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Prediction of forest vegetation distribution; based on landcover change

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Contents

Introduction

- IPCC Fourth Assessment Report :
“It’s certain that
human activity is main factor in climate change”

- Landcover change affects :
biodiversity, CO_2 emission, circulation of carbon

- Global warming → Ecosystem
We must cope with global warming actively.

In the existing studies,
Researchers only consider environmental elements
(such as forest pattern …) without human activity.

Objectives

- **Integration** of
  landcover change by human activity and
  forest pattern by climate change
- **Prediction** of
  sensitive forest vegetation in climate change

Methods

Landcover Map

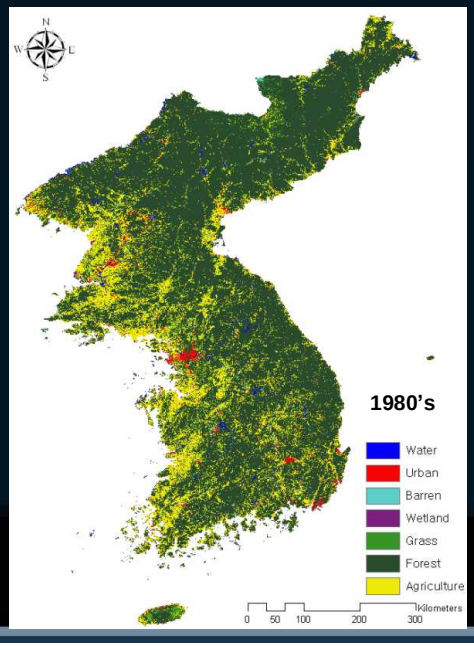
- provided *Water Management Information System (WAMIS)*
  - analyzed by using Landsat satellite images
  - the analysis year : 1975, 1980(MSS), 1985, 1990, 1995(TM), 2000(ETM+)
  - classes :
    waters, urban, barren, wetland, grassland, forest, agriculture
  - given by administrative district units

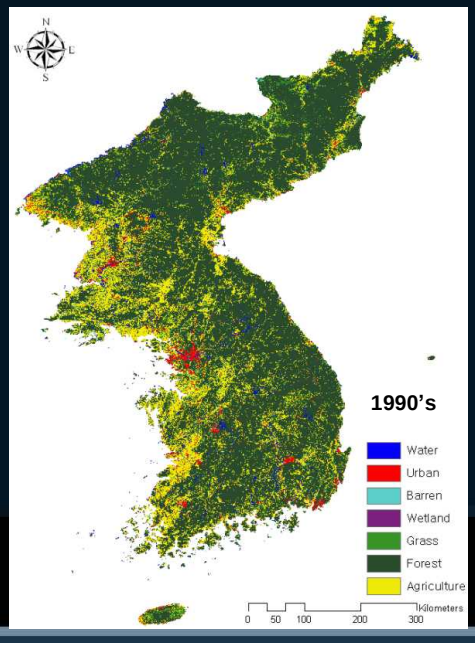
1975 1980 1985 1990 1995 2000

Methods

Landcover Map

- provided *Ministry of Environment*
  - analyzed by using Landsat satellite images
  - the analysis year : late in 1980's(TM), late in 1990's(TM, ETM+)
  - classes :
    waters, urban, barren, wetland, grassland, forest, agriculture
  - analyze all Korean areas including North Korea

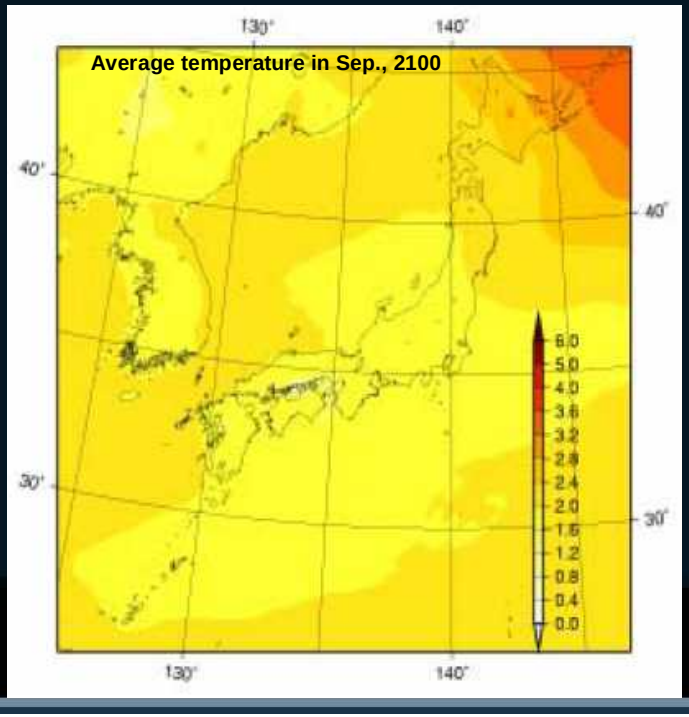


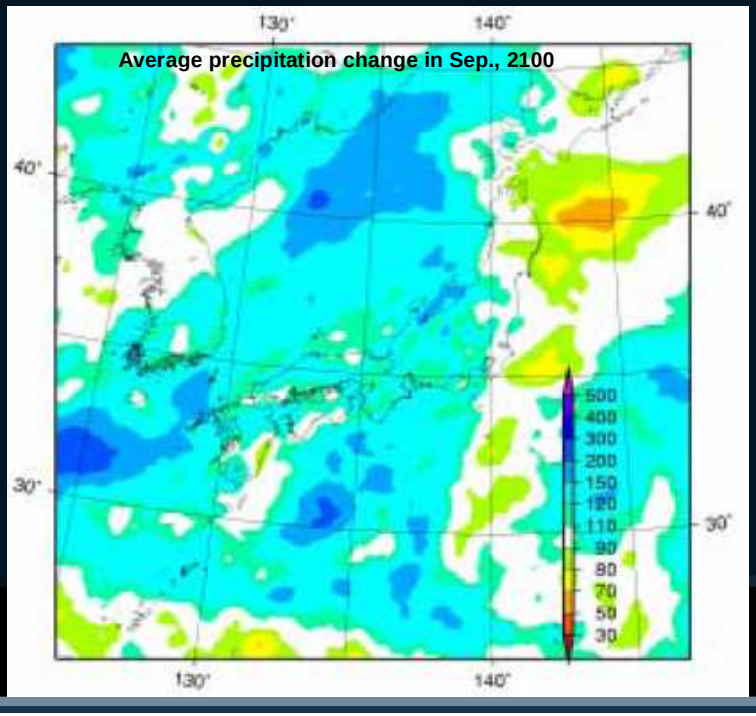


Methods

Regional climate models

- calculated into 20km grid units using Lambert Projection includes partial Japan areas (about 2,500㎞×2,500㎞)
- using IPCC SRES-A2 scenario





Methods

Vegetation Map

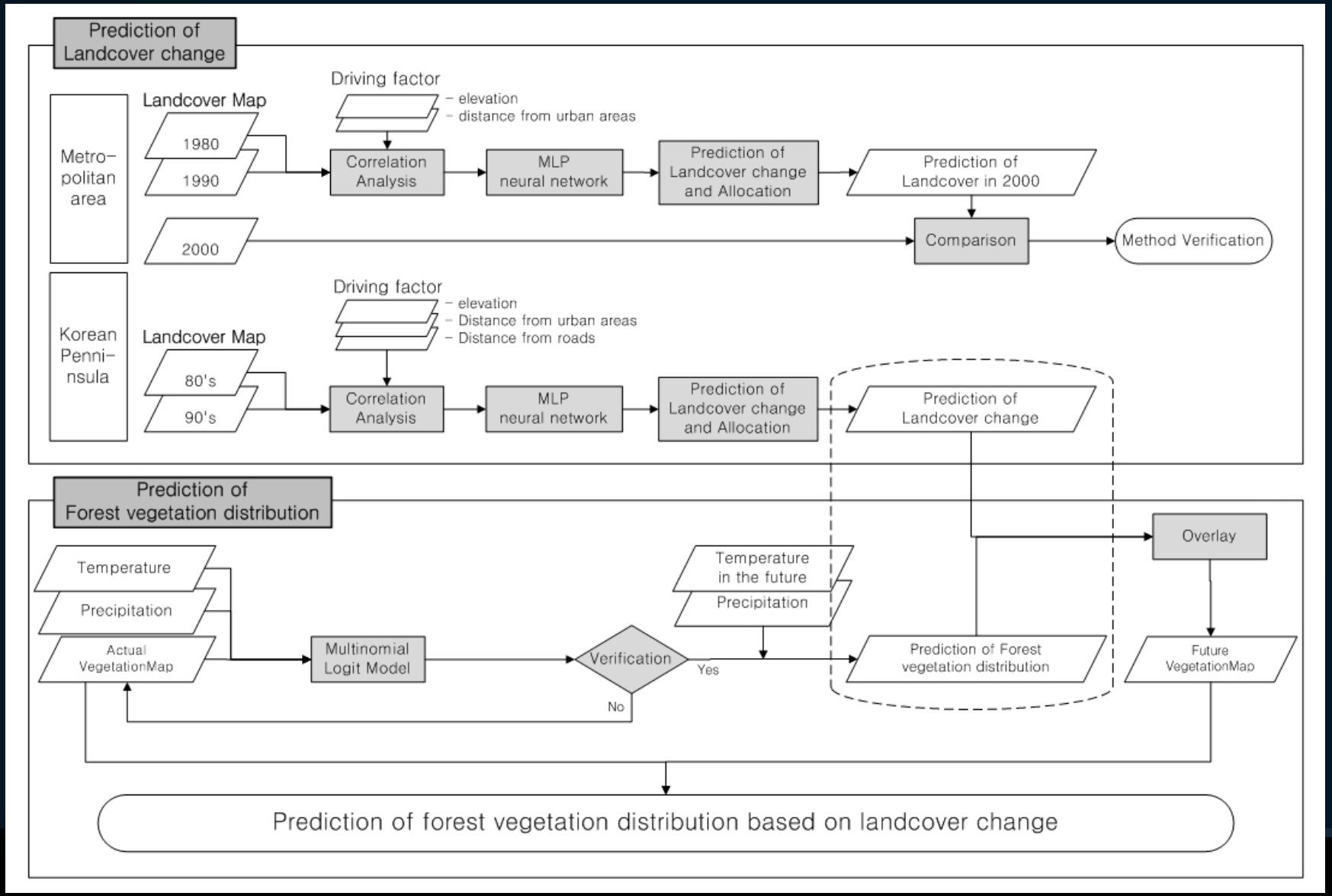
- obtained using aerial photographs and field surveys
  based on basic information such as landuse etc.
- displaying typical plant communities in the region
- surveying periods : 1986~1990 (First national environment survey)

Methods

Vegetation Map

	Dominant Communities
Pinus densiflora	*Pinus densiflora (1)*
Quercus Spp.	*Quercus acutissima, Quercus aliena, Quercus dentata, Quercus grosseserrata, Quercus mongolica, Quercus serrata, Quercus variabilis (7)*
Alpine Plants	*Abies holophylla, Abies koreana, Abies nephrolepis, Betula ermanii, Betula platyphylla, Empetrum nigrum var. japonicum, Juniperus chinensis var. sargentii, Juniperus rigida, Pinus koraiensis, Pinus pumila, Rhododendron mucronulatum var. ciliatum, Taxus cuspidata, Thuja koraiensis, Thuja orientalis L. (14)*
Evergreen Broad-Leaved Plants	*Castanopsis cuspidata var. sieboldii, Castanopsis cuspidata var. thunbergii, Camellia japonica L., Cinnamomum japonicum, Daphniphyllum macropodum, Elaeagnus macrophylla, Ilex integra, Litsea japonica, Machilus thunbergii, Quercus acuta, Quercus myrsinaefolia (11)*

Methods


Prediction of Landcover change
Metro-politan area
Landcover Map
1980
1990
2000
Driving factor
- elevation
- distance from urban areas
Correlation Analysis
MLP neural network
Prediction of Landcover change and Allocation
Prediction of Landcover in 2000
Comparison
Method Verification
Korean Penni-nsula
Landcover Map
80's
90's
Driving factor
- elevation
- Distance from urban areas
- Distance from roads
Correlation Analysis
MLP neural network
Prediction of Landcover change and Allocation
Prediction of Landcover change
Prediction of Forest vegetation distribution
Temperature
Precipitation
Actual VegetationMap
Multinomial Logit Model
Verification
Yes
No
Temperature in the future
Precipitation
Prediction of Forest vegetation distribution
Overlay
Future VegetationMap
Prediction of forest vegetation distribution based on landcover change

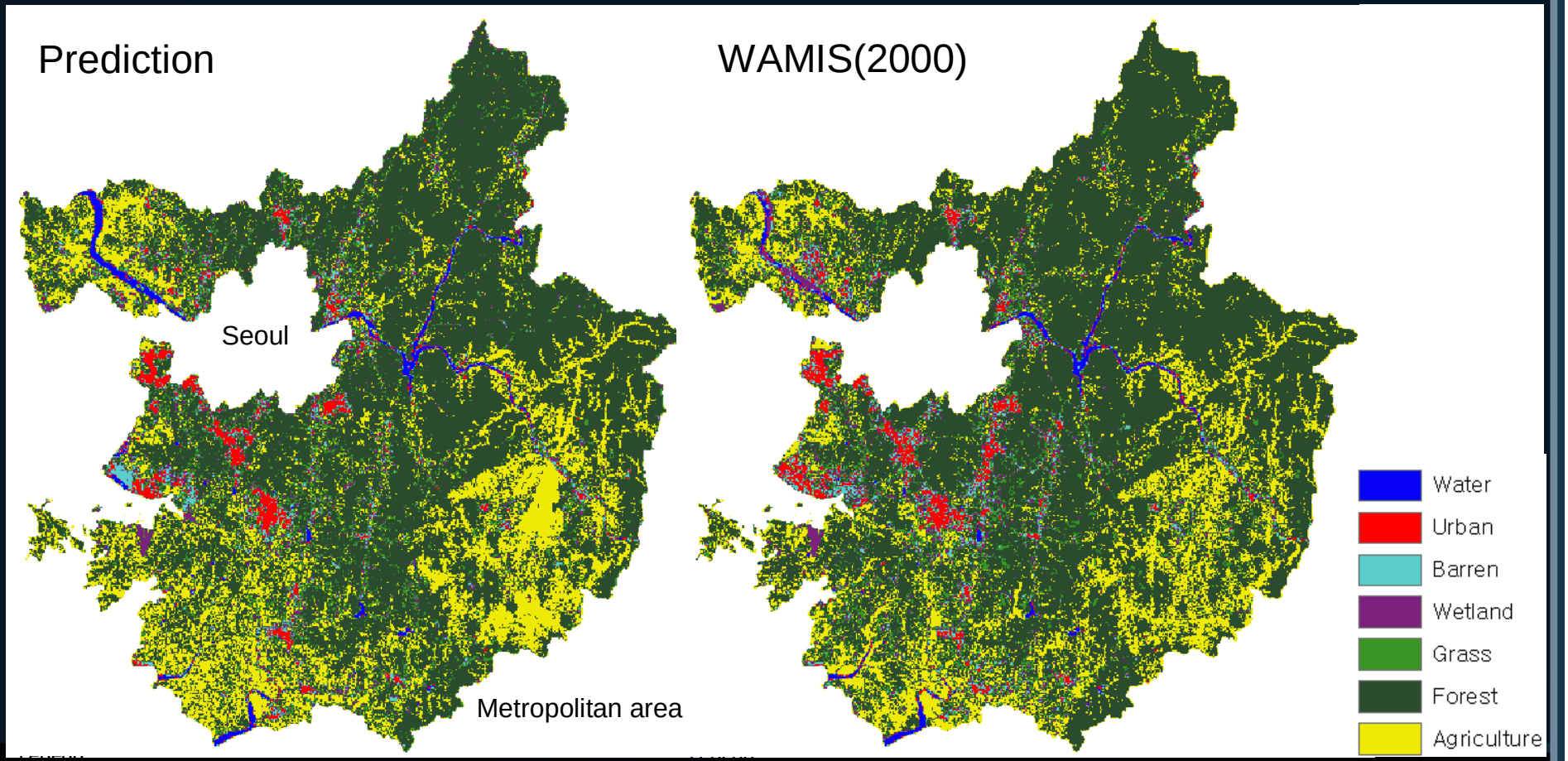
Results

Driving factors for prediction of landcover change

	elevation	Distance from urban areas	Correlation with change possibility
total	0.3198	0.1682	0.4169
Urban	0.1540	0.1077	0.6163
Barren	0.2337	0.0760	0.1712
Wetland	0.1665	0.0823	0.2069
Grassland	0.0755	0.0417	0.2925
Forest	0.1763	0.1296	0.1920
Agriculture	0.7828	0.6619	0.7739

Results

Comparison between results and WAMIS's



Results

Comparison between results and WAMIS's

prediction / WAMIS	waters	urban	Barren	Wetland	grassland	forest	agriculture	total
Waters	**12,2086**	2,881	355	1,121	593	4,352	15,018	14,6406
Urban	6,244	**285,789**	55,592	3,065	29,163	95,102	231,069	70,6024
Bare ground	2,561	30,329	**37,125**	1,224	9,341	47,490	92,537	22,0607
Wet land	20,406	1,996	146	**19,238**	564	4,884	5,584	5,2818
Grassland	729	38,580	7,355	161	**73,574**	195,753	160,252	47,6404
Forest	4,551	145,820	17,114	1,531	73,059	**3,920,658**	435,988	459,8721
Agriculture	13,071	226,070	62,539	11,495	99,611	416,547	**1,707,562**	2,536,895
total	169,648	731,465	180,226	37,835	285,905	4,684,786	2,648,010	**8,737,875**

- about 70.6% classified accuracy

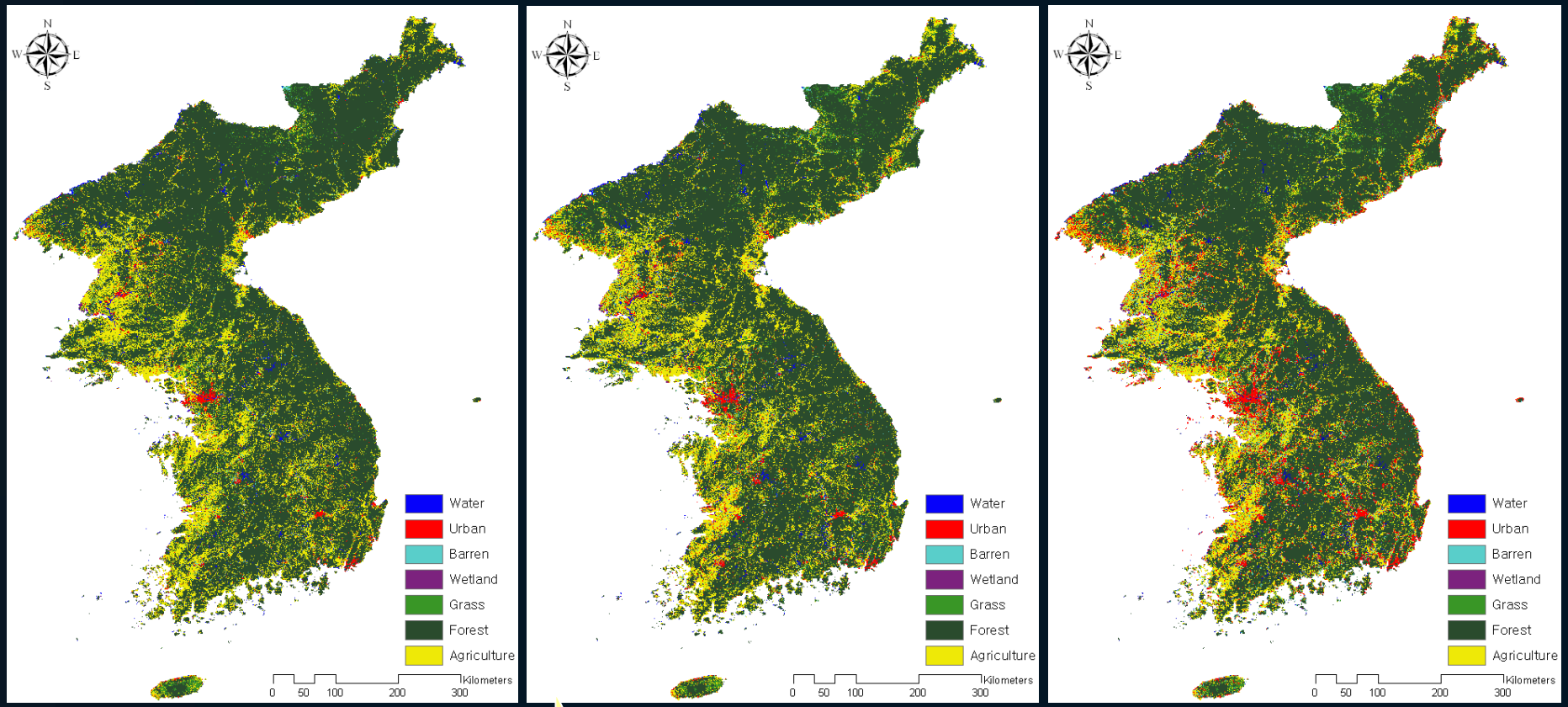
Results

Driving factors for prediction of landcover change

	elevation	Distance from roads	Distance from urban areas	Correlation with change possibility	Correlation with limits
Total	0.2779	0.1785	0.1940	0.4452	0.3333
Urban	0.1292	0.1070	0.1287	0.7057	0.1867
Barren	0.1798	0.1299	0.0816	0.1415	0.1323
Wetland	0.1315	0.1002	0.0270	0.1922	0.1045
Grassland	0.0493	0.0620	0.0753	0.2137	0.0370
Forest	0.1987	0.1724	0.2079	0.2212	0.1867
Agriculture	0.8261	0.7946	0.8372	0.8949	0.7917

Results

Landcover change and prediction in Korean peninsula



1980's

71.3% Accuracy

1990's

2090's

Results

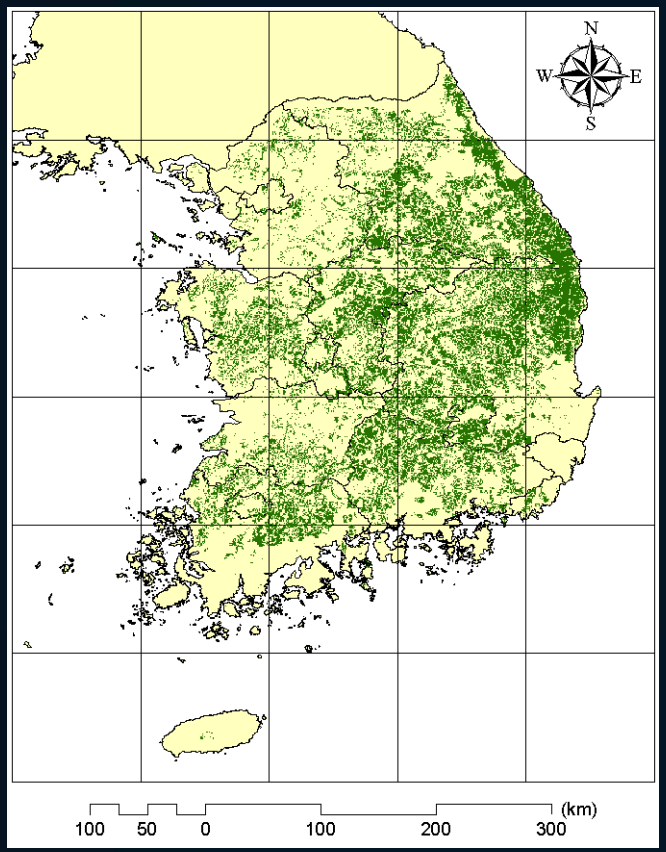
Landcover comparison between 1990's and 2090's

	1990's		2090's	
	area(㎢)	ratio(%)	area(㎢)	ratio(%)
Waters	4.0	1.4	4.0	1.4
Urban	7.1	2.4	19.5	6.6
Barren	4.4	1.5	9.5	3.2
Wetland	0.6	0.2	0.4	0.1
Grassland	14.0	4.7	13.3	4.5
Forest	206.8	69.7	194.1	65.4
Agriculture	60.0	20.2	55.9	18.8
Total	296.8	100	296.8	100

• In the prediction results, Barren, agriculture, grassland, forest (in this order) turn to urban area.

Results

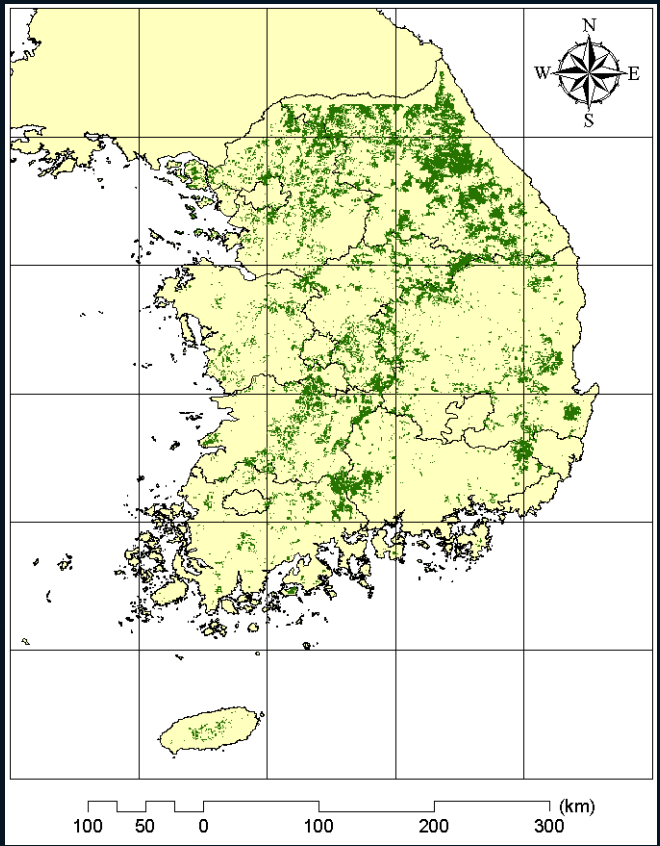
Vegetation map – a colony of pine trees



Pinus densiflora	Ranges	Means
Area	56.2 %	
Elevation (m)	1~1,492	312.1
Mean temperature (℃)	1.5~14.8	10.5
Total precipitation (㎜)	971.2~1,741.5	1,252.3
Warmth index (month·℃)	34.3~120.3	89.3

Results

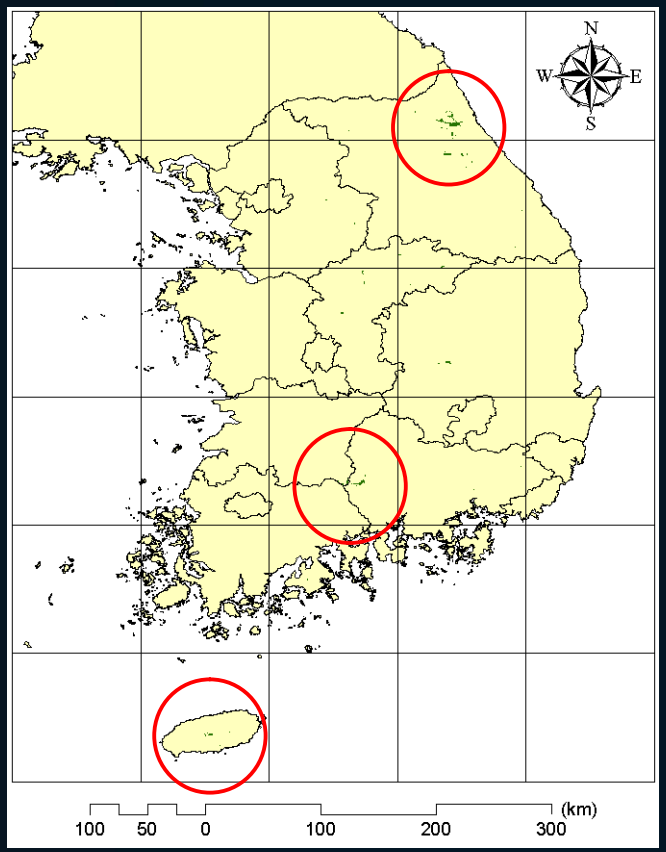
Vegetation map – a colony of oaks



Quercus Spp.	Ranges	Means
Area	30.4 %	
Elevation (m)	1~1,641	509.3
Mean temperature (℃)	2.0~15.9	9.0
Total precipitation (㎜)	973.6~1,809.9	1,298.4
Warmth index (month·℃)	36.8~130.7	79.4

Results

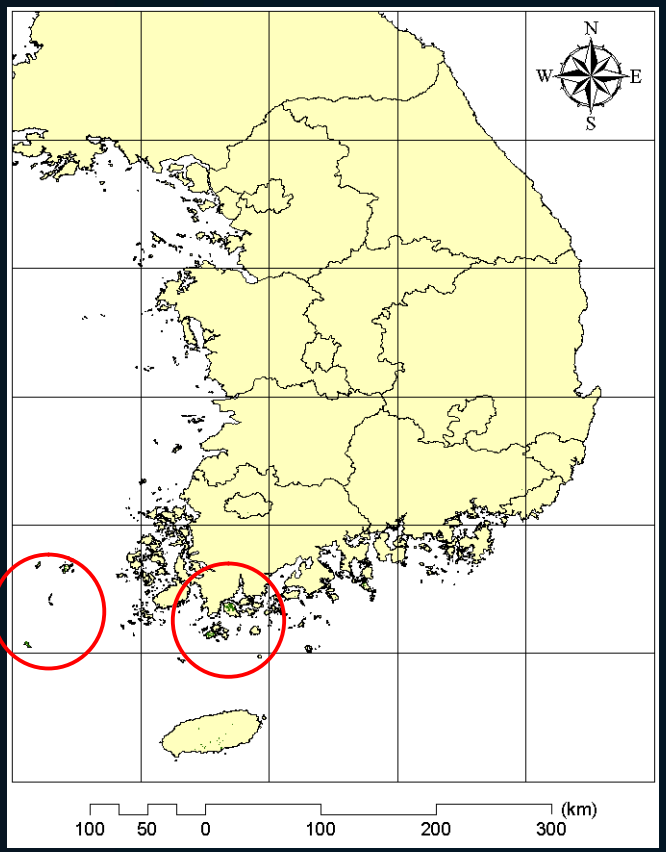
Vegetation map – the alpine and the subalpine



Alpine and subalpine	Ranges	Means
Area	0.26 %	
Elevation (m)	86~1,824	1,024.1
Mean temperature (℃)	1.2~15.9	5.7
Total precipitation (㎜)	1,019.2~1,837.7	1,346.7
Warmth index (month·℃)	30.9~130.6	57.3

Results

Vegetation map – Evergreen broad-leaved trees



Evergreen Broad-Leaved Plants	Ranges	Means
Area	0.16 %	
Elevation (m)	1~626	197.4
Mean temperature (℃)	10.9~16.3	13.4
Total precipitation (㎜)	960.8~1,853.1	1,374.5
Warmth index (month·℃)	84.9~135.4	106.1

Results

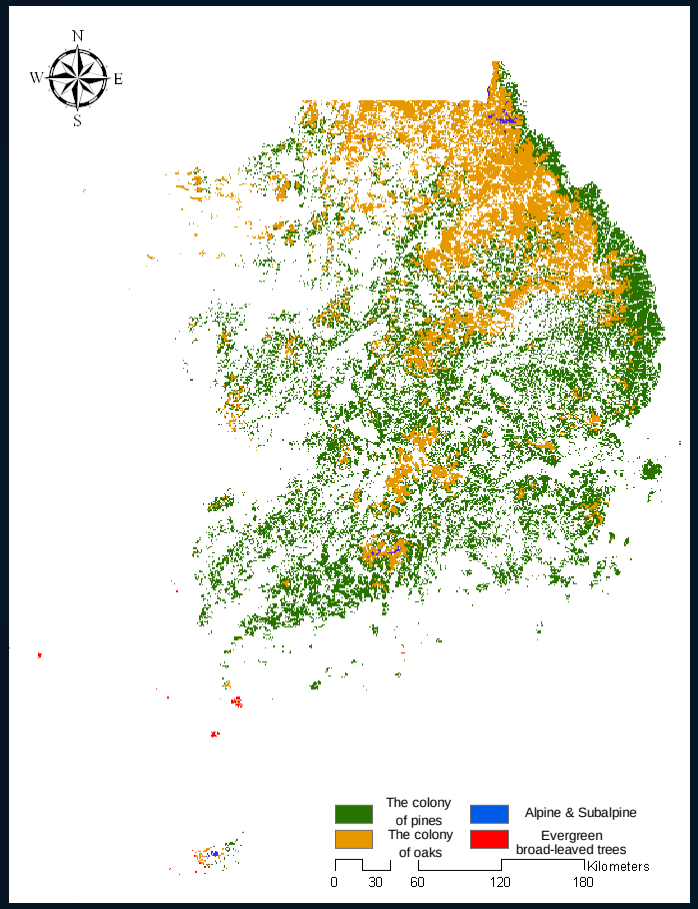
Development of prediction model in vegetation distribution

colony	equation
Pinus densiflora (G1)	$-12.0476-0.00521\times DEM-2.6116\times minT_{DEC}+1.7969\times maxT_{FEB}+0.2134\times P_{JAN}-0.3691\times avgT_{APR}$
Quercus Spp.(G2)	$-5.3671-0.00404\times DEM-2.2380\times minT_{DEC}+1.1788\times maxT_{FEB}+0.1508\times P_{JAN}-0.5100\times avgT_{APR}$
Alpine& subalpine Plants(G3)	$15.3224-0.0112\times DEM-1.8516\times minT_{DEC}+1.5856\times maxT_{FEB}+0.1338\times P_{JAN}-2.9754\times avgT_{APR}$

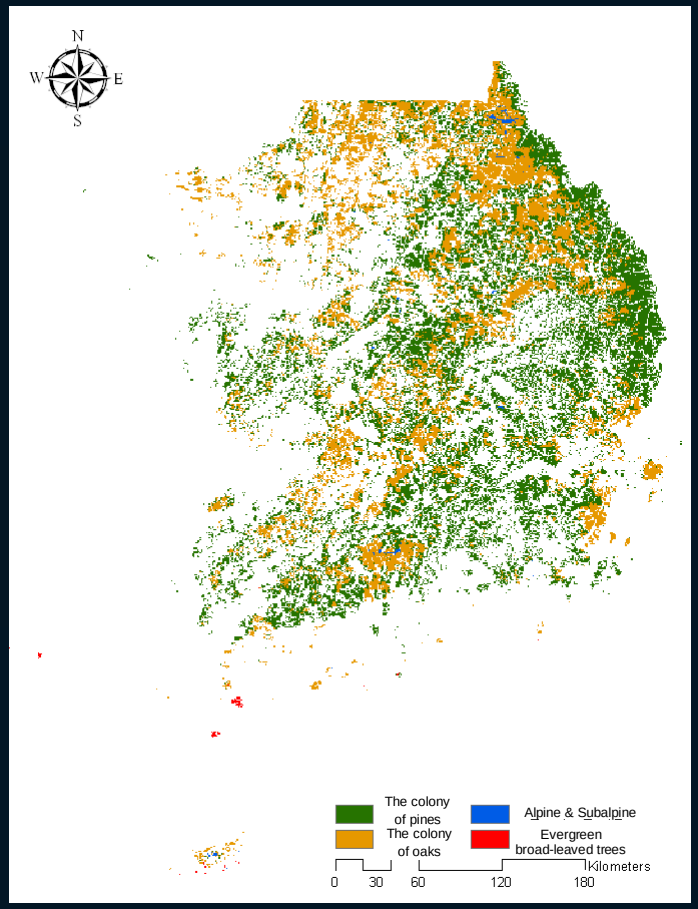
- EG1=EXP(G1), EG2=EXP(G2), EG3=EXP(G3), SUM=1+EG1+EG2+EG3
- P1=EG1/SUM, P2=EG2/SUM, P3=EG3/SUM, P4=1/SUM
- class matrix : IF P1>P2 & P1>P3 & P1>P4 THEN *Pinus densiflora* =1
- class accuracy : 63.6%

Results

Prediction of current vegetation distribution



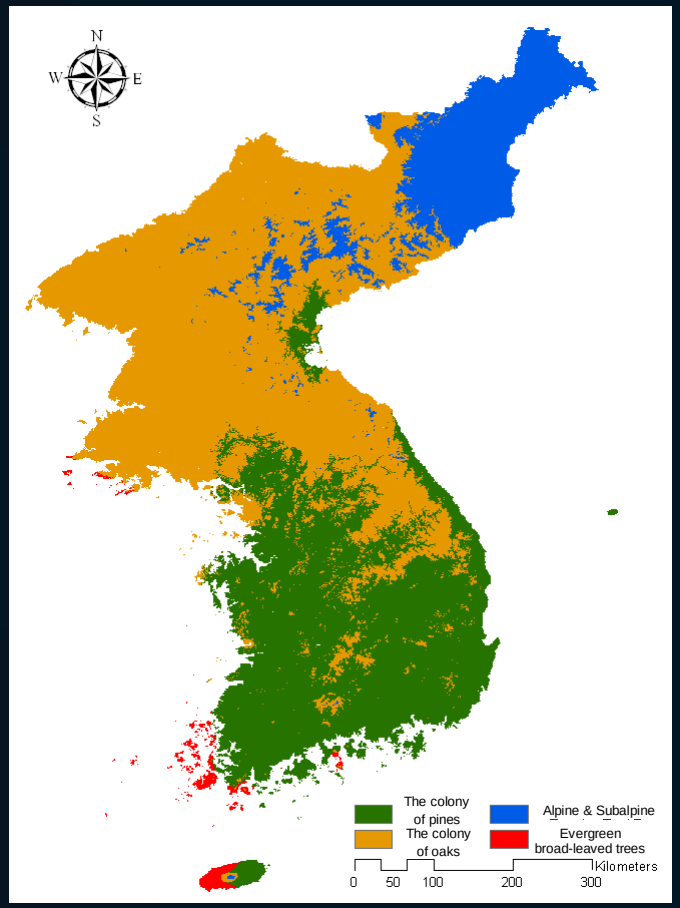
prediction



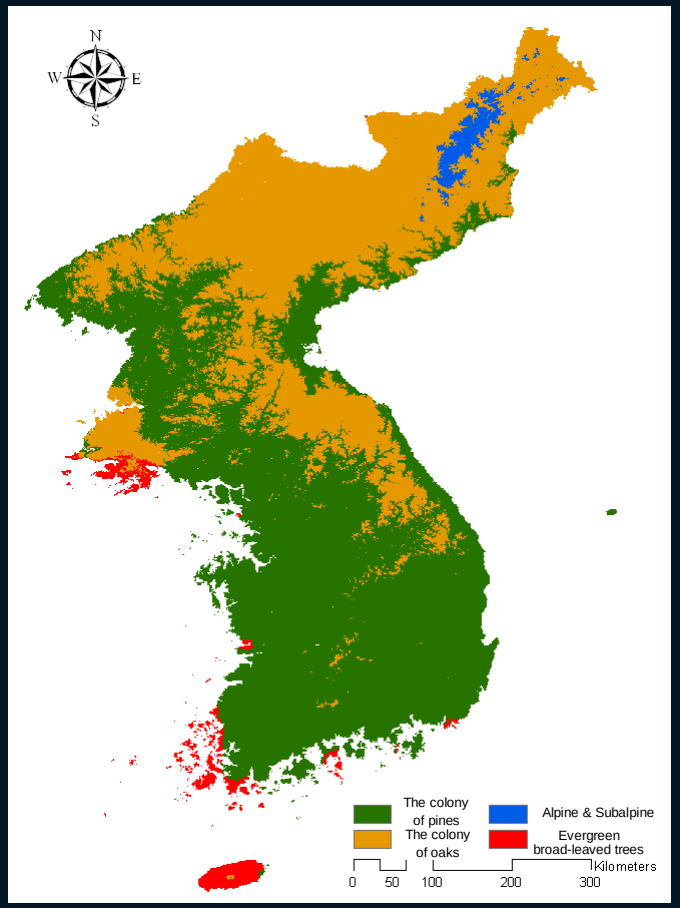
actual vegetation map

Results

Prediction of vegetation distribution in Korean peninsula



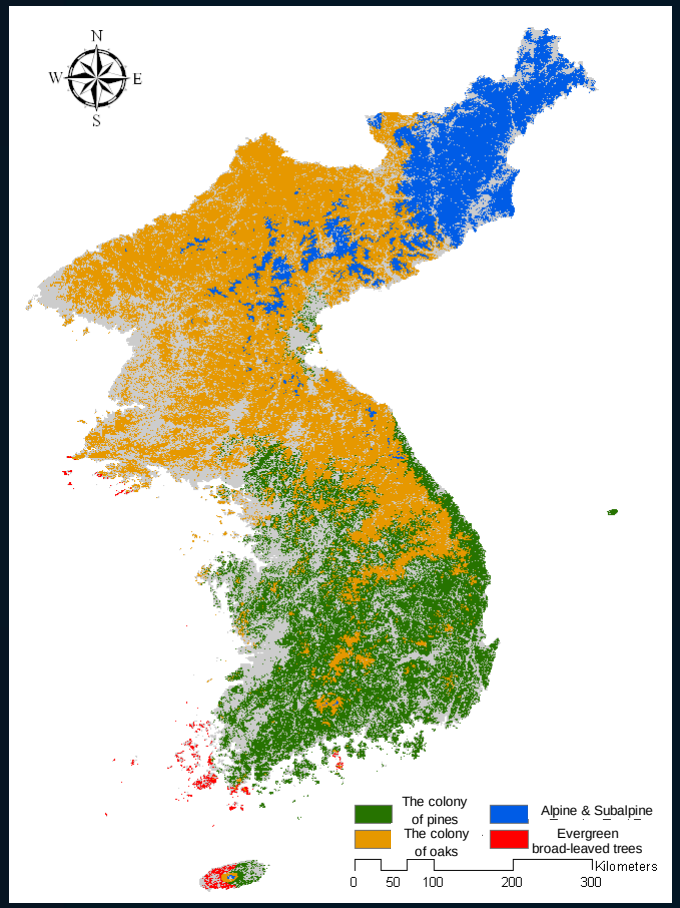
Current (2000)



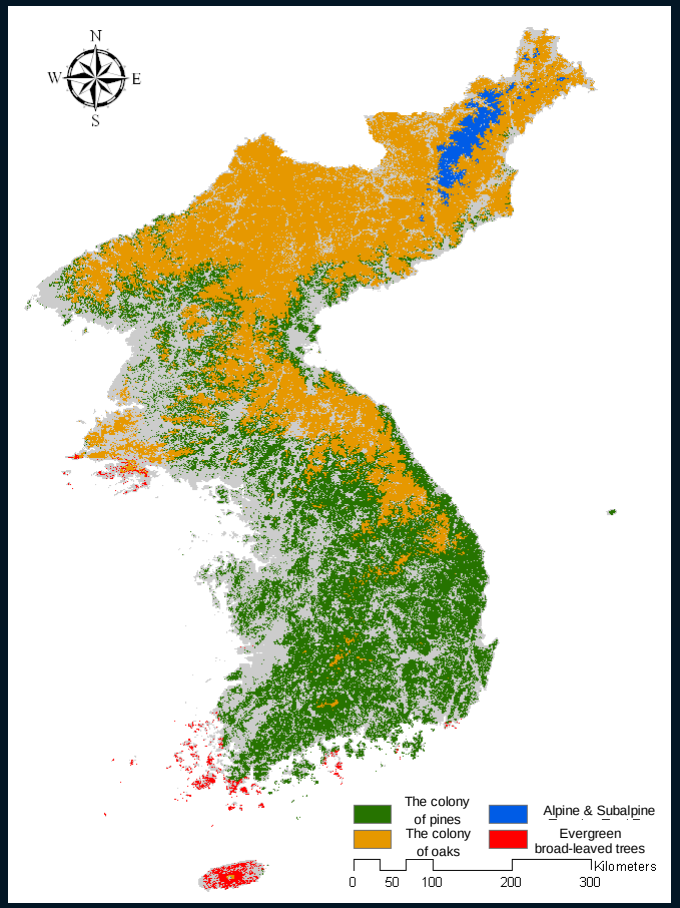
Future (2090)

Results

Prediction of vegetation distribution using landcover change



Current (2000)



Future (2090)

Results

Prediction of vegetation distribution using landcover change

	1990's		2090's		Change rate (%)
	area(㎢)	ratio(%)	area(㎢)	ratio(%)	
Pinus densiflora	70,680	30.8	98,202	45.5	**38.9**
Quercus Spp.	122,233	53.2	109,800	50.9	**-10.2**
Alpine& subalpine Plants	35,158	15.3	4,832	2.2	**-86.3**
Evergreen broad-leaved trees	1,686	0.7	2,868	1.3	**70.1**
total	229,757	100	215,702	100	**-6.1**

Discussion

- Because of urban area's expansion,
  it's predicted that 6% reduction in forest areas
- especially,
  86% reduction in the alpine and the subalpine
- Proper measurements in forest vegetation must be prepared for climate change
- This study has a meaning that we considered both human activity and environmental change in forest vegetation change
- Developments of scenarios for landcover change prediction and improvements of models including ecological succession are required

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Thank You