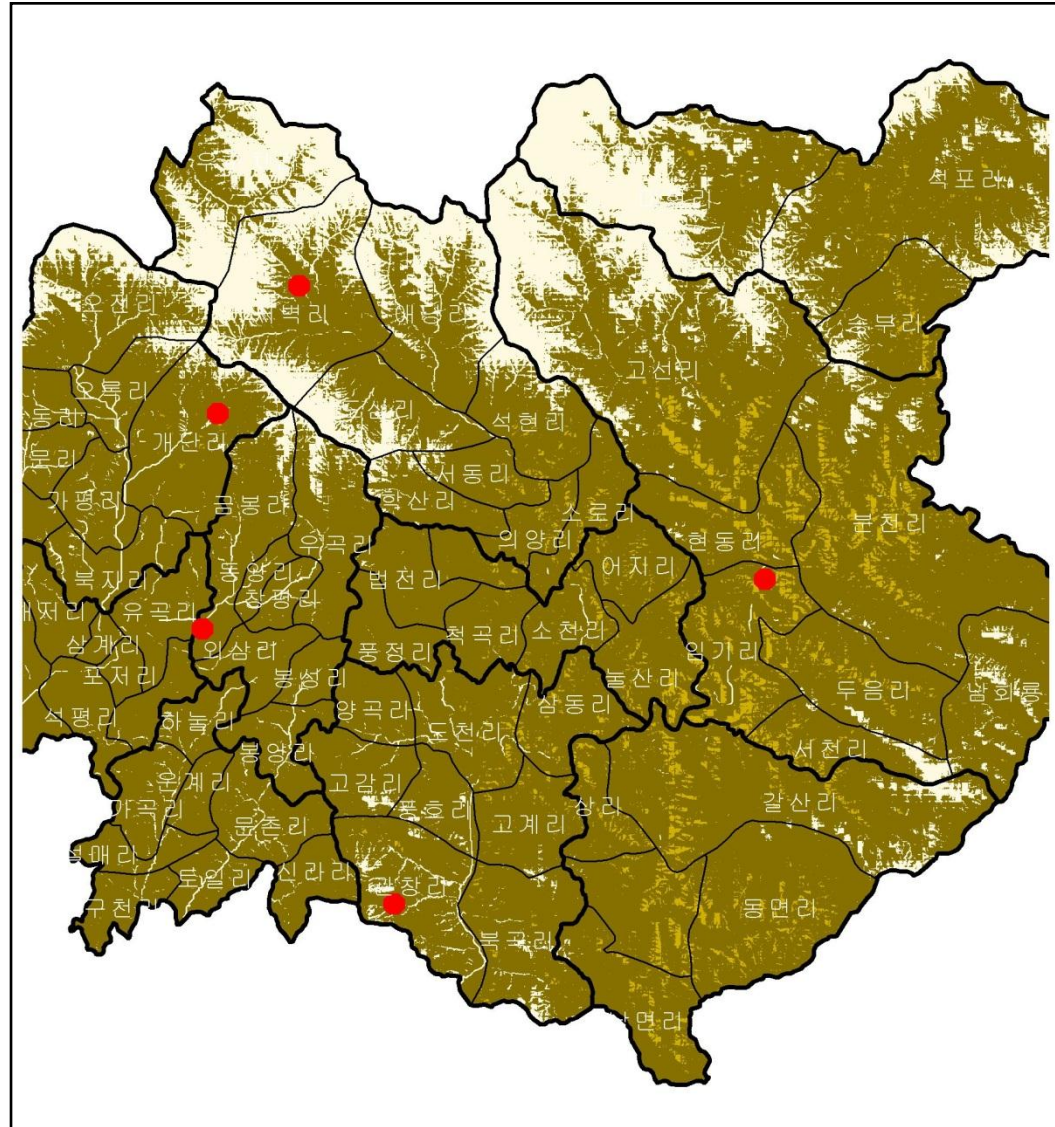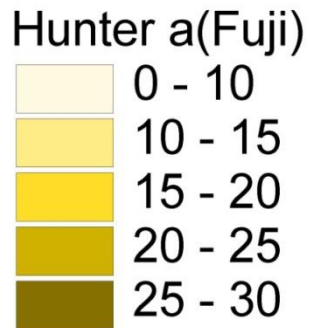
Identification of optimal production zones

**Anthocyanin content :
15 ㎍/㎤ above**

Anthocyanin(Fuji)
- 0 - 4
- 4 - 8
- 8 - 12
- 12 - 16
- 16 - 20
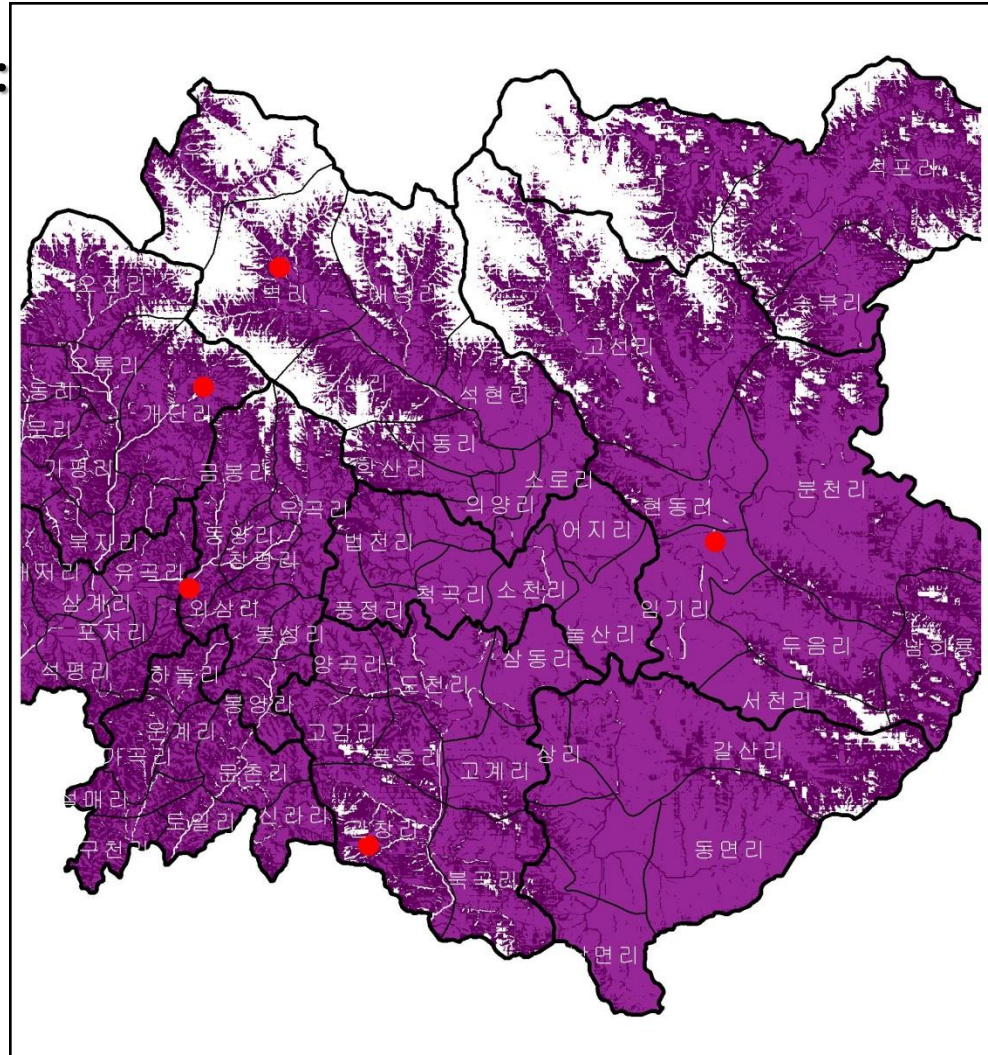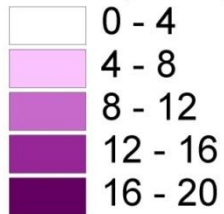
Identification of optimal production zones

**Best area
for high quality**
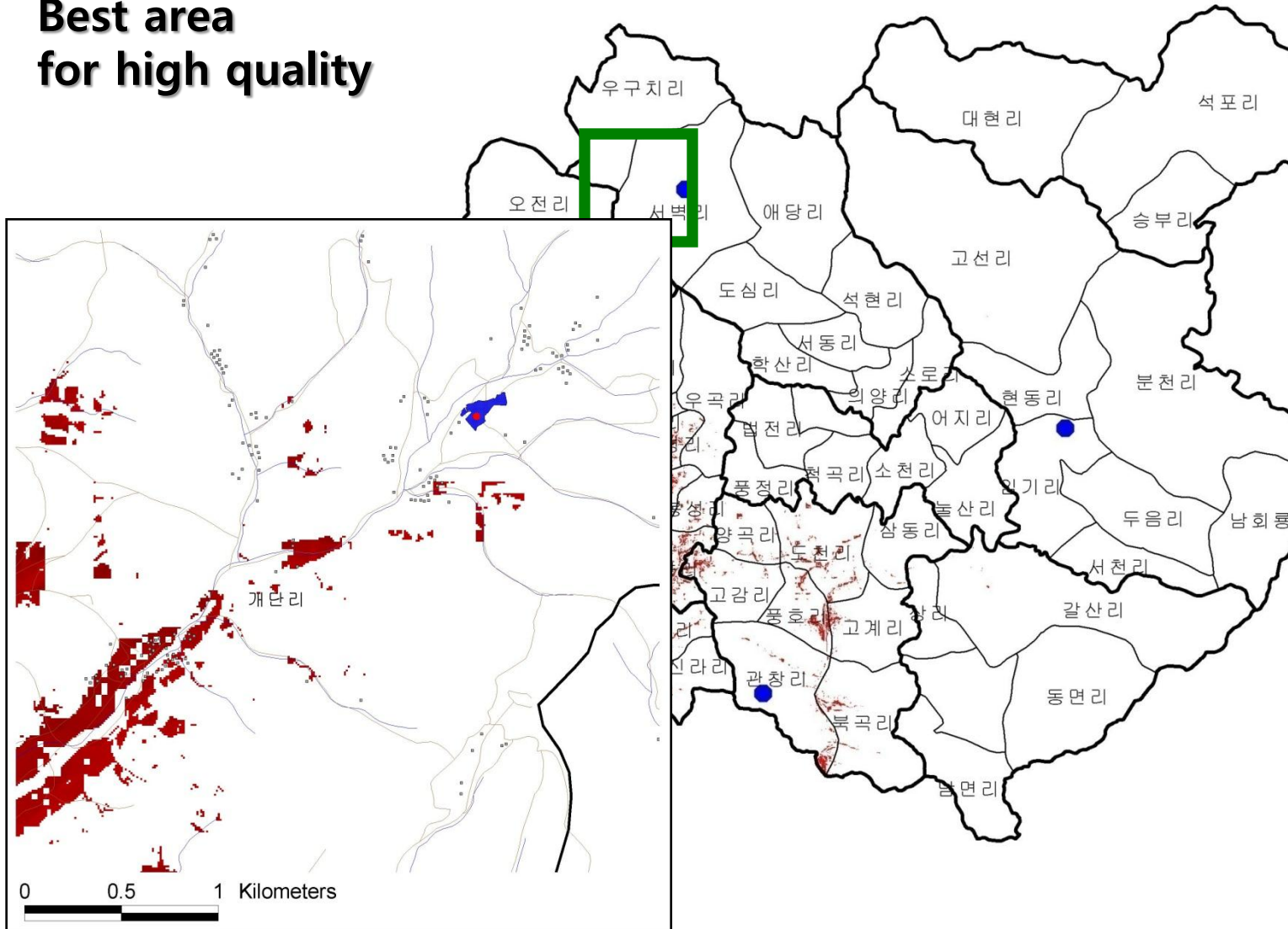
III. Applied DCMs – IA under CC scenario

High Resolution Climate Change Scenario

2011-2040 A2

Extreme low temp.
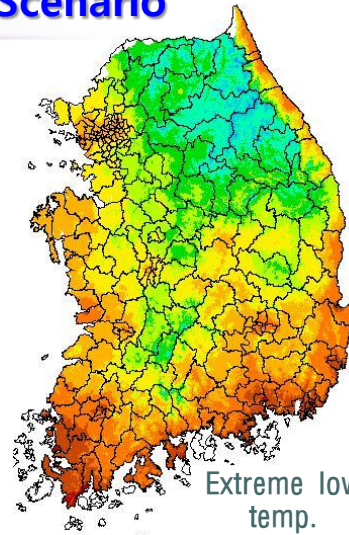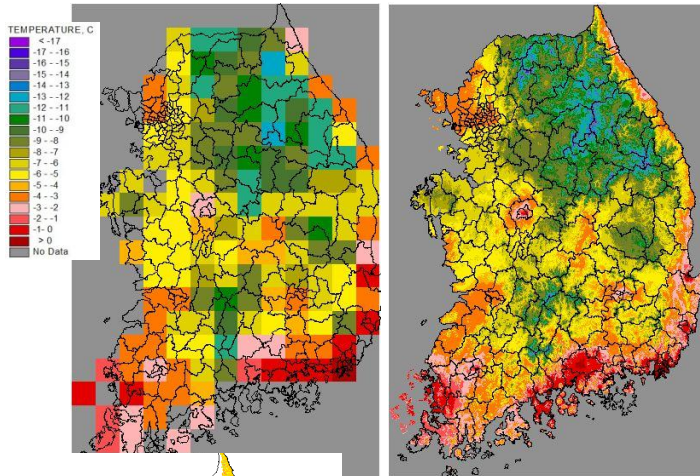
Seasonal solar radiations
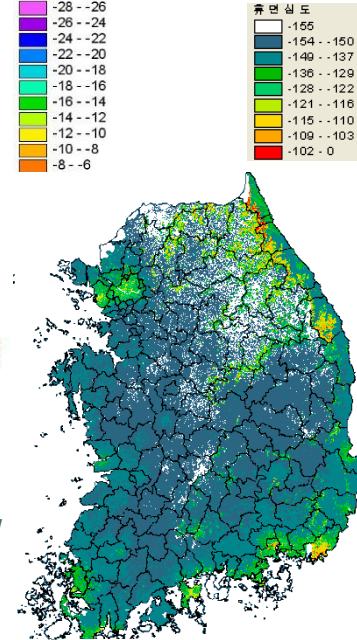
Dormancy Depth
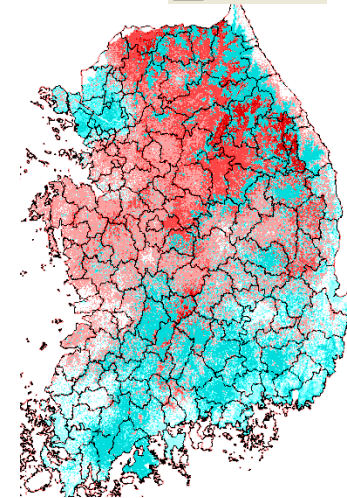
Cold tolerant period
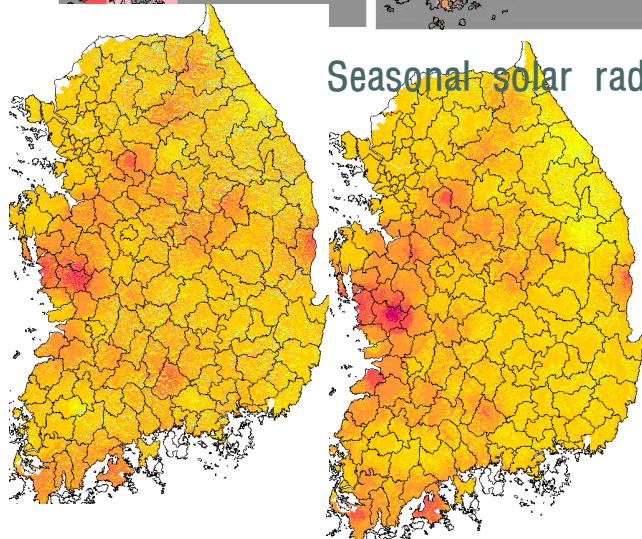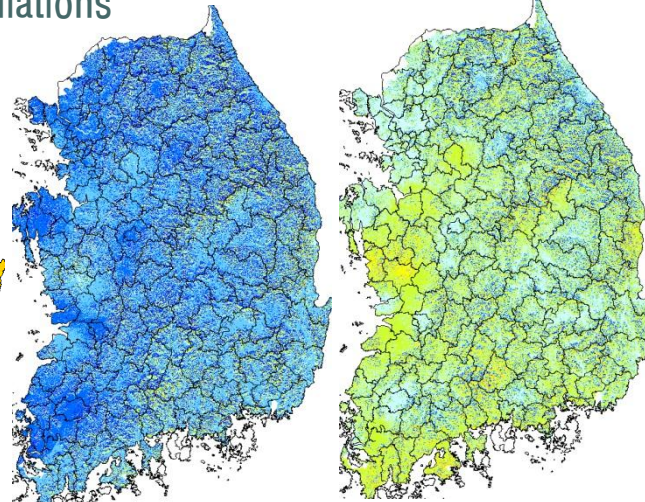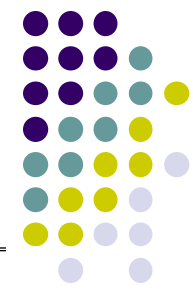
Flowering Projection under Climate Change (Cherry blooming)

Impact assessment **under** Climate Change
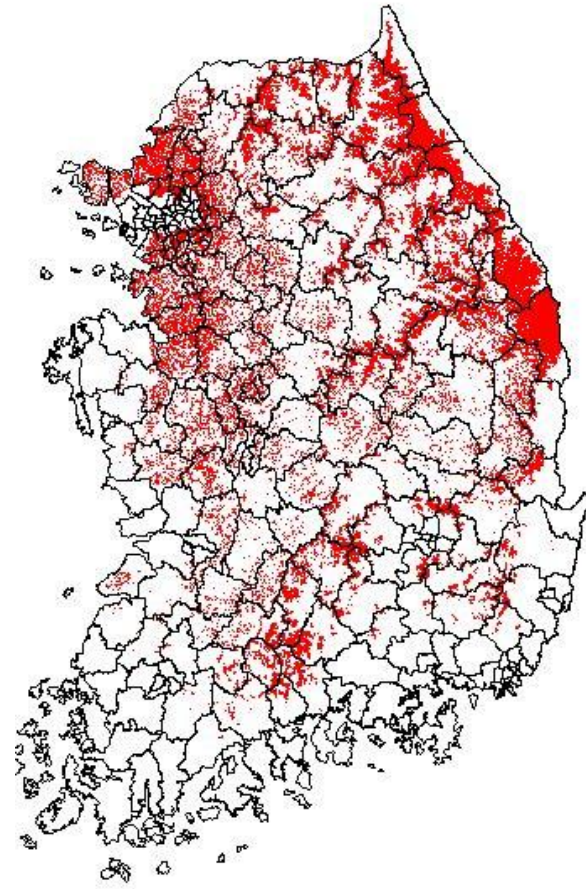
Vulnerable area to cold damage under CC

Freeze Risk, %
- 0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100

1971-2000
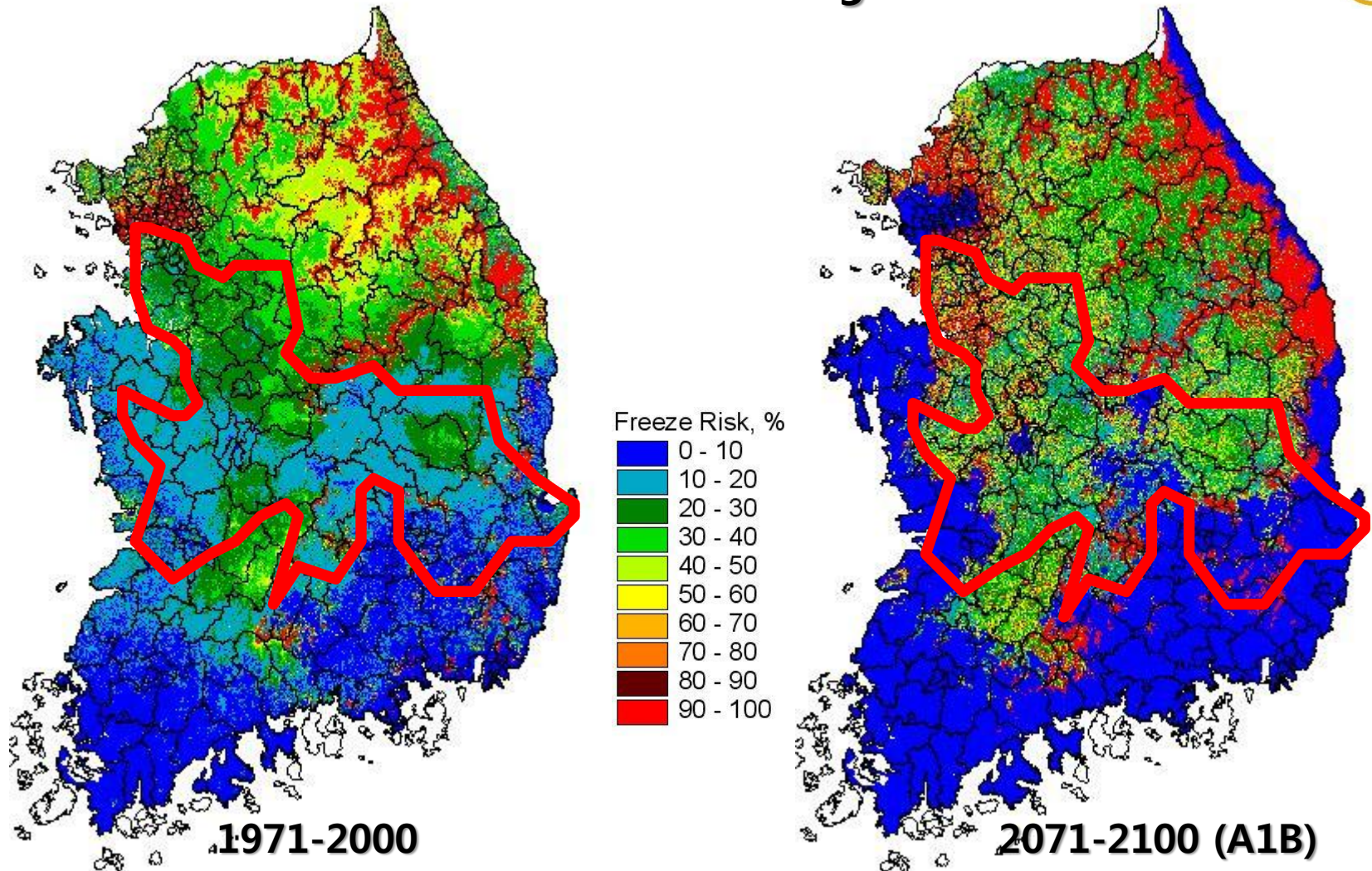
2071-2100 (A1B)

Impact assessment under Climate Change

Vulnerable area to cold damage under CC
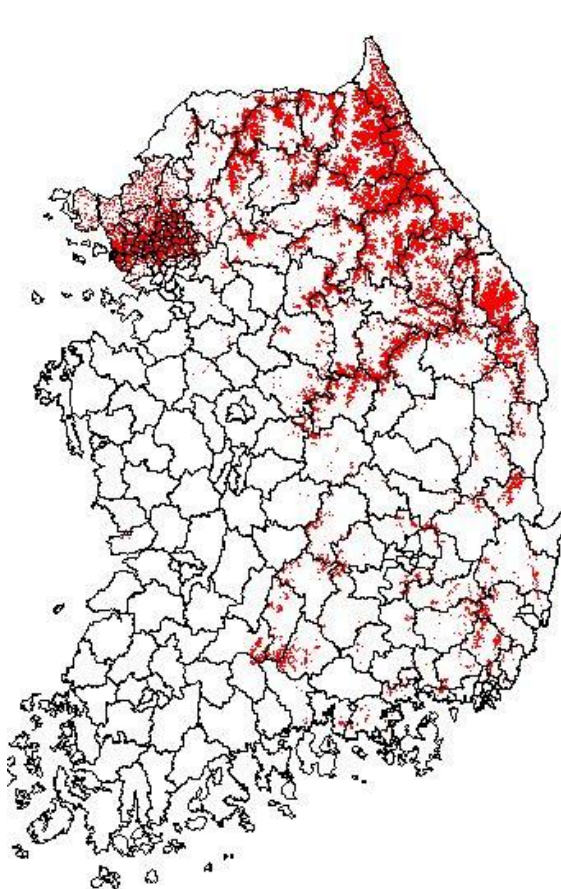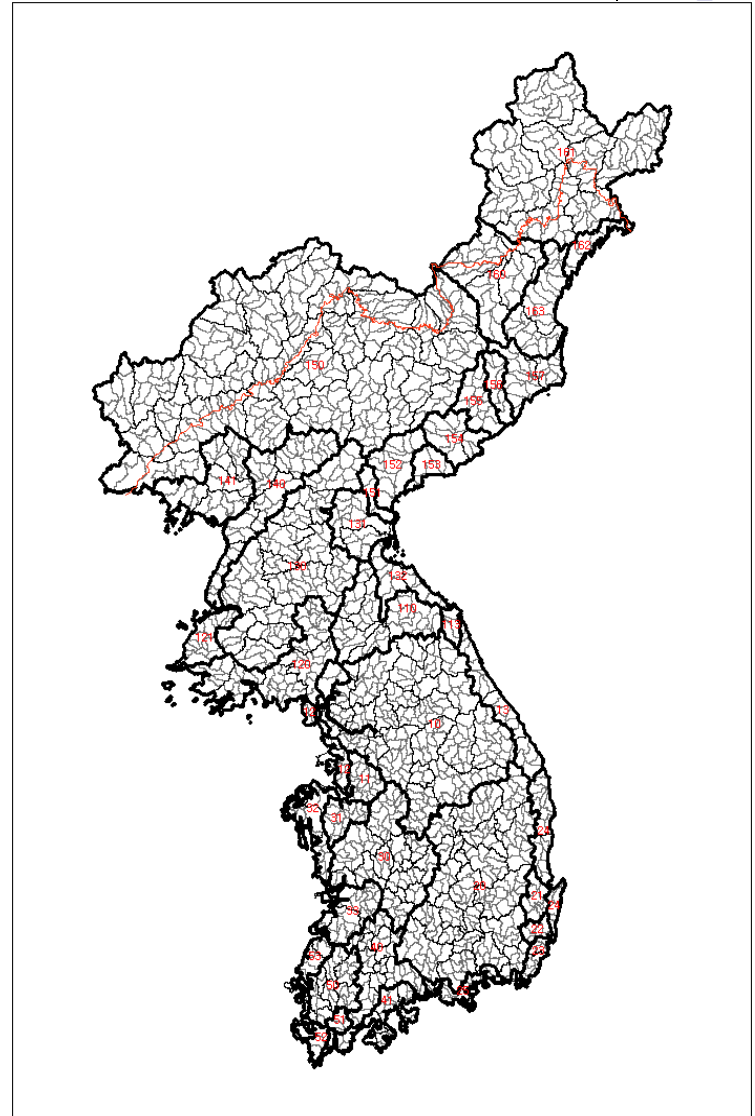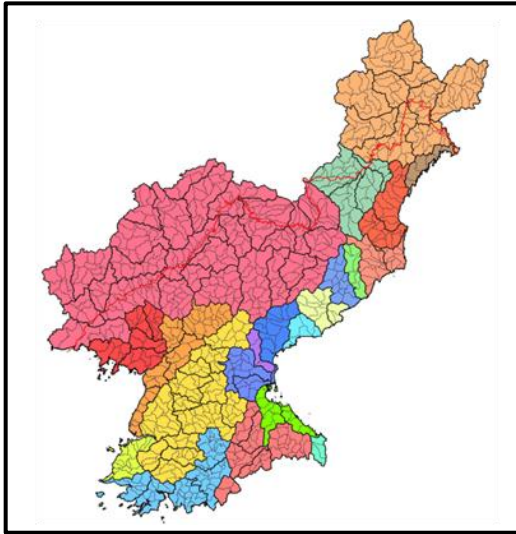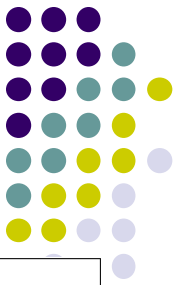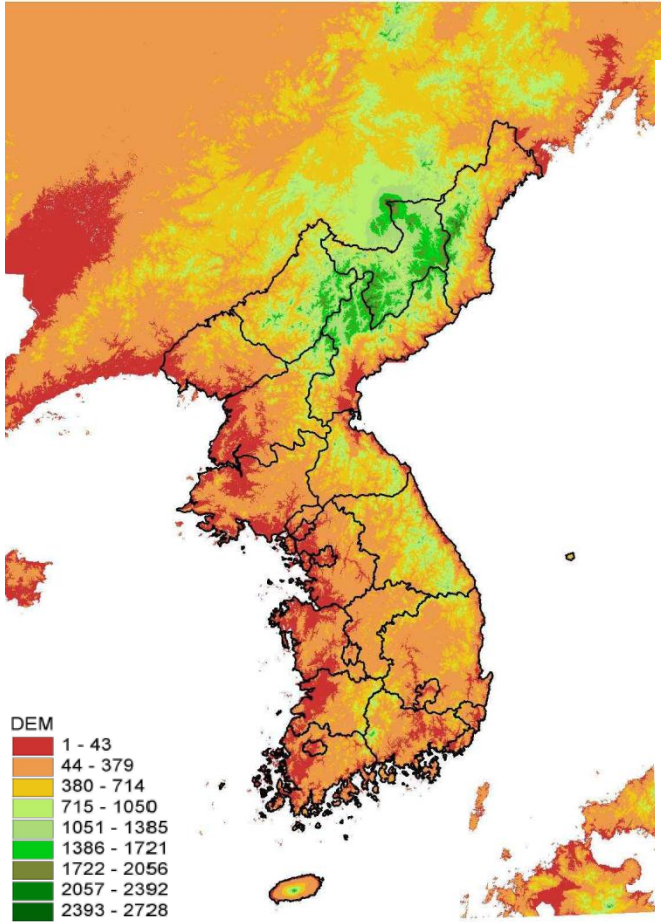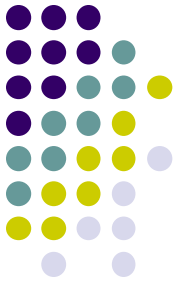

1971-2000

2071-2100 (A1B)

Probability > 70%
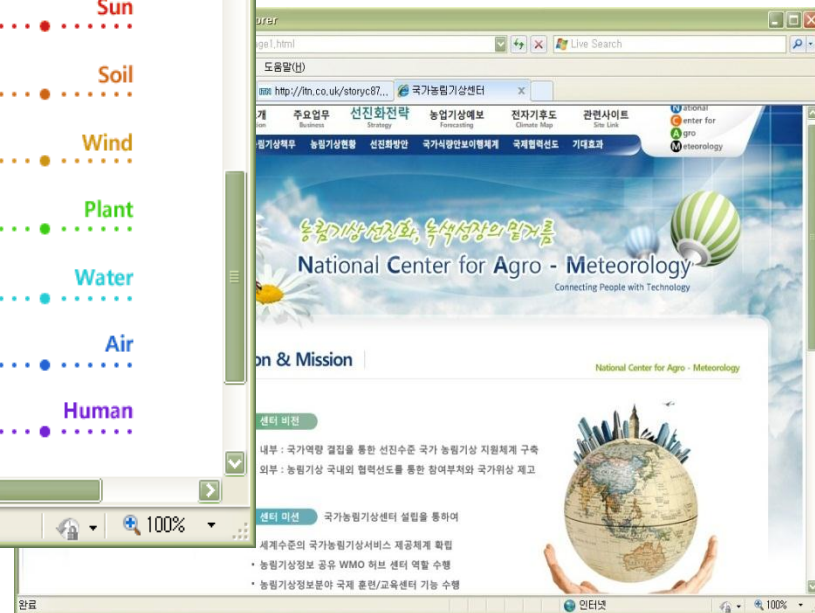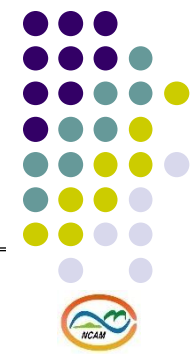
Thank You !
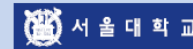
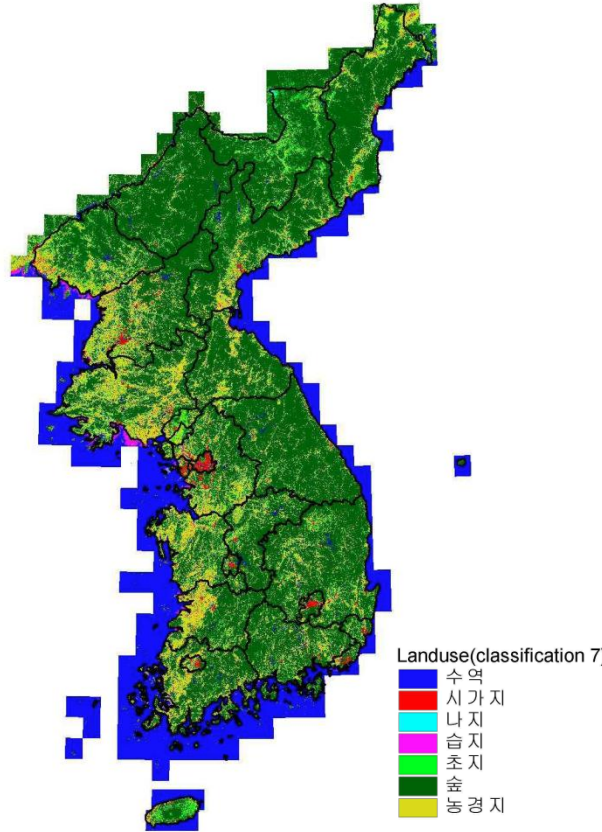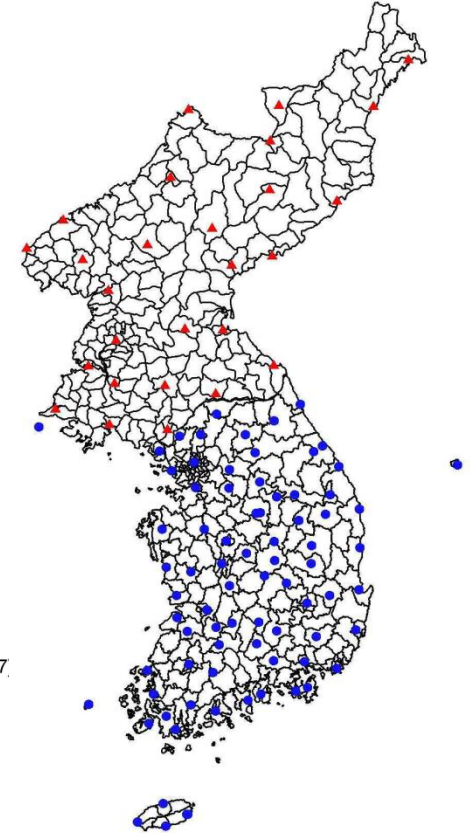# [Ref] Unified HDCMs for Korean Peninsular

Background HD Maps

DEM
- 1 - 43
- 44 - 379
- 380 - 714
- 715 - 1050
- 1051 - 1385
- 1386 - 1721
- 1722 - 2056
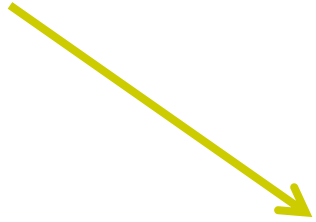- 2057 - 2392
- 2393 - 2728

Landuse(classification 7)
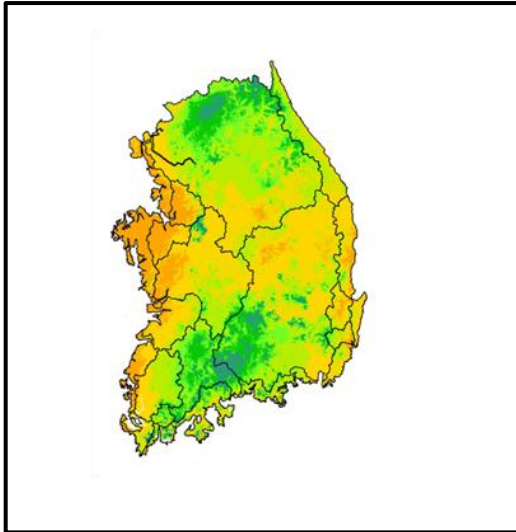- 수역
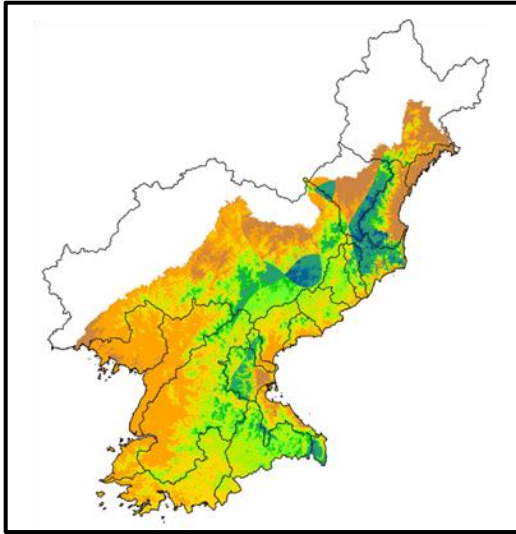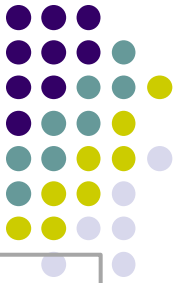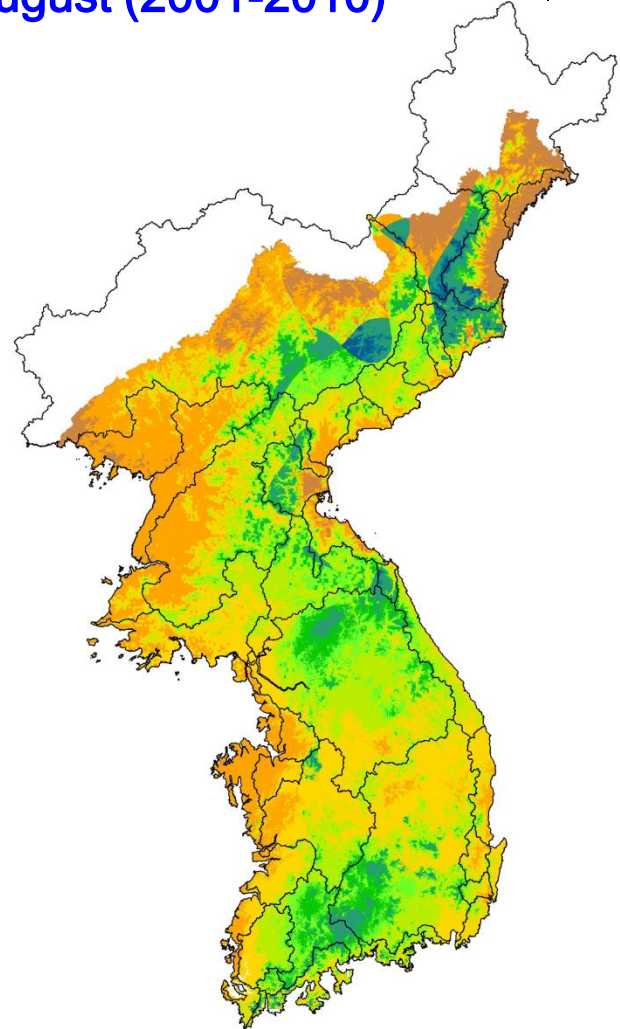- 시가지
- 나지
- 습지
- 초지
- 숲
- 농경지
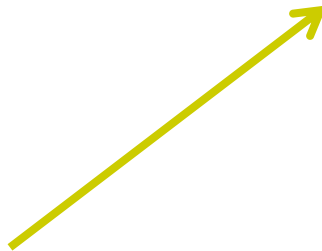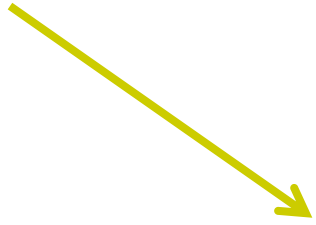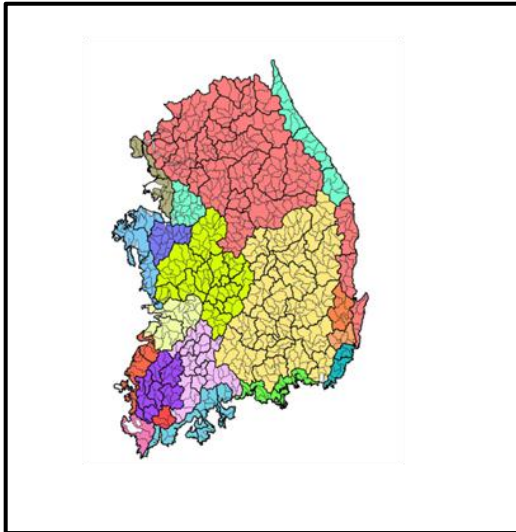
▸ 30m Resolution DEM

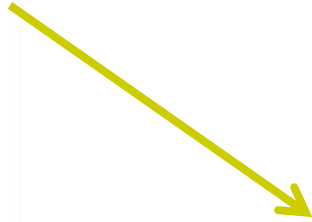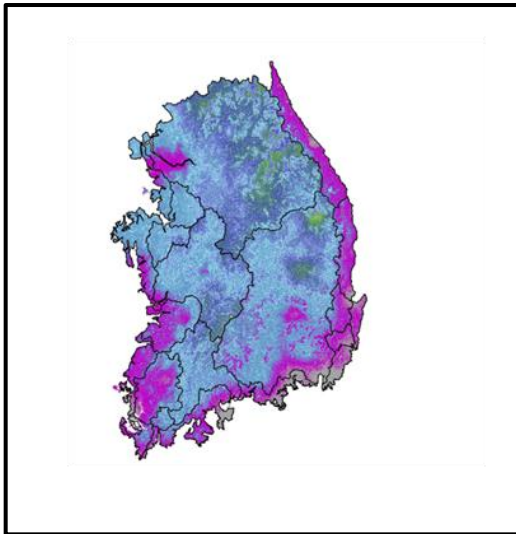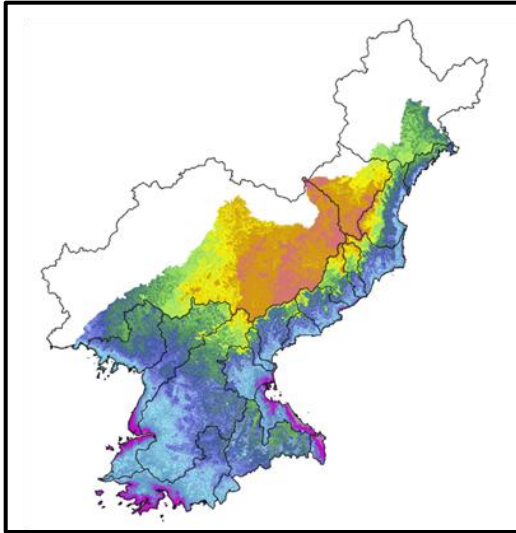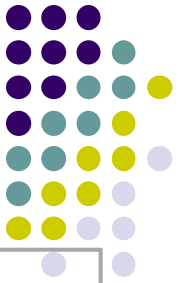▸ 30m Resolution Vegetation Map

▸ Manned Weather Stations
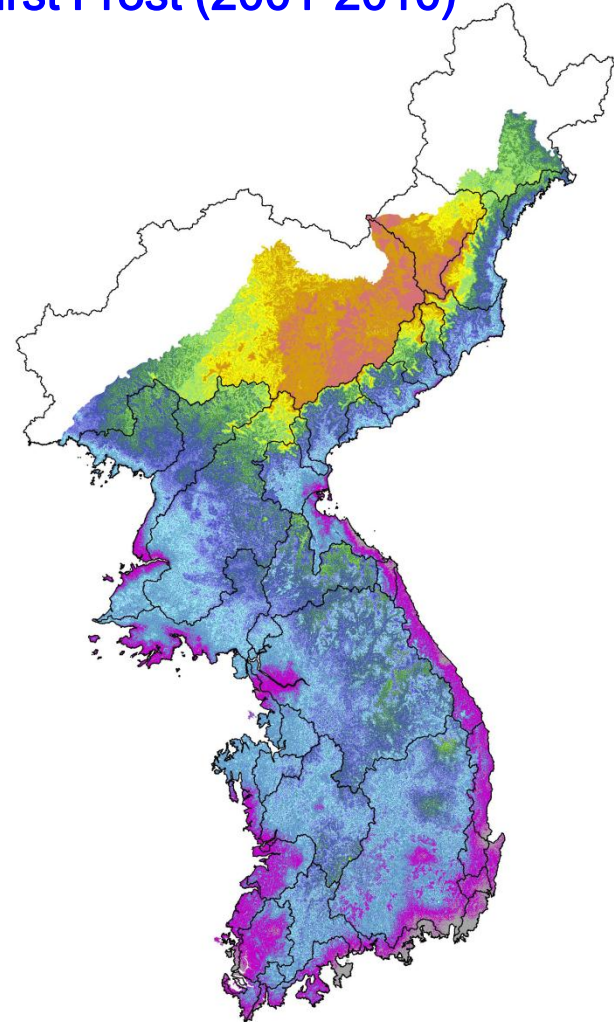 (N. Korea 27, S Korea 76)

Precipitation accumulated

August (2001-2010)
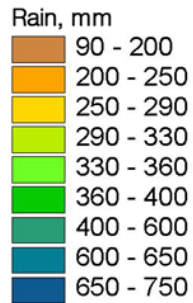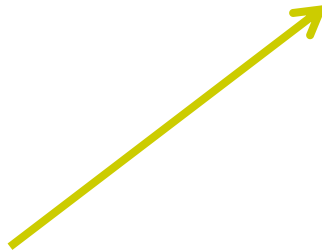
Rain, mm
- 90 - 200
- 200 - 250
- 250 - 290
- 290 - 330
- 330 - 360
- 360 - 400
- 400 - 600
- 600 - 650
- 650 - 750

Applied Maps

First Frost (2001-2010)

First dates of killing frost, DOY

- █ < 23 Aug
- █ 24 Aug - 7 Sep
- █ 8 Sep - 17 Sep
- █ 18 Sep - 27 Sep
- █ 28 Sep - 2 Oct
- █ 3 Oct - 6 Oct
- █ 7 Oct - 10 Oct
- █ 11 Oct - 14 Oct
- █ 15 Oct - 18 Oct
- █ 19 Oct - 27 Oct
- █ 28 Oct - 6 Nov
- █ > 7 Nov

Effective GDD

GDD Tbase=0℃
(2001-2010)
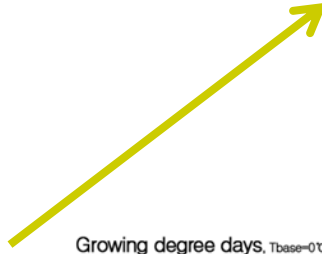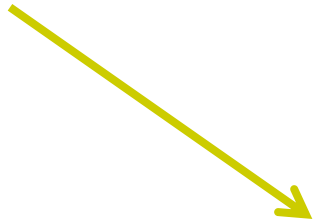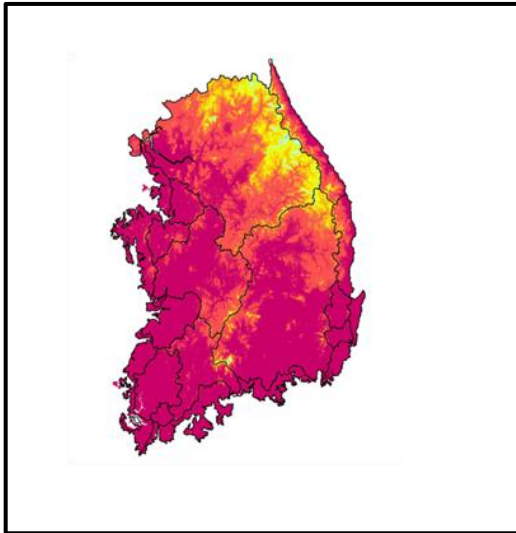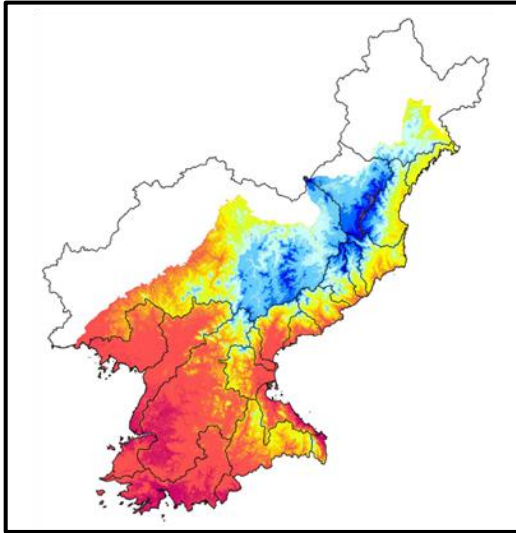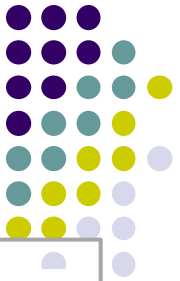
Growing degree days, Tbase=0℃
- 1000 - 1500
- 1500 - 1800
- 1800 - 2100
- 2100 - 2400
- 2400 - 2800
- 2800 - 3200
- 3200 - 3400
- 3400 - 3600
- 3600 - 3800
- 3800 - 4000
- 4000 - 4500
- 4500 - 5500
- 5500 - 6000
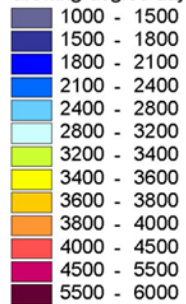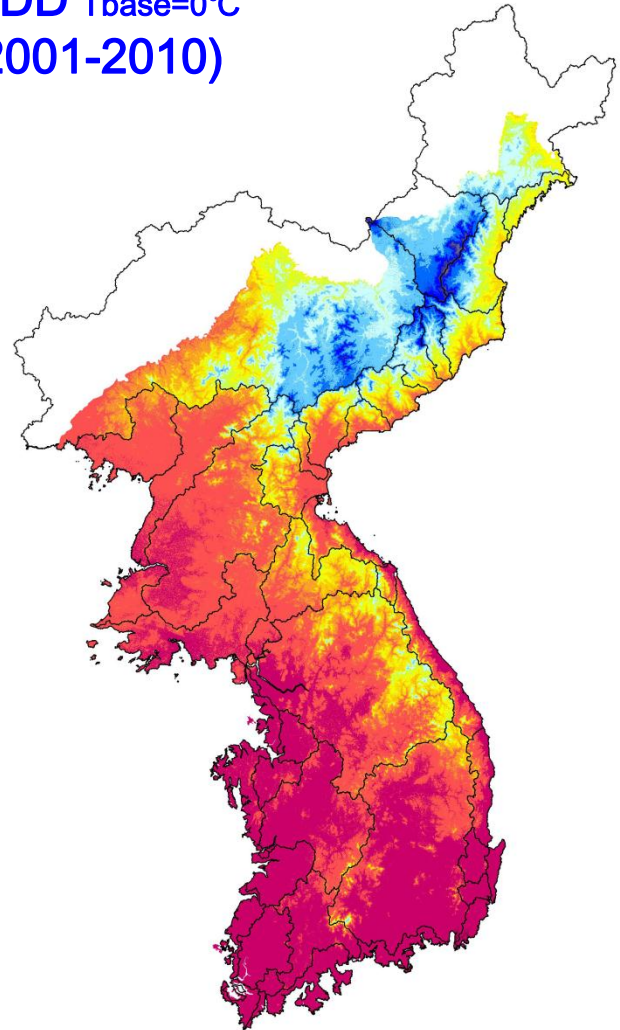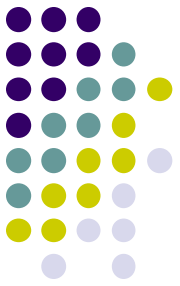
➢Climate Change Scenario projected for 2011-2100 at 10 years interval on
   temperature and precipitation.

Monthly Tmax in July

2001 ~ 2010

2011 ~ 2020

2041 ~ 2050

2081 ~ 2090

Temp. (℃)
10 - 13
13 - 16
16 - 17
17 - 18
18 - 20
20 - 22
22 - 24
24 - 26
26 - 28
28 - 29
29 - 31
31 - 32
32 - 35
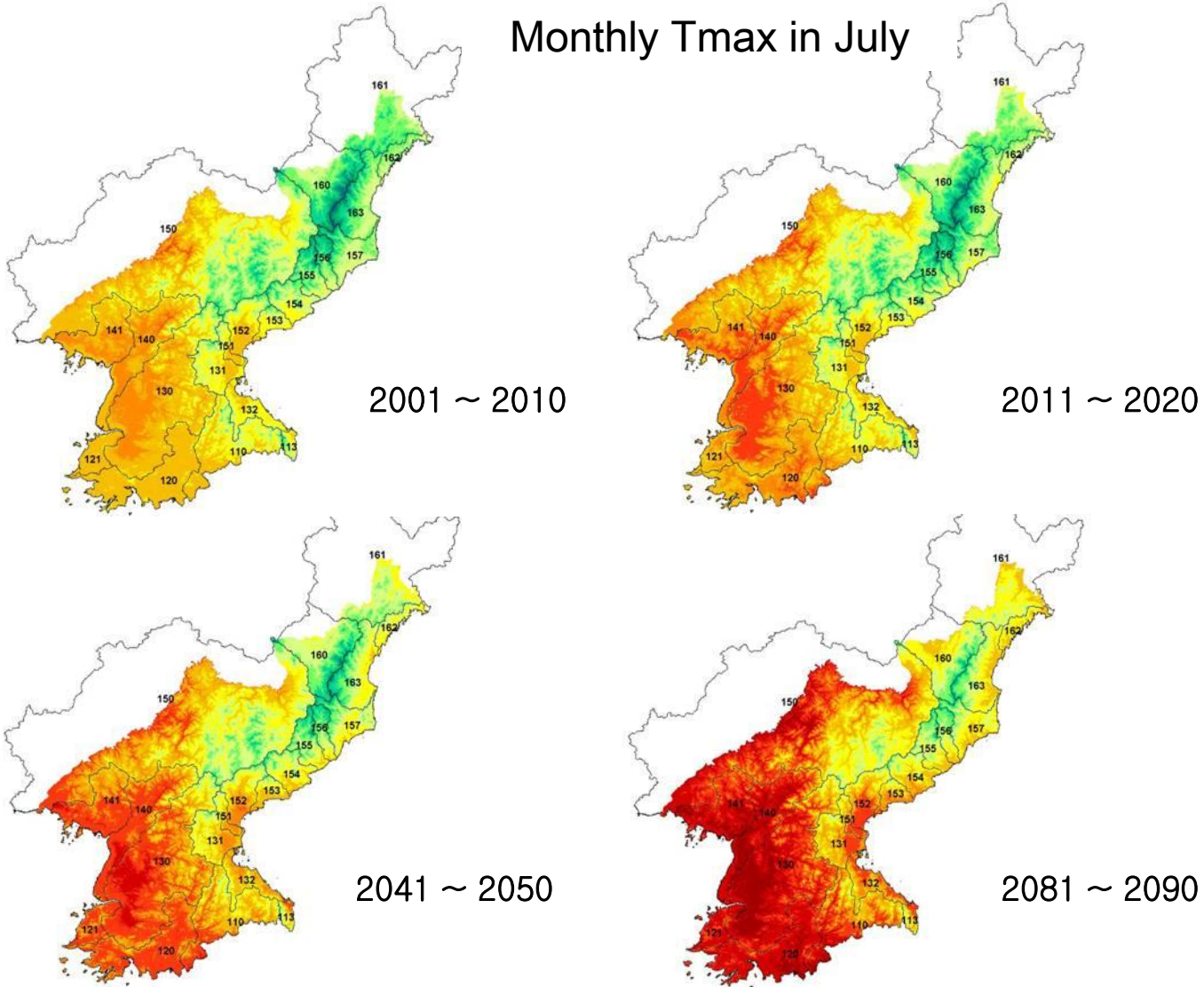
Impact assessment under Climate Change

Shifts in AgroEcological Zones under Climate Change Scenario

Apple "Fuji"

Cool area
Best area
Good area
Poor area

Normal

1℃ increase

2℃ increase