

Assessment of ecosystem vulnerability with CEVSA model in Korea

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Introduction



CO₂ absorption

Assessment of
Vulnerability

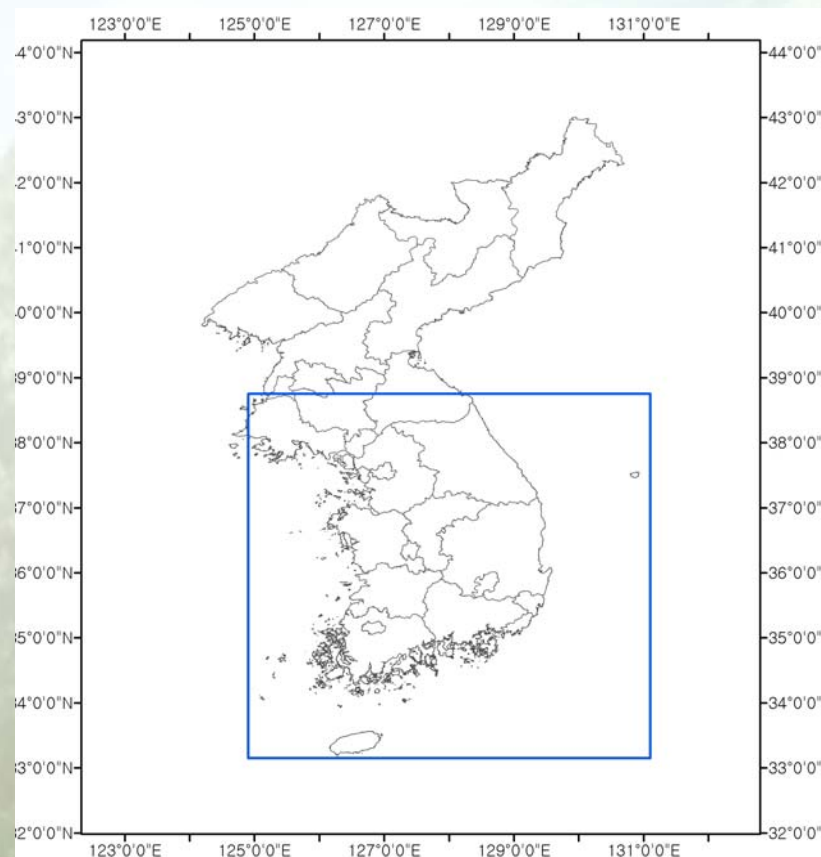


Developing
adaptation system
for climate change



Study materials

- Study area
(WGS-84)
 - Longitude: $124^{\circ}54' \sim 131^{\circ}6'$
 - Latitude: $33^{\circ}9' \sim 38^{\circ}45'$
- Spatial resolution
 - 0.05°
- ArcGIS
- Visual Basic, Fortran



Study materials

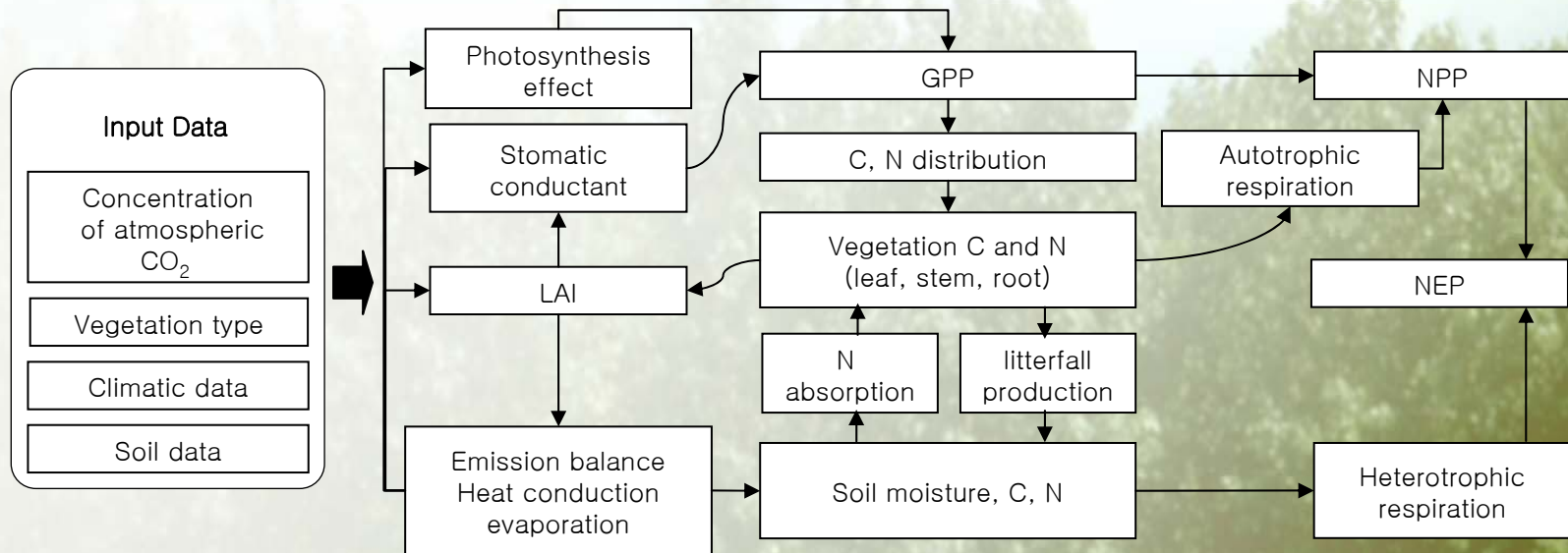
□ Input data for CEVSA model

Input data		Unit
CO ₂	Concentration of atmospheric CO ₂	ppm
Climate data	10 days average temperature of 30 years	0.1 °C
	10 days average precipitation of 30 years	0.1mm
	10 days average cloudiness of 30 years	%
	10 days average relative humidity of 30 years	%
Soil data	Average soil carbon	gC/m ²
	Average soil nitrogen	gC/m ²
	The percent of sand, silt and clay	%
Land cover	vegetation types	12 classes



Study materials

□ Structure of CEVSA model



- Static model
- Dynamic model



Potential vegetation distribution

□ Climatic parameters

- T_{\min} : minimum coldest month temperature
- GD5 : accumulated temperature over 5°C
- Wet index



Assessment of vulnerability

- Assessment of vulnerability

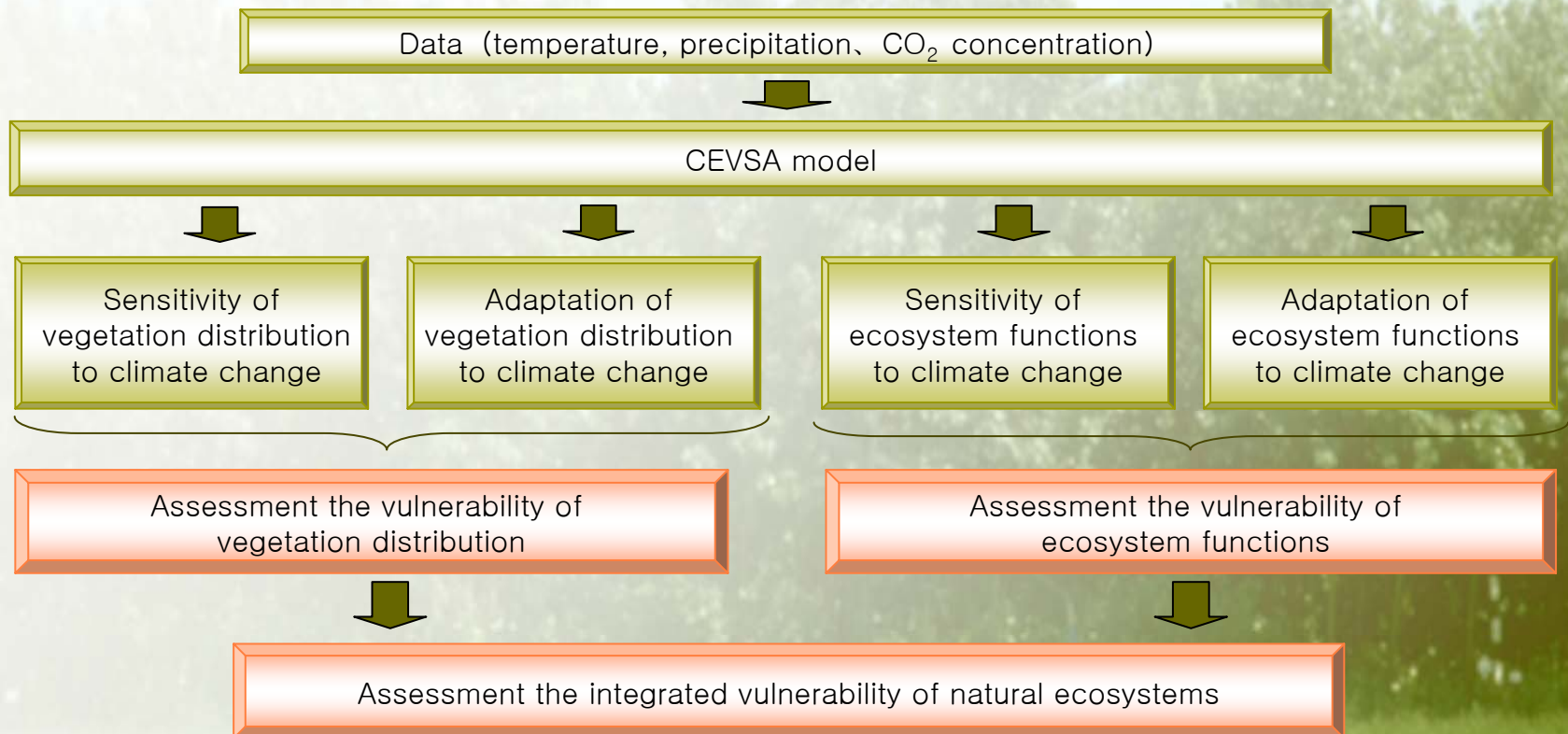
$$V = S - A$$

V: Vulnerability, S: Sensitivity, A: Adaptation



Assessment of vulnerability

- The framework of vulnerability assessment to natural ecosystems



Assessment of vulnerability

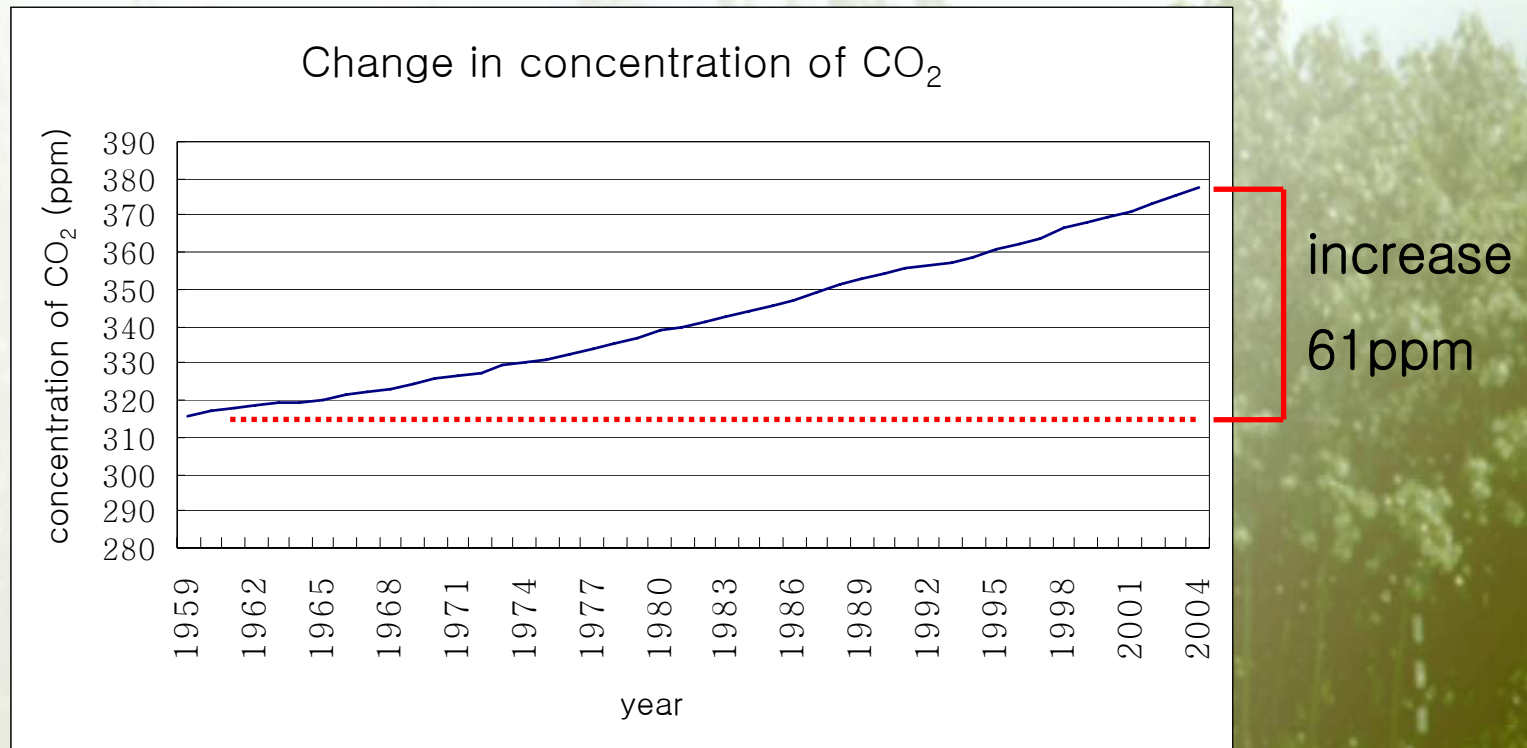
□ Indicators of assessing vulnerability

		indicators	Sub-indicators	Means of indicator
Integrated of ecosystem vulnerability	assessment to vegetation distribution	Change of vegetation type	Actual change times	S
			Actual change direction	A
	Potential change times	S		
	Potential change direction	A		
	assessment to ecosystem functions	NPP	Annuals variability	S
			The trend	A
Annuals variability			S	
The trend			A	
assessment to ecosystem functions	VC	Annuals variability	S	
		The trend	A	
		Annuals variability	S	
		The trend	A	
assessment to ecosystem functions	SC	Annuals variability	S	
		The trend	A	
		Annuals variability	S	
		The trend	A	
assessment to ecosystem functions	NEP	Annuals variability	S	
		The trend	A	
		Annuals variability	S	
		The trend	A	



Data preparation

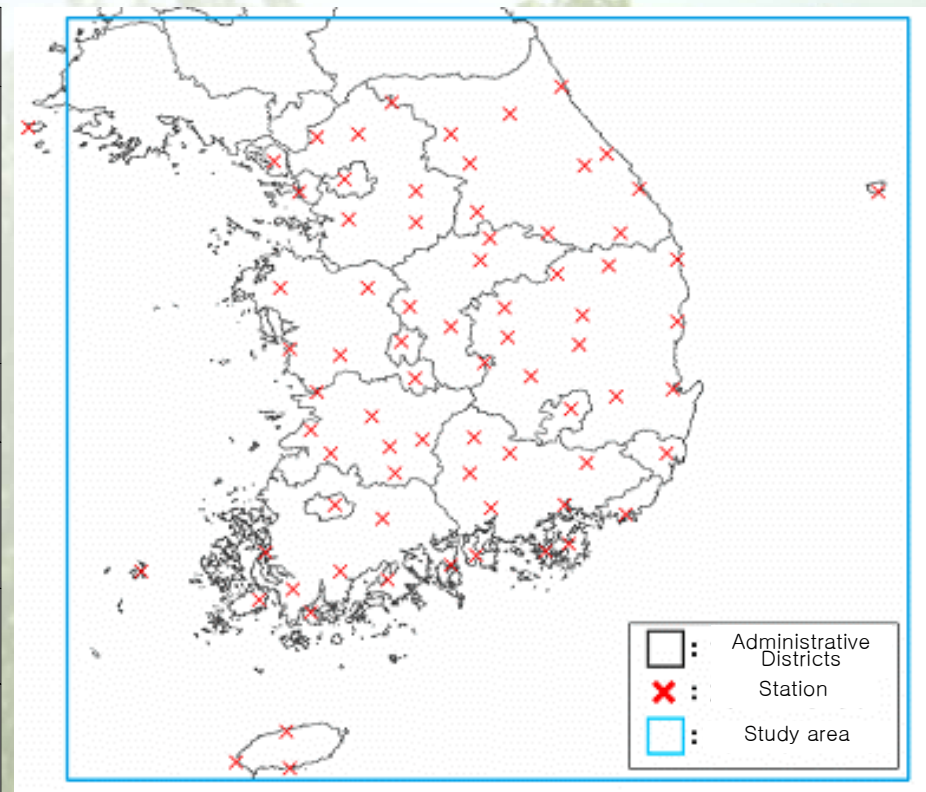
□ Concentration of CO₂ (Mauna Loa, Hawaii)



Data preparation

□ Climate data (1977~2006)

contents	Description
Climate factor	4 factors - Temperature (unit : °C) - Precipitation (unit : mm) - Relative humidity (unit : %) - Cloudiness (unit : %)
period	Past 30 years : 1977~2006
Number of station	75 stations (excluding Soengsan and Gochang)
Observation interval	Daily observed data
source	Korea Meteorological Administration (http://www.kma.go.kr/)



Data preparation

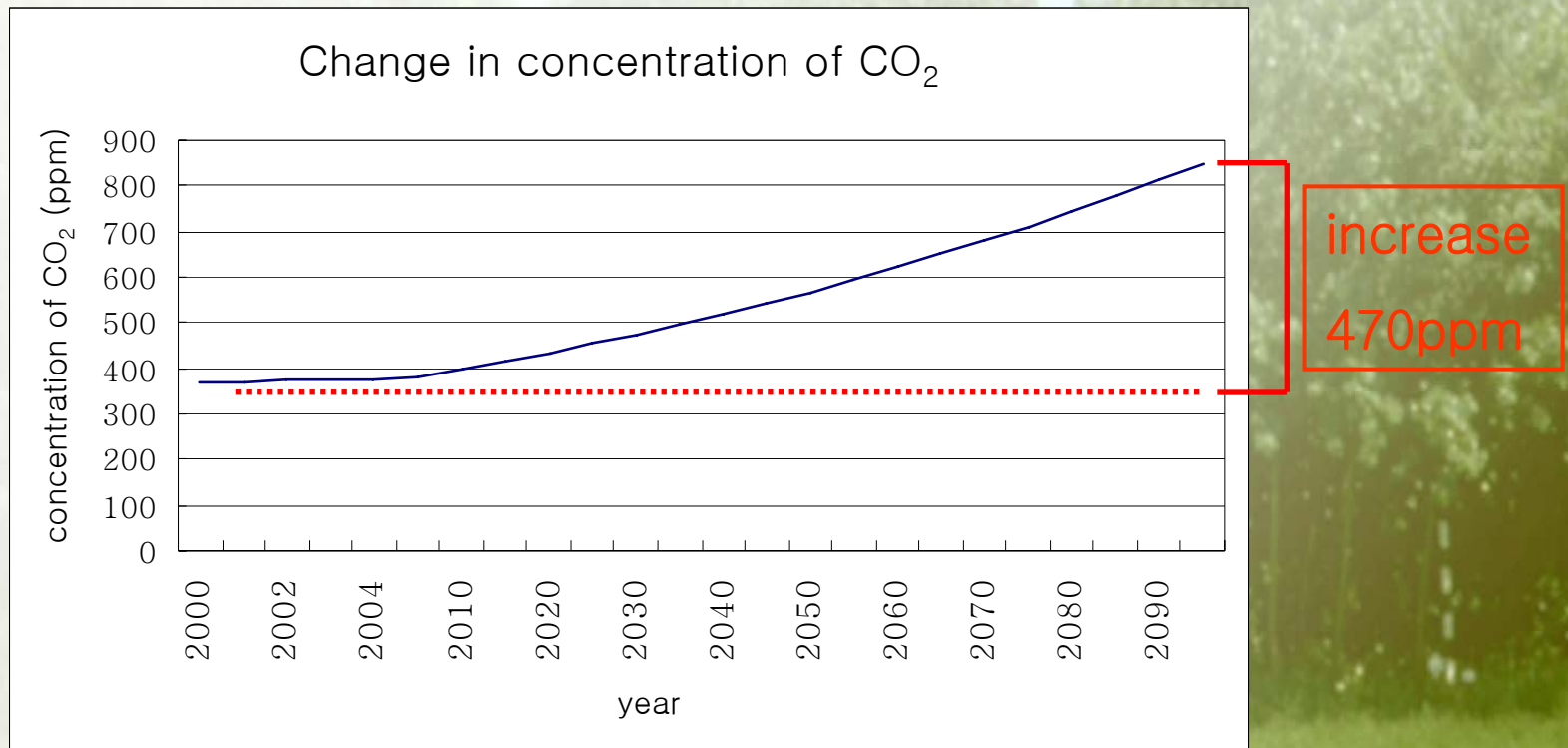
□ Climate data (2007~2100)

contents	Description
Climate factor	2 factors - Temperature (unit : °C) - Precipitation (unit : mm)
period	2001~2100
Spatial range	Korea
Observation interval	10 days
Spatial resolution	0.2432° × 0.2432° ※ About 27km × 27km
source	International Institute of meteorological reaserch



Data preparation

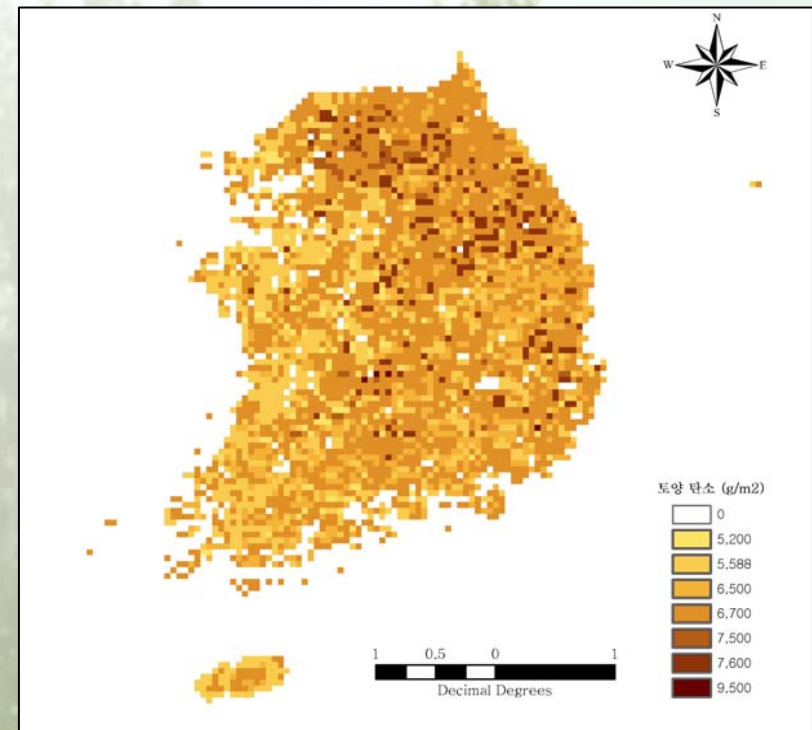
- Climate model and Scenario
ECHO-G, A1B



Data preparation

□ Soil data (soil carbon)

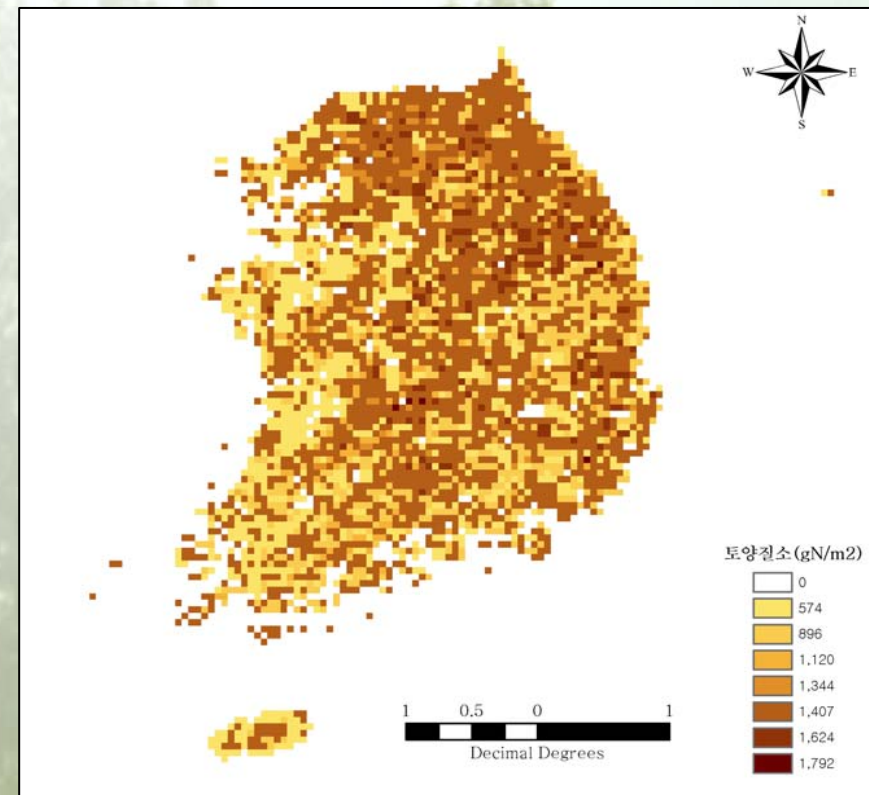
Forest type	Amount of Carbon		reference
	Jeon et al, 1998 (tonC/ha)	Unit for CEVSA model (gC/m ²)	
Pinus rigida	52	5,200	-Jeon et al, 1998
Pinus densiflora	65	6,500	
Pinus koraiensis	75	7,500	
Larix leptolepis	76	7,600	
Quercus accutissima	95	9,500	
others	-	6,700	
Nonforest	-	5,588	-Applying soil carbon of vacant land to except human disturbance
City and built up	-	0	



Data preparation

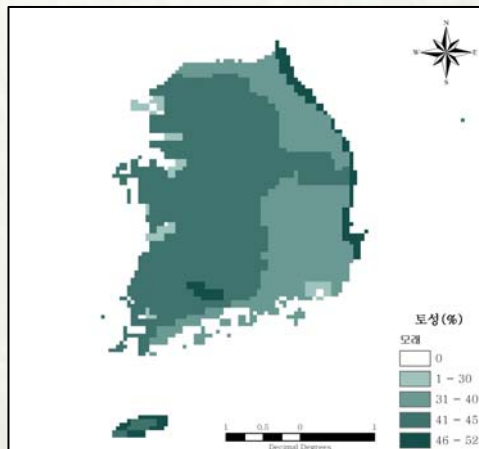
□ Soil data (soil nitrogen)

Forest type	Amount of Nitrogen		reference
	Kim et al,1991 T.N (%)	Unit for CEVSA model(gN/m ²)	
Pinus koraiensis	0.24	1,344	-Kim et al,1991
Larix leptolepis	0.29	1,624	
Pinus rigida	0.20	1,120	
Quercus acutissima	0.32	1,792	
Pinus densiflora	0.16	896	
others	-	1407	
Nonforest	-	574	- Applying soil nitrogen of devastated region to except human disturbance
City and built up	-	0	

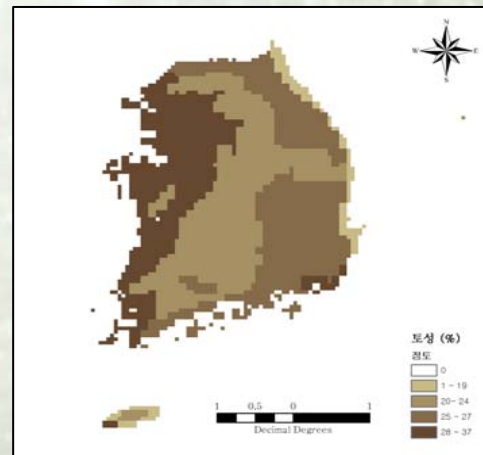


Data preparation

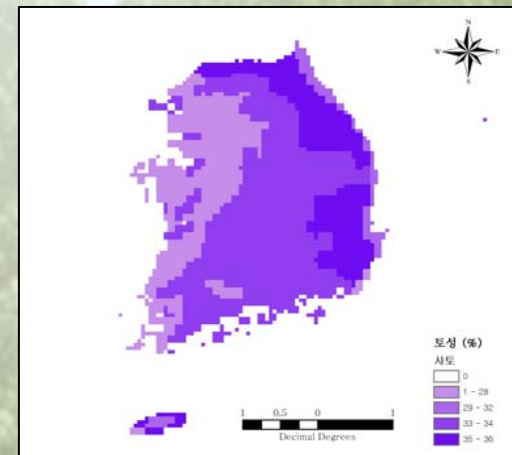
- Soil data (soil texture)
source : FAO



Percentage of soil sand



Percentage of soil clay



Percentage of soil silt

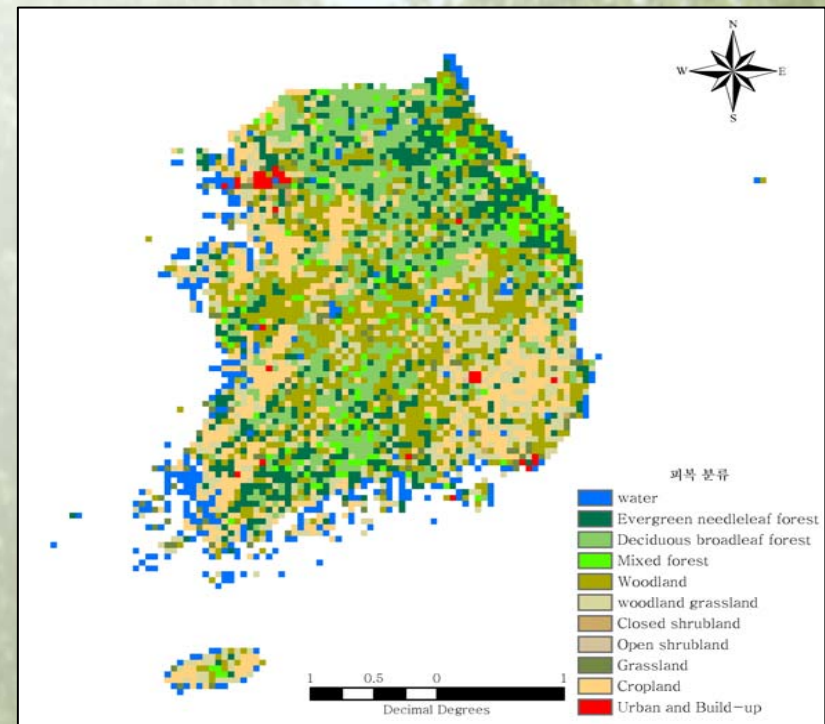


Data preparation

□ Land cover

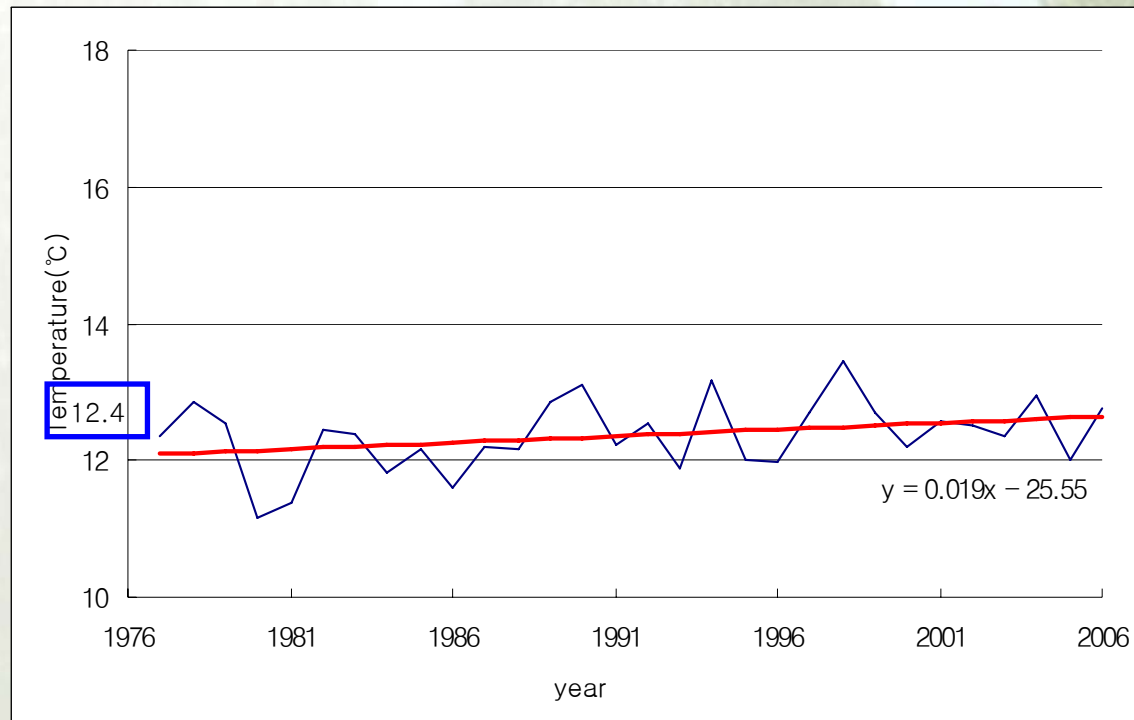
University of Maryland (M. C. Hansen, et al, 1997)

land cover classification	Area (km ²)	Component ratio(%)
water	8,102.24	7.80
evergreen needleleaf forest	16,052.57	15.44
deciduous broadleaf forest	16,027.25	15.42
Mixed forest	4,785.39	4.60
woodland	23,775.02	22.87
woodland grassland	15,115.75	14.54
closed shrubland	227.88	0.22
open shrubland	75.96	0.07
grassland	2,607.91	2.51
cropland	16,331.08	15.71
urban and built-up	835.54	0.80
계	103,936.59	100.00



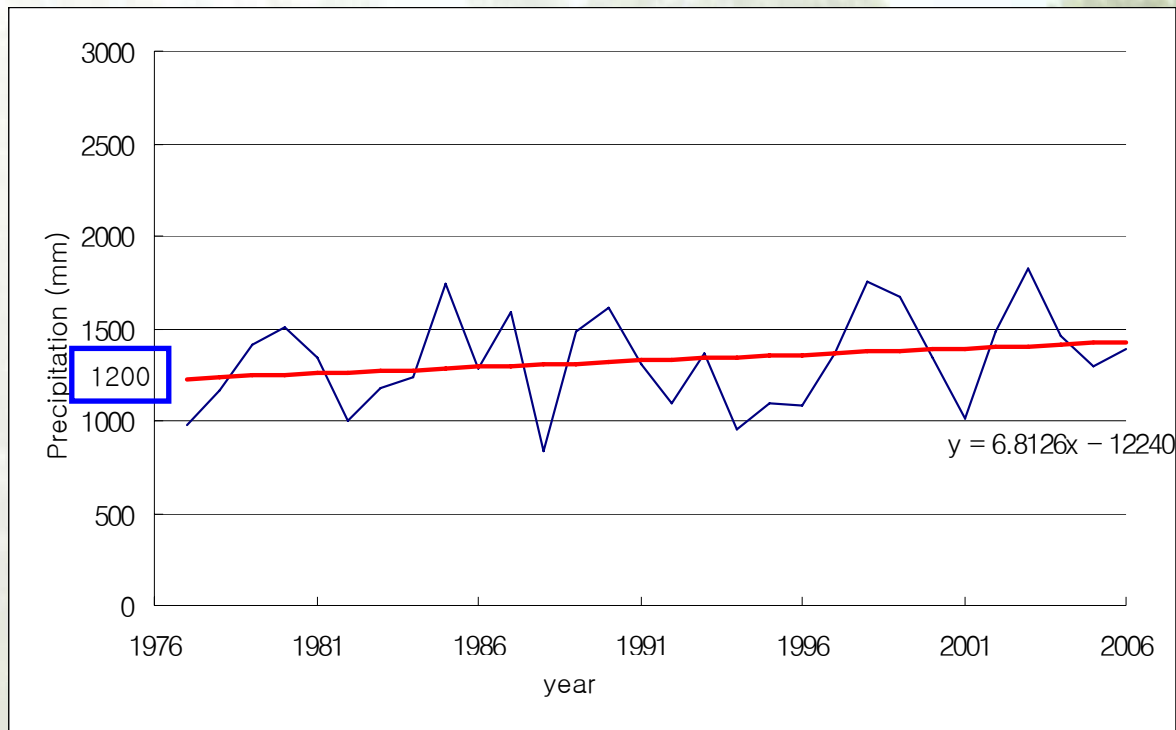
Results

- Change in annual average of Temperature during 1976~2006



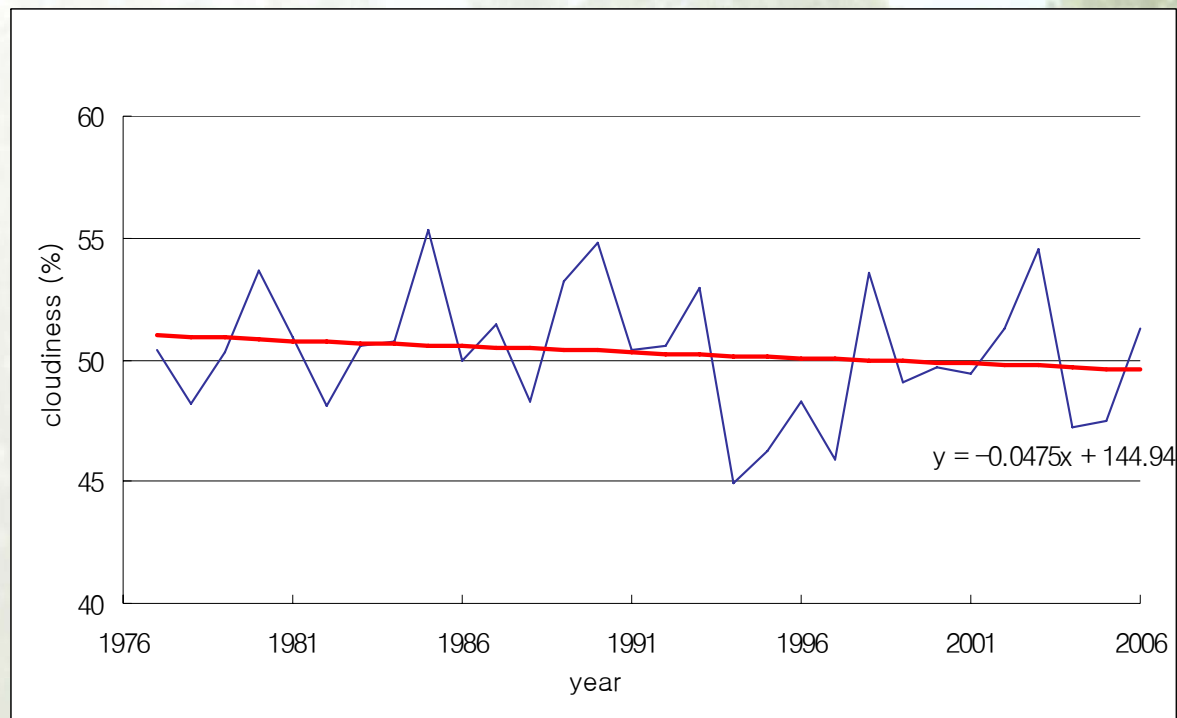
Results

- Change in annual average of precipitation during 1976~2006



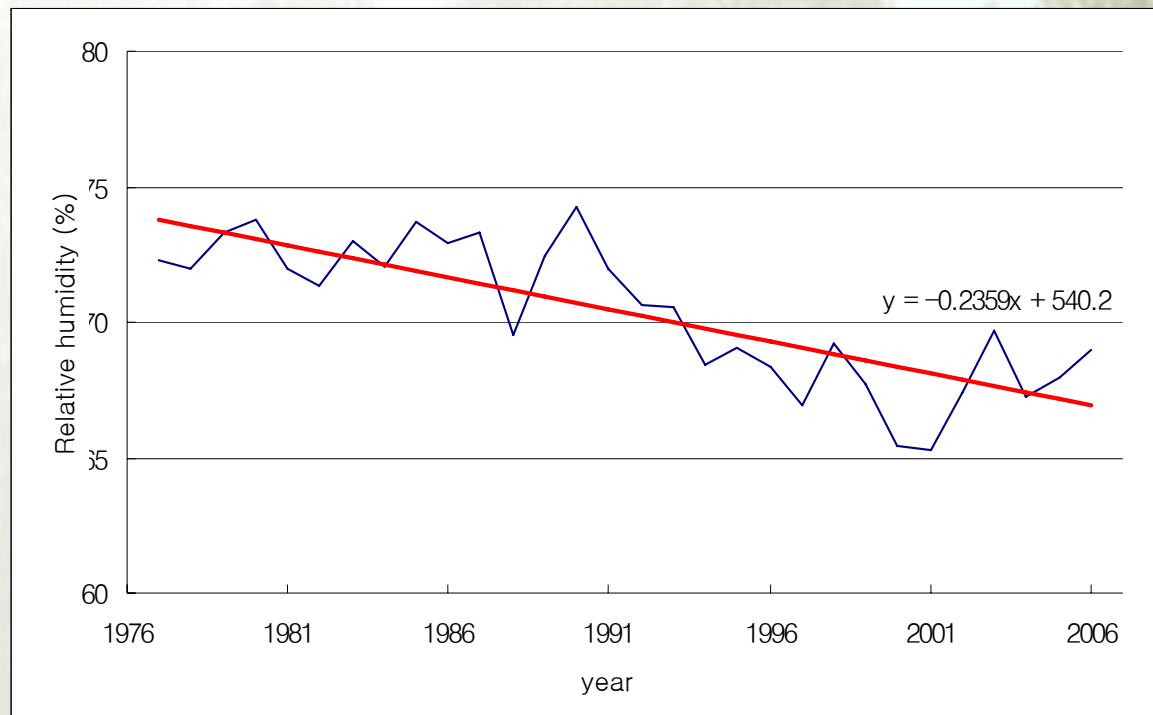
Results

- Change in annual average of cloudiness during 1976~2006



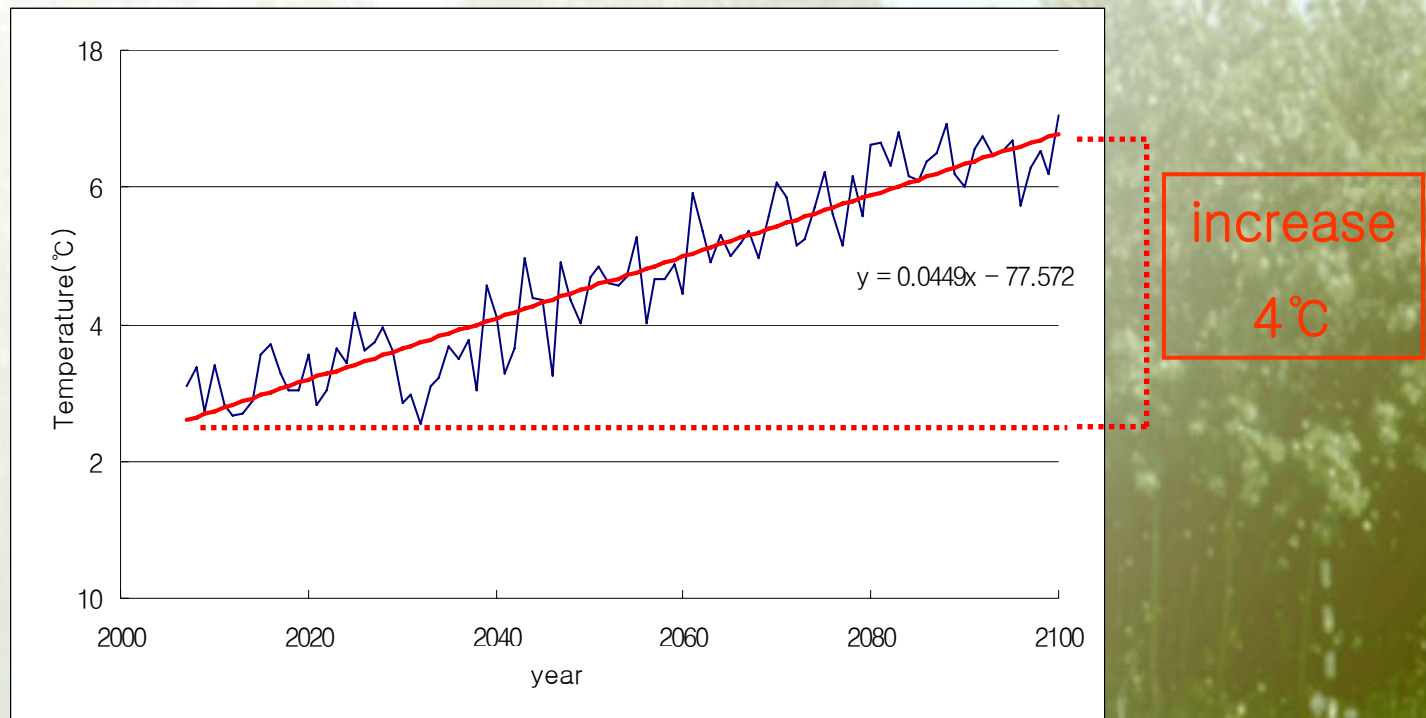
Results

- Change in annual average of relative humidity during 1976~2006



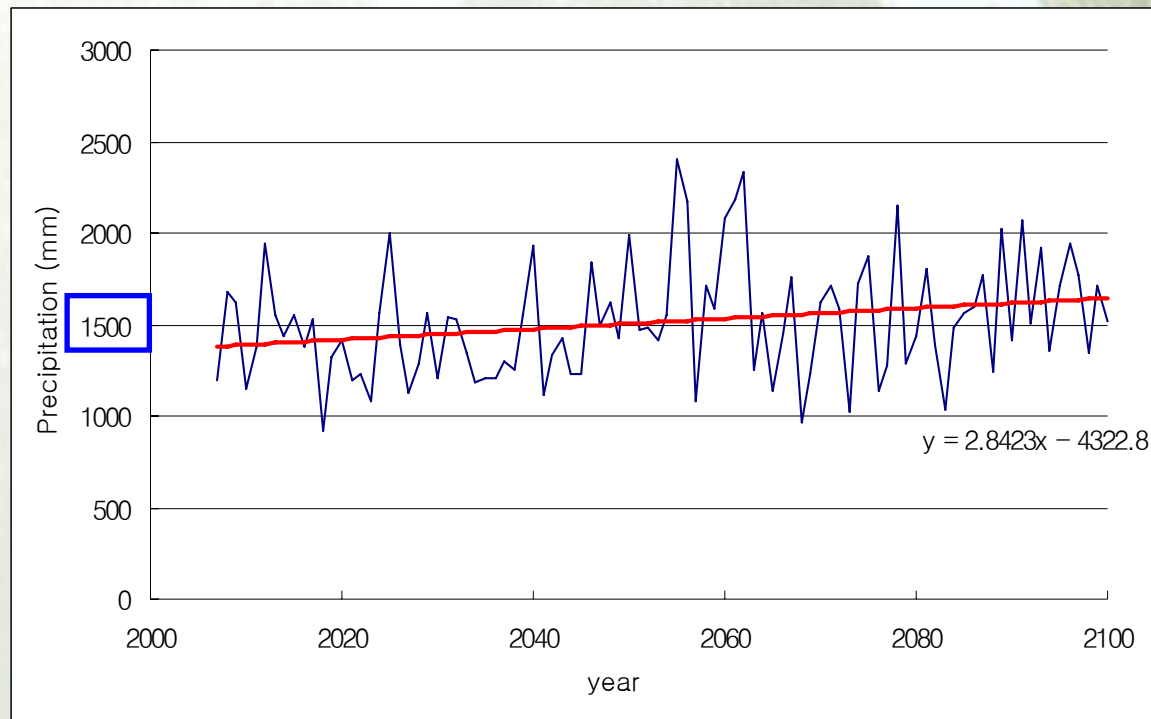
Results

- Change in annual average of temperature during 2007~2100



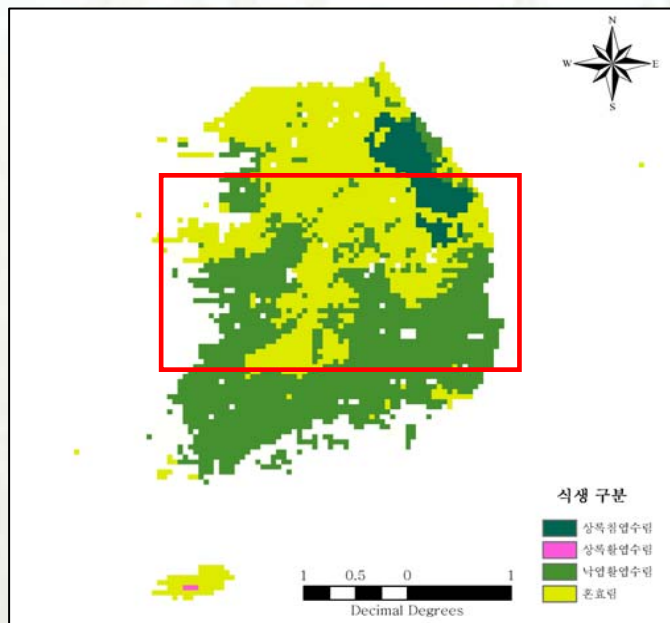
Results

- Change in annual average of precipitation during 2007~2100

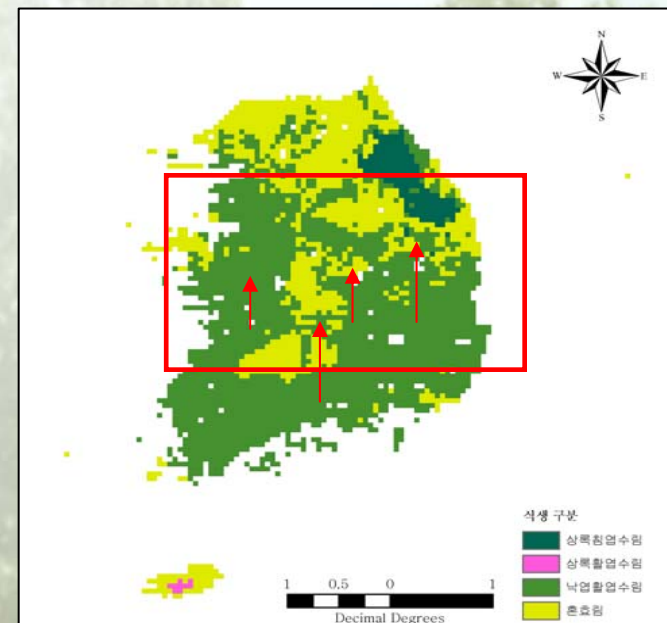


Results

□ Potential vegetation distribution



under current climate(1977~2006)



under future climate(2071~2100)

Change in potential vegetation distribution



Results

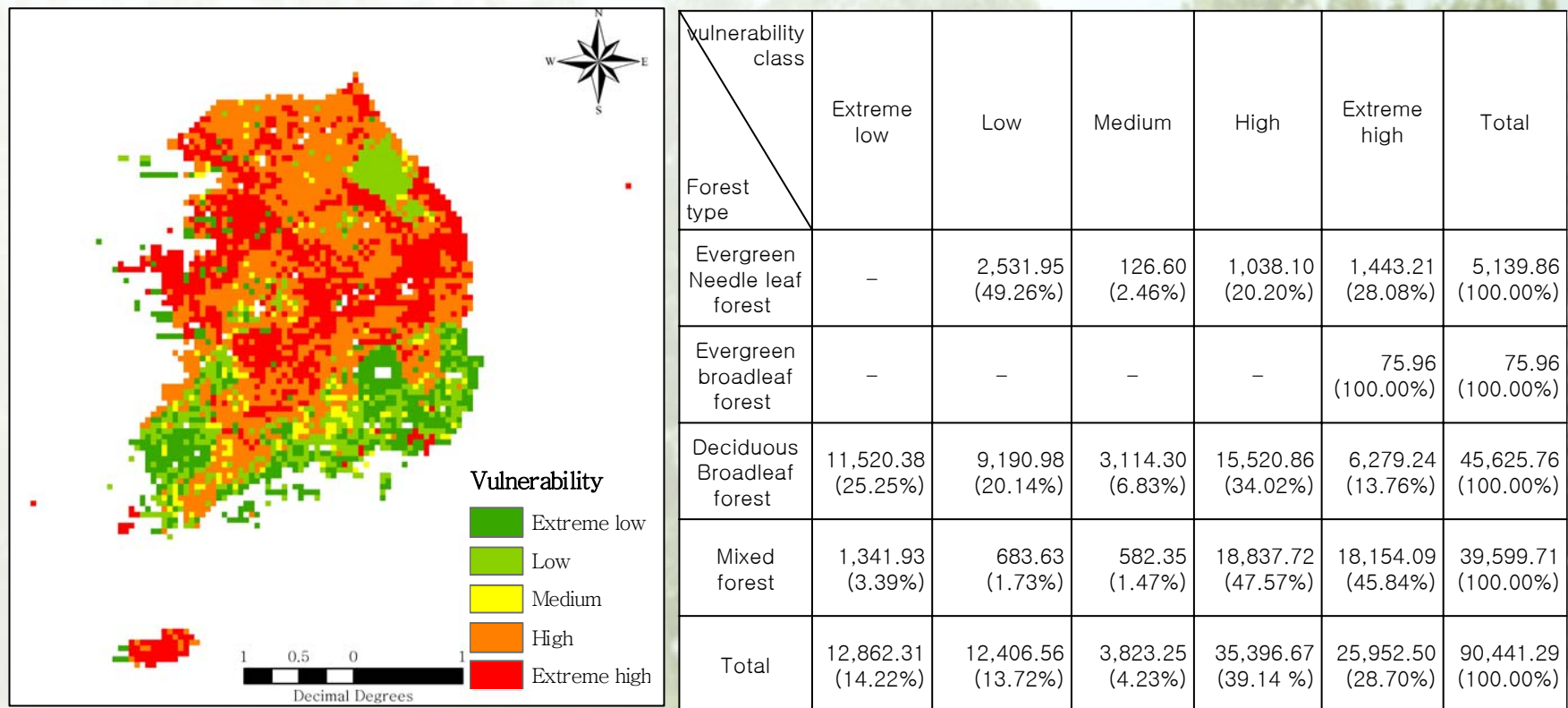
□ Difference of current and future vegetation distribution

Vegetation type	current (1977~2006)		future (2071~2100)		difference	
	area (km ²)	Component ratio (%)	area (km ²)	Component ratio (%)	area (km ²)	Component ratio (%)
Evergreen needleleaf forest	5,139.86	5.68	3,975.16	4.40	-1,164.70	-22.66
Evergreen broadleaf forest	75.96	0.08	227.88	0.25	151.92	200.00
Deciduous Broadleaf forest	45,625.76	50.45	58,741.26	4.95	13,115.51	28.75
Mixed forest	39,599.71	43.78	27,496.99	30.40	-12,102.73	-30.56
Total	90,441.29	100.00	90,441.29	100.00		



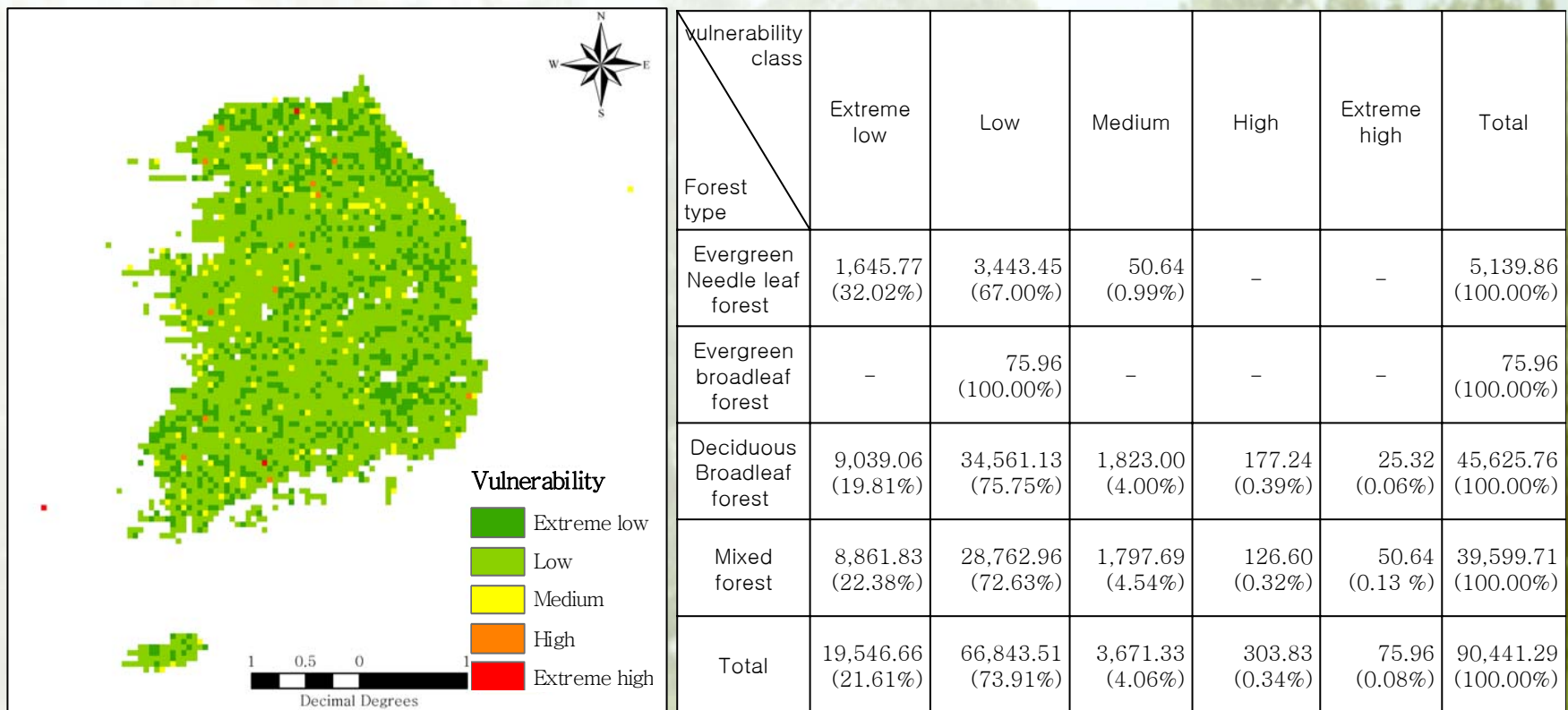
Results

- Vulnerability of potential vegetation distribution under current climate(1977~2006)



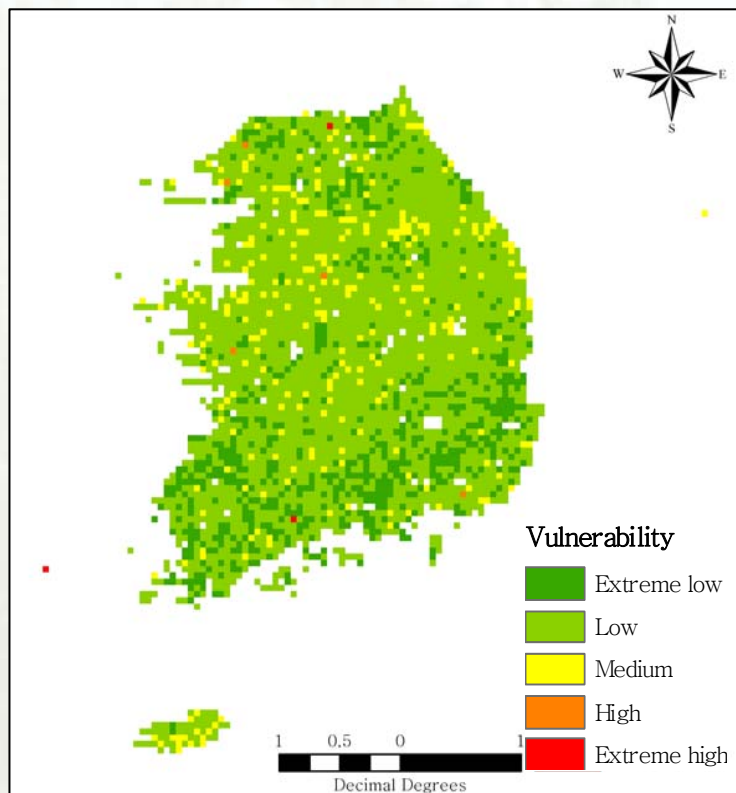
Results

▣ Vulnerability of ecosystem function under current climate(1977~2006)



Results

□ Vulnerability of ecosystem under current climate (1977~2006)

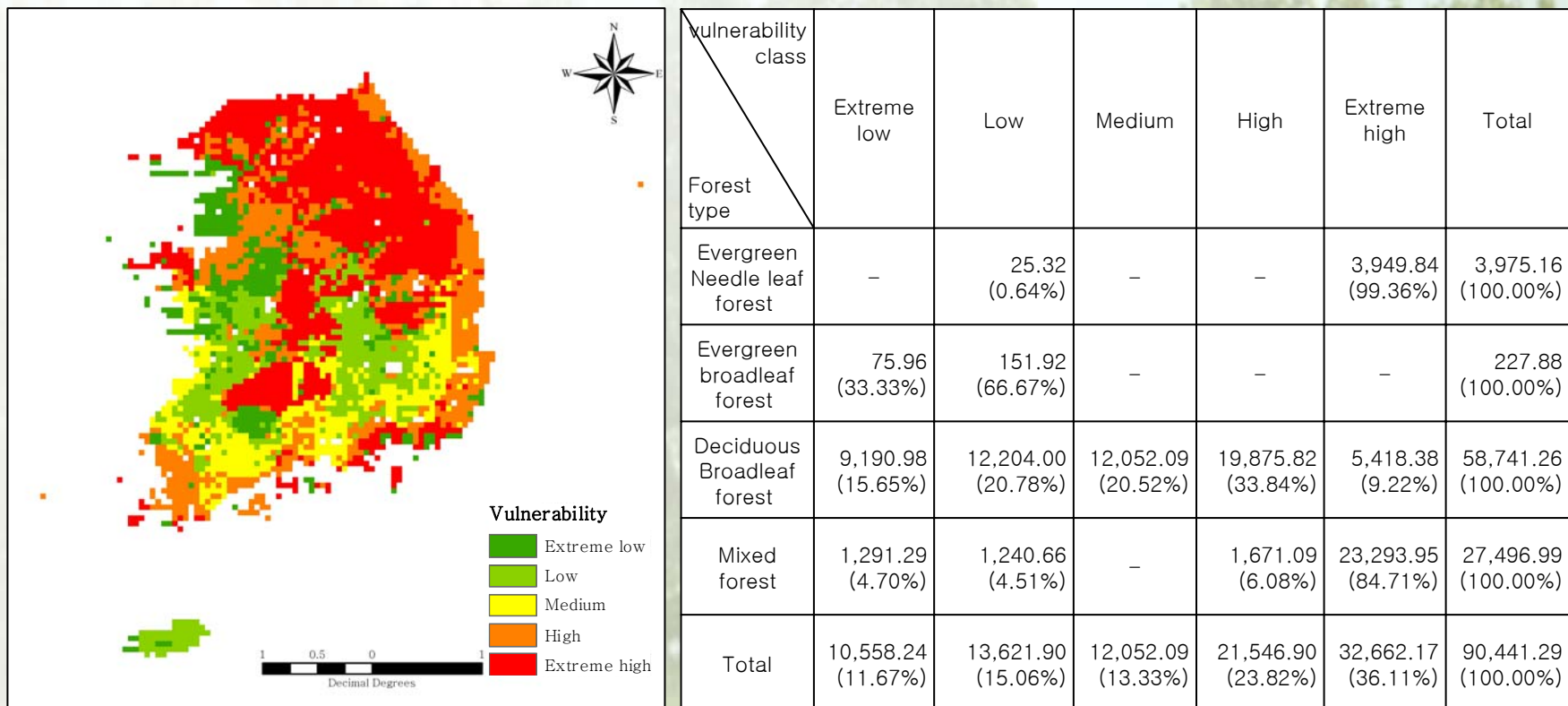


vulnerability class \ Forest type	Extreme low	Low	Medium	High	Extreme high	Total
	Evergreen Needle leaf forest	227.88 (4.43%)	4,810.71 (93.60%)	101.28 (1.97%)	-	-
Evergreen broadleaf forest	-	-	75.96 (100.00%)	-	-	75.96 (100.00%)
Deciduous Broadleaf forest	12,482.52 (27.36%)	31,092.36 (68.15%)	1,974.92 (4.33%)	50.64 (0.11%)	25.32 (0.06%)	45,625.76 (100.00%)
Mixed forest	3,671.33 (9.27%)	31,067.04 (78.45%)	4,734.75 (11.96%)	75.96 (0.19%)	50.64 (0.13%)	39,599.71 (100.00%)
Total	16,381.72 (18.11%)	66,970.10 (74.05%)	6,886.91 (7.61%)	126.60 (0.14%)	75.96 (0.08%)	90,441.29 (100.00%)

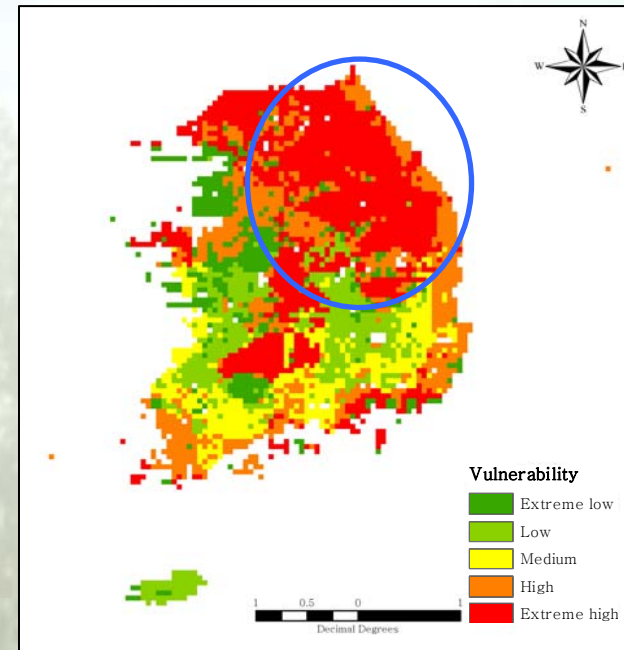
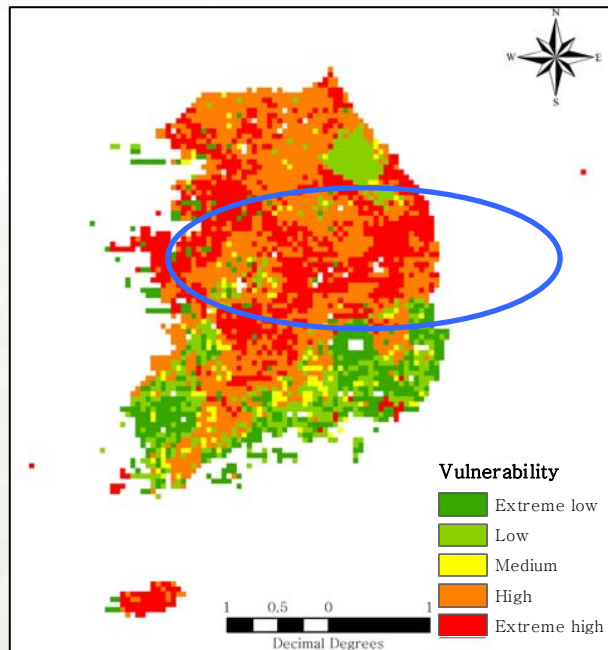


Results

- Vulnerability of potential vegetation distribution under future climate(2071~2100)



Results

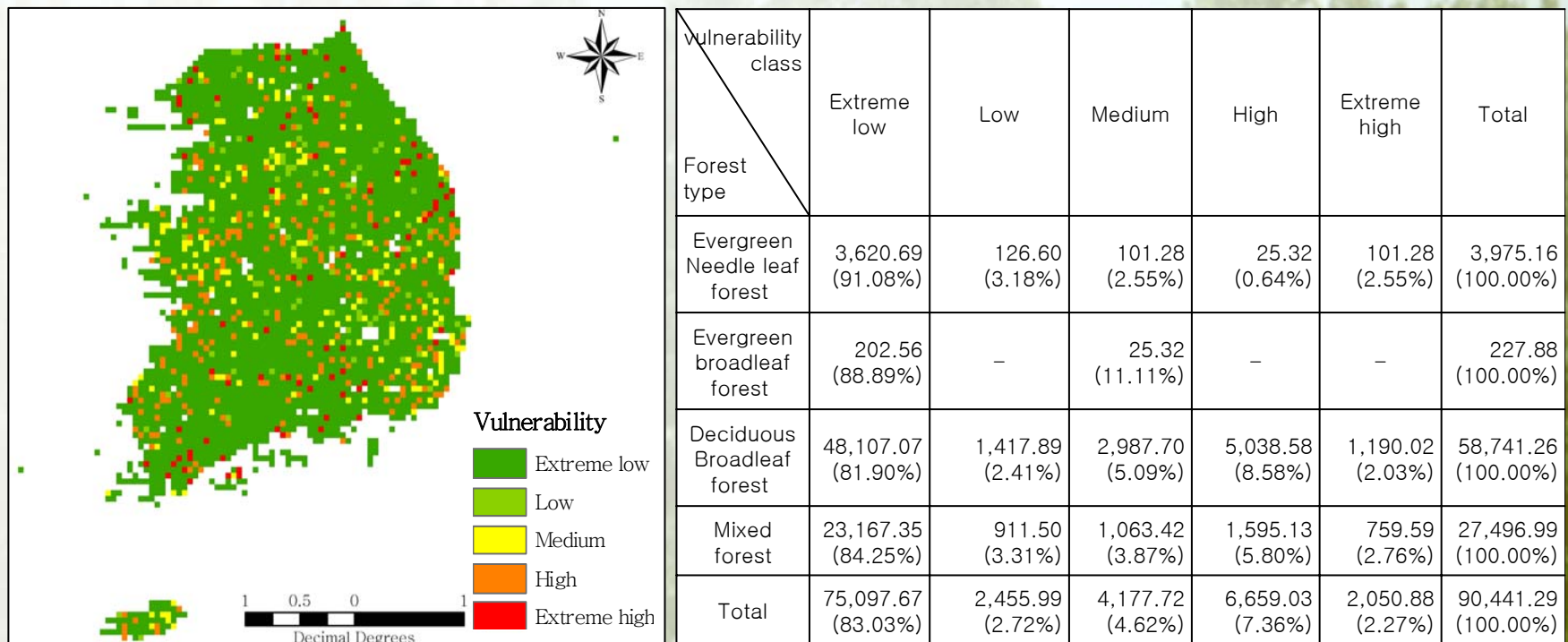


Time \ Vulnerability class	Vulnerability class					Total
	Extreme low	Low	Medium	High	Extreme high	
Current	12,862.31 (14.22%)	12,406.56 (13.72%)	3,823.25 (4.23%)	35,396.67 (39.14 %)	25,952.50 (28.70%)	90,441.29 (100.00%)
Future	10,558.24 (11.67%)	13,621.90 (15.06%)	12,052.09 (13.33%)	21,546.90 (23.82%)	32,662.17 (36.11%)	90,441.29 (100.00%)



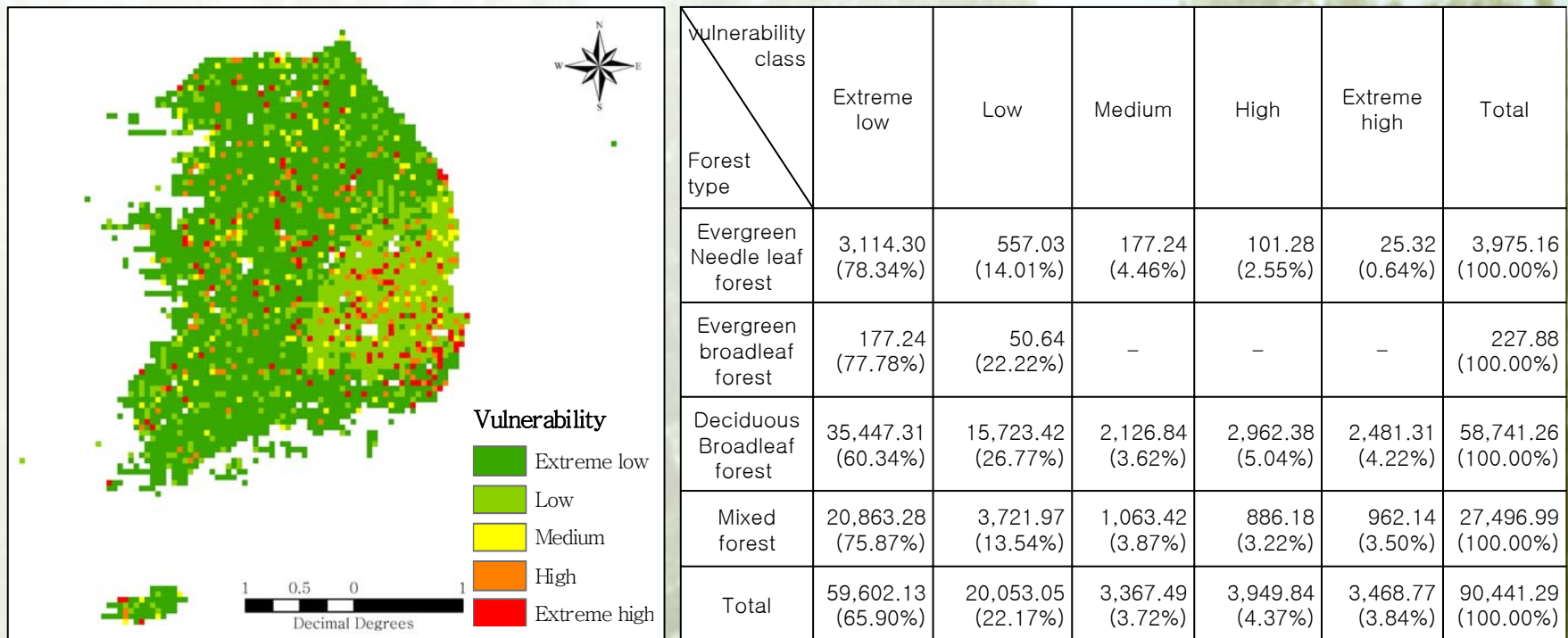
Results

▣ Vulnerability of NPP under future climate(2071~2100)



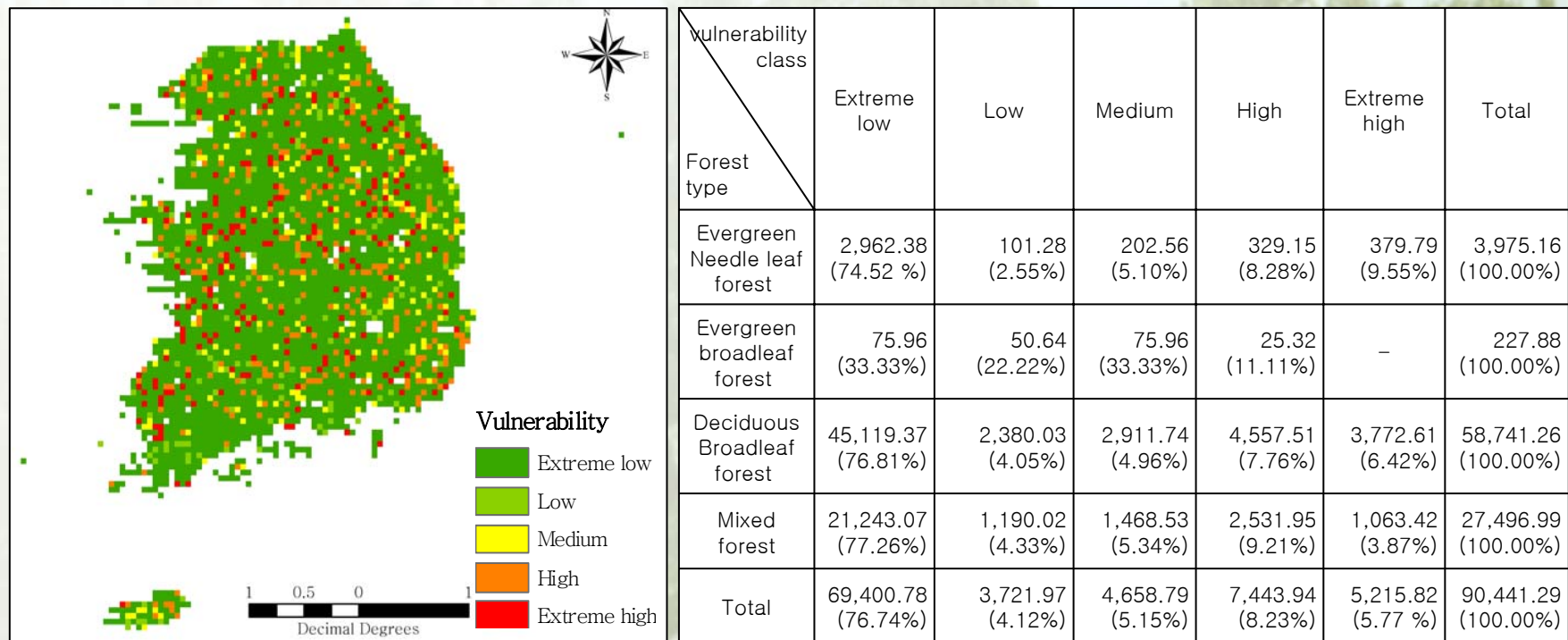
Results

▣ Vulnerability of NEP under future climate (2071~2100)



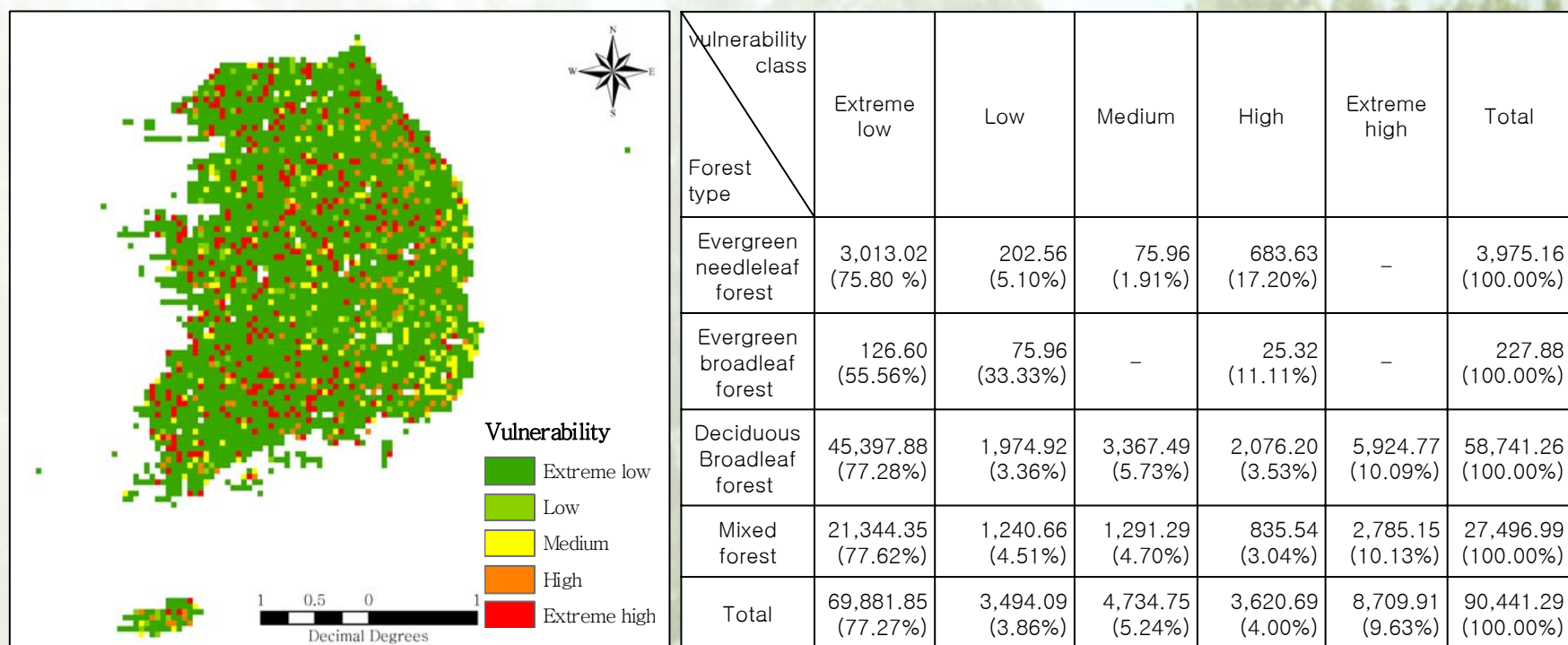
Results

▣ Vulnerability of SCS under future climate (2071~2100)



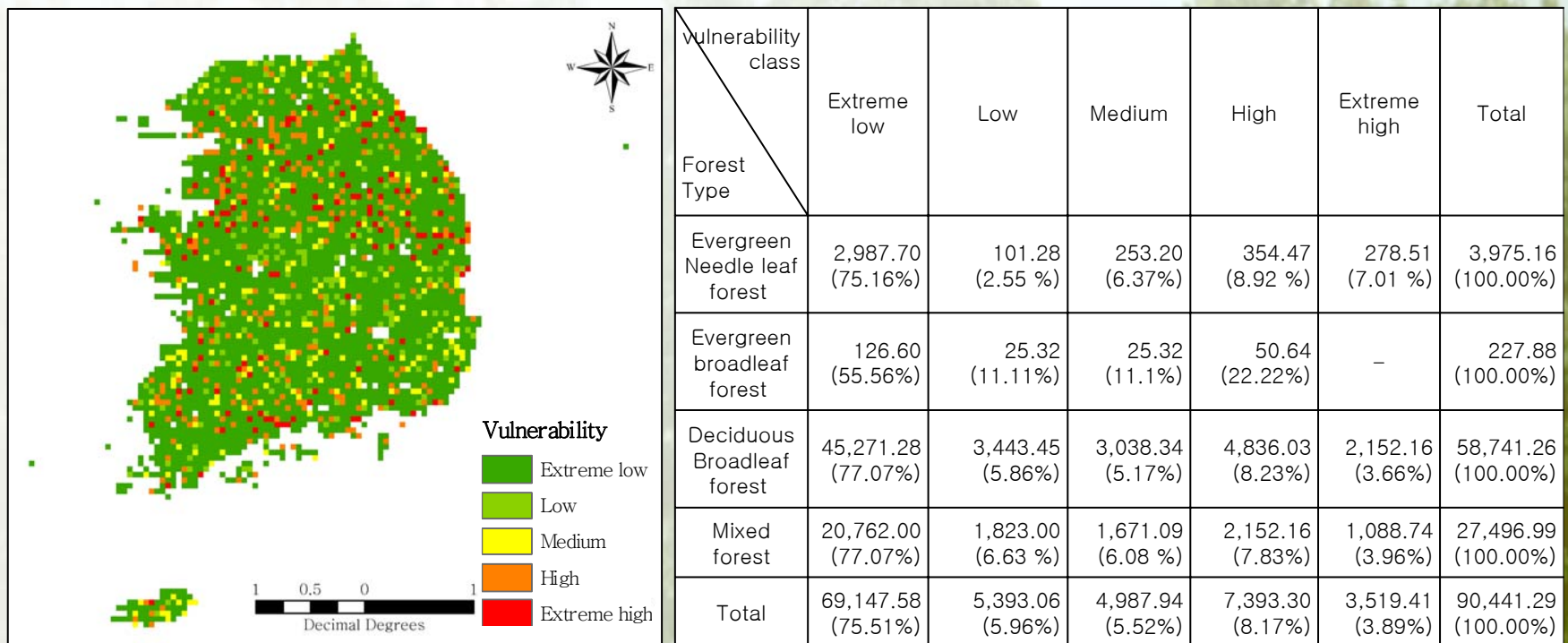
Results

▣ Vulnerability of VCS under future climate (2071~2100)

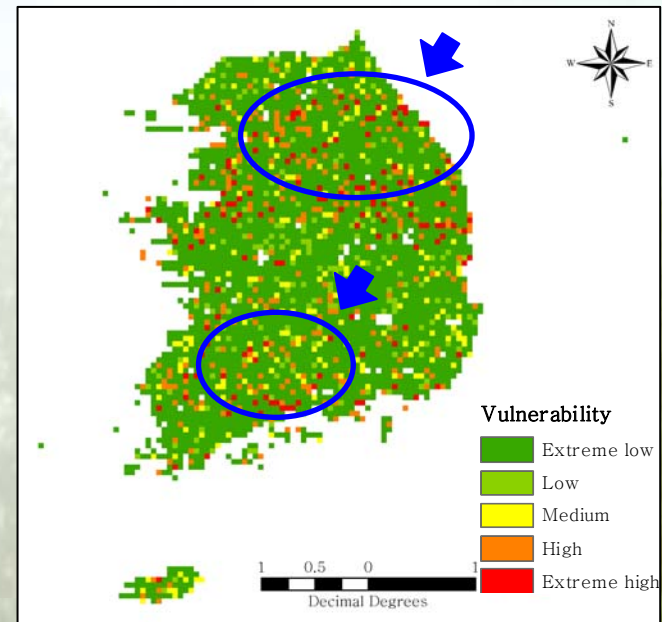
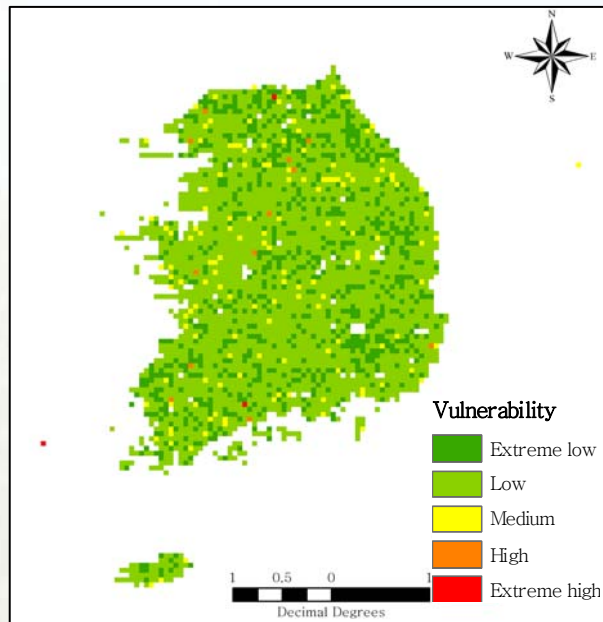


Results

- Vulnerability of ecosystem function under future climate(2071~2100)



Results

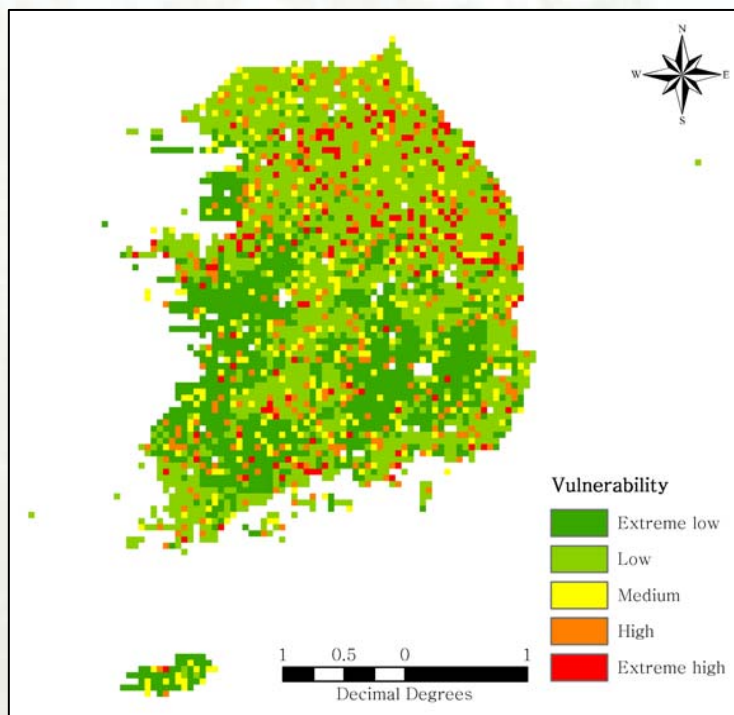


Vulnerability class \ Time	Extreme low	Low	Medium	High	Extreme high	Total
Current	19,546.66 (21.61%)	66,843.51 (73.91%)	3,671.33 (4.06%)	303.83 (0.34%)	75.96 (0.08%)	90,441.29 (100.00%)
Future	69,147.58 (75.51%)	5,393.06 (5.96%)	4,987.94 (5.52%)	7,393.30 (8.17%)	3,519.41 (3.89%)	90,441.29 (100.00%)



Results

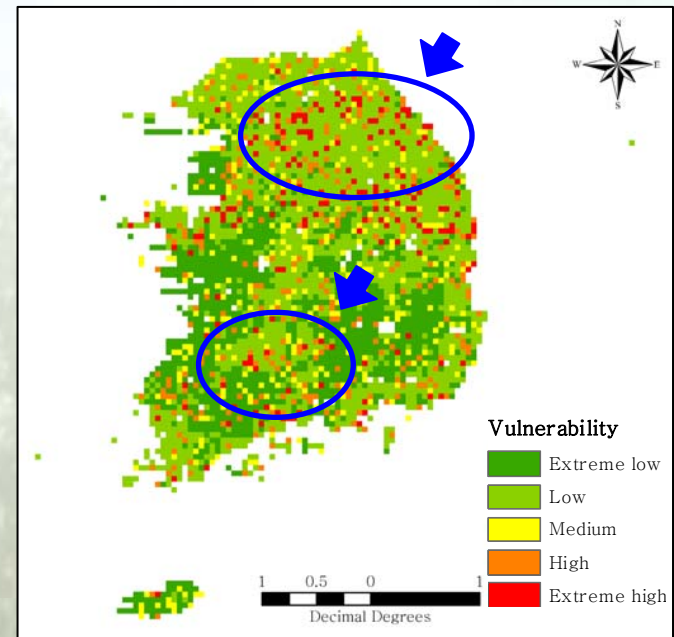
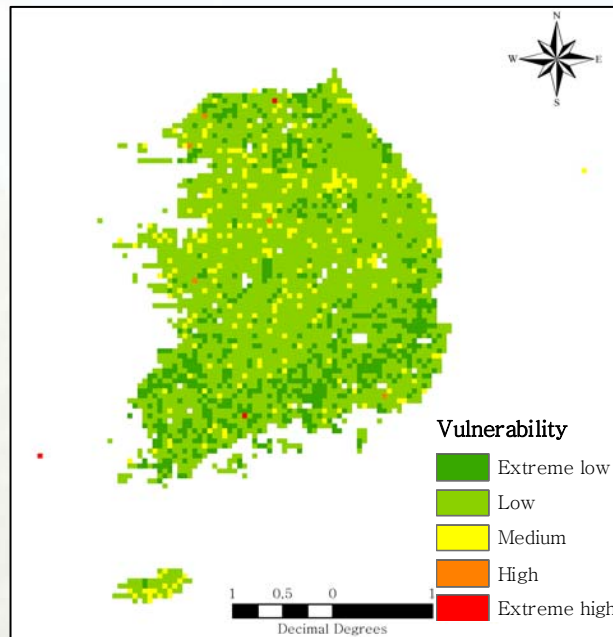
▣ Vulnerability of ecosystem under future climate (2071~2100)



vulnerability class Forest type	Extreme low	Low	Medium	High	Extreme high	Total
	Evergreen Needle leaf forest	25.32 (0.64%)	2,962.38 (74.52%)	151.92 (3.82%)	354.47 (8.92%)	481.07 (12.10%)
Evergreen broadleaf forest	151.92 (66.67%)	-	75.96 (33.33%)	-	-	227.88 (100.00%)
Deciduous Broadleaf forest	25,952.50 (44.18%)	20,103.69 (34.22%)	5,646.25 (9.61%)	5,063.90 (8.62%)	1,974.92 (3.36%)	58,741.26 (100.00%)
Mixed forest	1,924.28 (7.00%)	18,787.08 (68.32%)	2,430.67 (8.84%)	2,202.80 (8.01%)	2,152.16 (7.83%)	27,496.99 (100.00%)
Total	28,054.02 (31.02%)	41,853.15 (46.28%)	8,304.80 (9.18%)	7,621.17 (8.43%)	4,608.15 (5.10%)	90,441.29 (100.00%)



Results

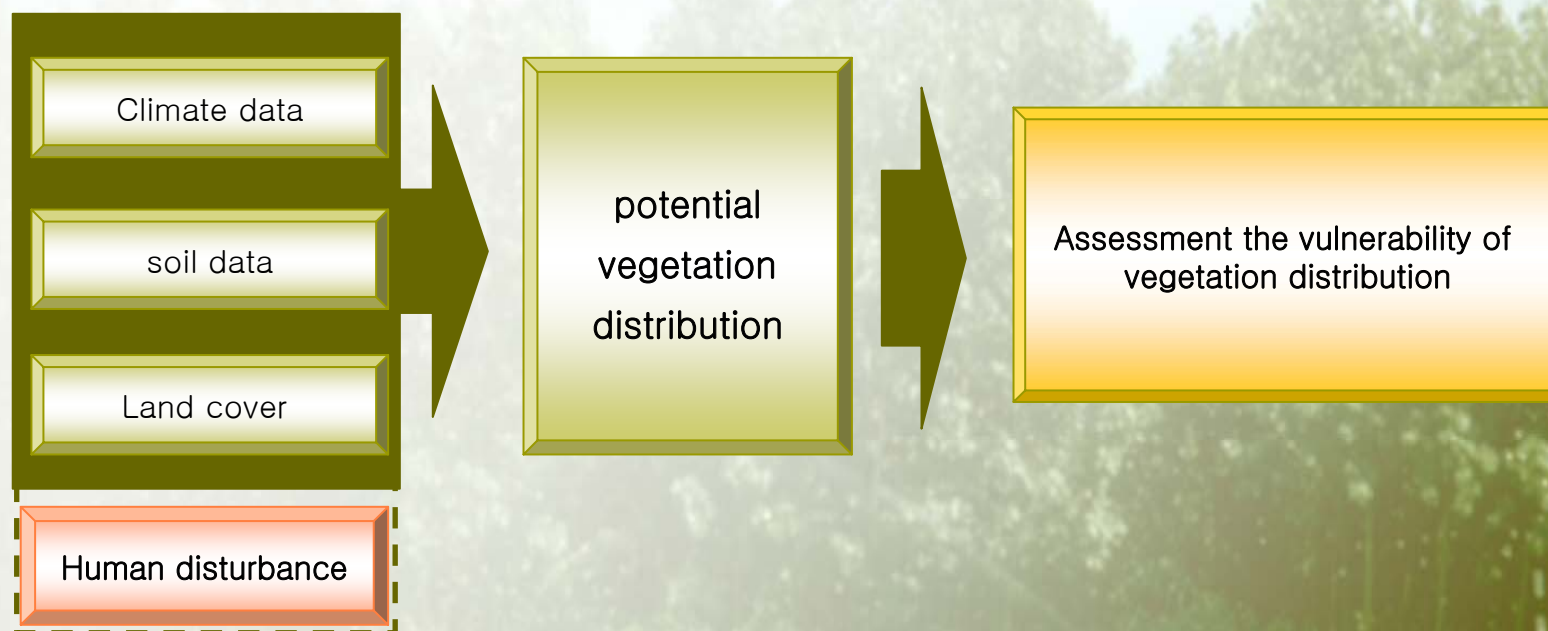


Vulnerability class \ Time	Vulnerability class					Total
	Extreme low	Low	Medium	High	Extreme high	
Current	16,381.72 (18.11%)	66,970.10 (74.05%)	6,886.91 (7.61%)	126.60 (0.14%)	75.96 (0.08%)	90,441.29 (100.00%)
Future	28,054.02 (31.02%)	41,853.15 (46.28%)	8,304.80 (9.18%)	7,621.17 (8.43%)	4,608.15 (5.10%)	90,441.29 (100.00%)



Discussion

- Assessing vulnerability with CEVSA model



→ Consider the human disturbance!!



THANK YOU



Dept. of Environmental Science and Ecological Engineering , Korea University