Climate Change Impact on Bio-climatic zone in Northeast Asia

SeongWoo Jeon[1)], Huicheul Jung[2)]
Yuyoung Choi[1)], Minjun Seong[1)],
Jinhoo Hwang[1)], Chul-Hee Lim[1)],

1) Korea University, 2) Korea Environment Institute

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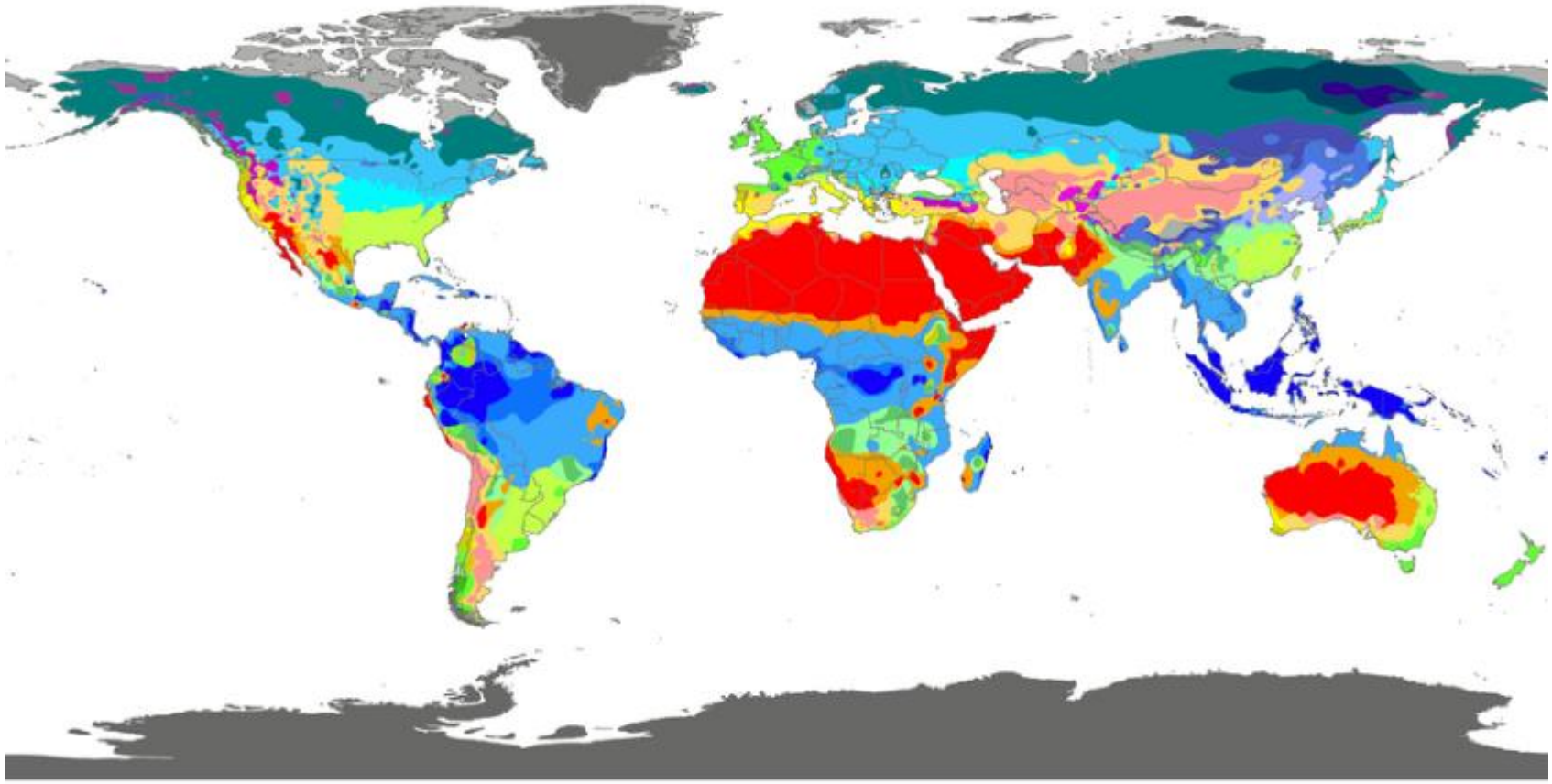
고려대학교 KOREA UNIVERSITY

한국환경정책·평가연구원 Korea Environment Institute

What is bio-climatic map?

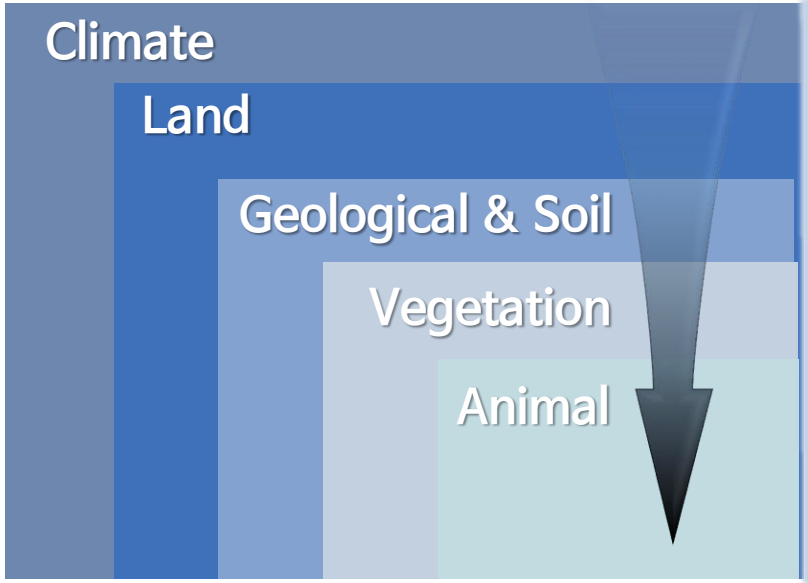
World map of Koppen-Geiger climate classification



What is bio-climatic map?

Bioclimatic map classifies land into homogenous zones by similar environment properties

Ecosystem spatial hierarchy



Conceptual model of ecosystem
(Klijin & deHaes, 1994)

Why do we need "Bio-climatic map" ?

Decline in biodiversity because of climate change

Rapid ecosystem changes due to climate change

Many species of plant and animal species will not be able to find suitable climatic conditions according to climate change (IPCC 5th)

<Examples of endangered species>

Seals

Gold frogs

Abies Koreana

Negative impact on human society including loss of ecosystem functions and services

We should monitor the change of biodiversity and distribution of species to respond the climate change

Goal of this study

(2015-2016)

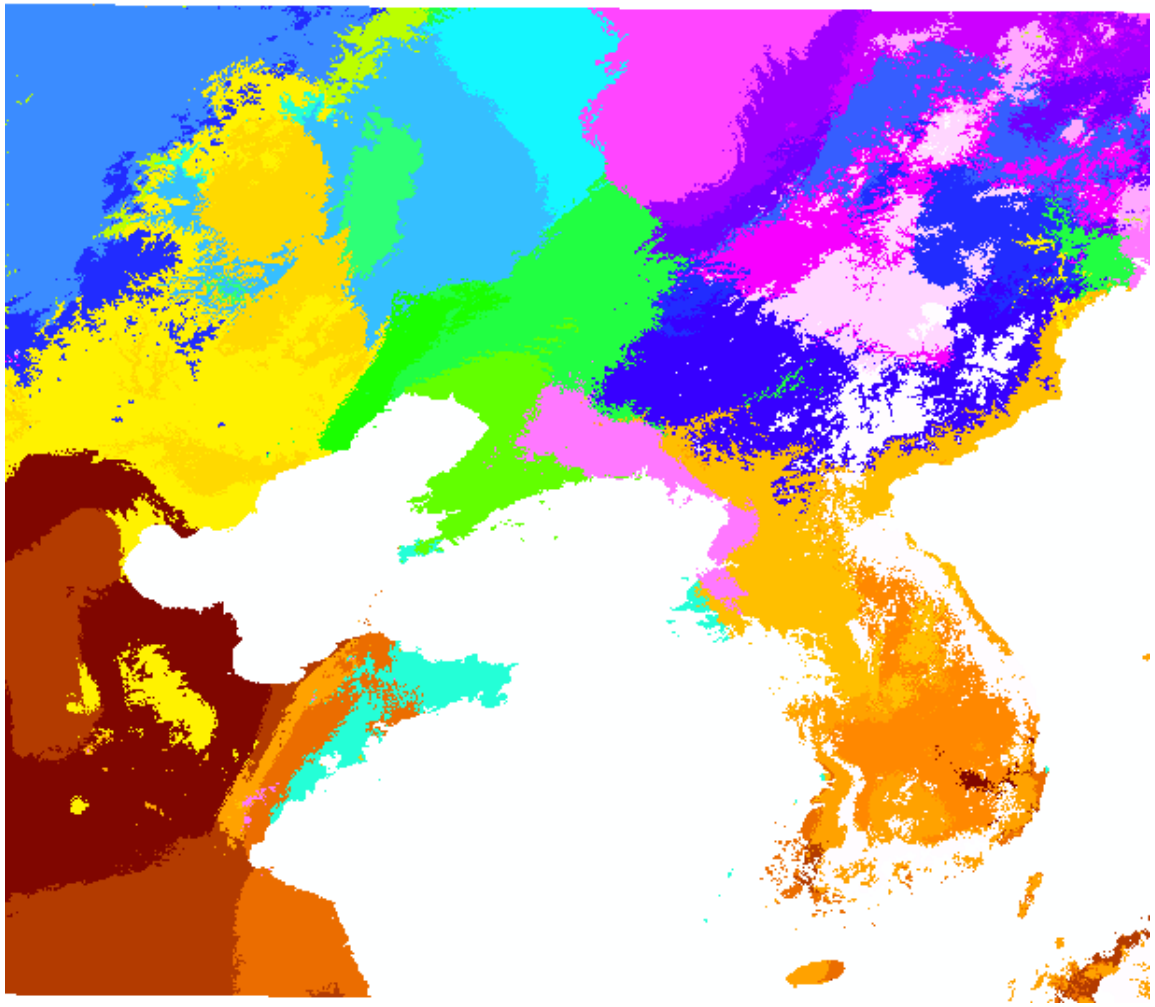
Developing bio-climatic classification method in Northeast Asia

(2016-2017)

Assessing climate change impact on bio-climatic zone in Northeast Asia

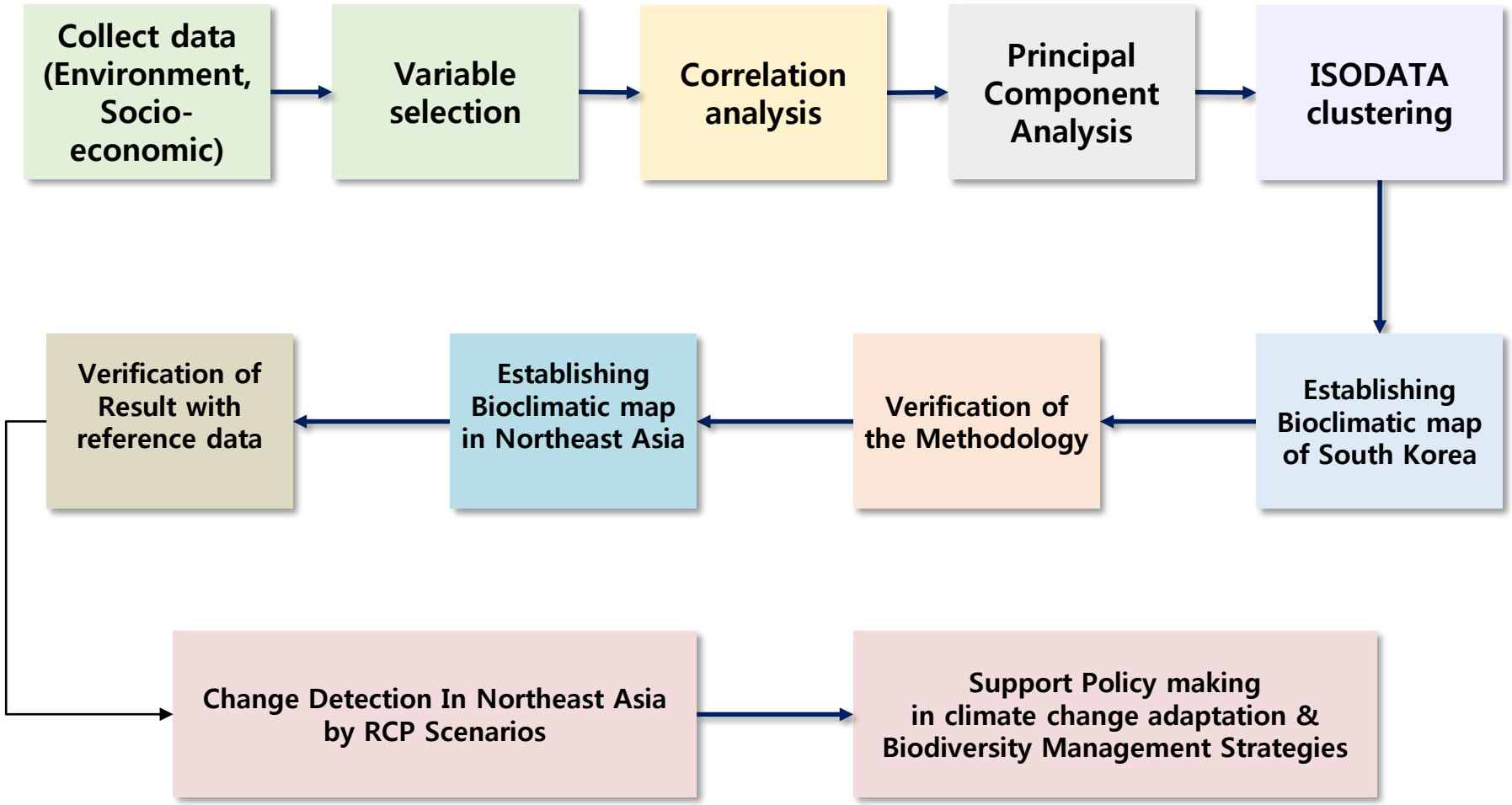
(2018)

Supporting Making adaptation plan in Regional and Local level



Ⅱ Materials and Methods

Flow Chart



Variable selection

MK-PRISM		
Time	2001-2010	
Resolution	1km²	
Variables	var2	Annual Mean diurnal range
	var3	Isothermality (%)
	var5	Maximum T of the warmest month(℃)
	var6	Minimun T of the coldest month (℃)
	var7	Annual T range
	var12	Growing degree-days on 5℃ base
	var23	Precipitation seasonality(%)
	var26	Precipitation of warmest quarter
	var27	Precipitation of coldest quarter
	var43	MTCI(Minimum Temperature Index of the Coldest Month)
	var44	PEI (Precipitation Effectiveness Index)
	var45	WI (Warmth Index)

Materials and Methods

Correlation analysis

	var2	var3	var5	var6	var7	var12	var23	var26	var27	var43	var44	var45
var2	1	0.89	0.14	-0.69	0.88	-0.55	0.52	-0.49	-0.45	0.68	-0.07	-0.34
var3	0.89	1	0.27	-0.36	0.57	-0.24	0.18	-0.26	-0.25	0.35	0.03	-0.13
var5	0.14	0.27	1	0.49	0.07	0.63	0.03	-0.05	-0.08	-0.5	-0.63	0.85
var6	-0.69	-0.36	0.49	1	-0.87	0.96	-0.67	0.5	0.44	-1	-0.23	0.84
var7	0.88	0.57	0.07	-0.87	1	-0.75	0.76	-0.61	-0.56	0.86	-0.1	-0.48
var12	-0.55	-0.24	0.63	0.96	-0.75	1	-0.58	0.44	0.34	-0.95	-0.31	0.92
var23	0.52	0.18	0.03	-0.67	0.76	-0.58	1	-0.48	-0.71	0.66	-0.18	-0.32
var26	-0.49	-0.26	-0.05	0.5	-0.61	0.44	-0.48	1	0.42	-0.51	0.39	0.25
var27	-0.45	-0.25	-0.08	0.44	-0.56	0.34	-0.71	0.42	1	-0.43	0.47	0.15
var43	0.68	0.35	-0.5	-1	0.86	-0.95	0.66	-0.51	-0.43	1	0.24	-0.83
var44	-0.07	0.03	-0.63	-0.23	-0.1	-0.31	-0.18	0.39	0.47	0.24	1	-0.52
var45	-0.34	-0.13	0.85	0.84	-0.48	0.92	-0.32	0.25	0.15	-0.83	-0.52	1

- Using software R
- Removing var6, var12
- Selection of independent variables

Principle Component Analysis (PCA)

	PC1	PC2	PC3	PC4	PC5
var2	**0.399687**	0.119999	0.399656	-0.02064	0.032238
var3	0.269583	0.160389	0.63227	-0.03946	0.32184
var5	-0.07493	**0.568793**	0.206798	-0.06105	-0.3348
var7	**0.443237**	0.050907	0.055942	-0.01609	-0.28685
var23	0.360238	0.079313	-0.33288	-0.38404	-0.48391
var26	-0.30661	-0.15662	0.214062	-0.77926	0.060588
var27	-0.30081	-0.22184	0.365121	0.430635	-0.54578
var43	**0.416556**	-0.24087	-0.04694	0.035574	-0.10728
var44	-0.03117	**-0.52344**	0.315664	-0.20358	-0.31117
var45	-0.27703	**0.470874**	0.053116	-0.10554	-0.23866
Standard deviation	2.1625	1.6238	1.1501	0.80382	0.63948
Proportion of Variance	0.4677	0.2637	0.1323	0.06461	0.04089
Cumulative Proportion	0.4677	0.7313	**0.8636**	0.92823	0.96913

PC1

- Var2 : Annual Mean diurnal range
- Var7 : Annual Temperature range
- Var43 : MTCI

(Minimum Temperature Index of the Coldest Month)

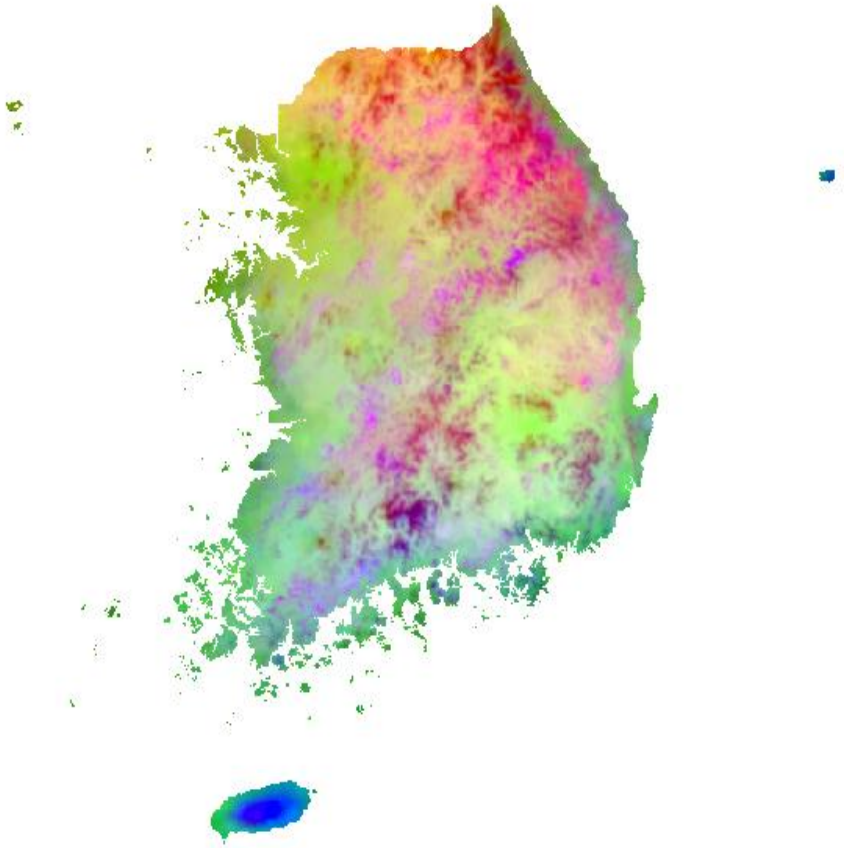
PC2

- Var5 : Maximum T of the warmest month(℃)
- Var44: PEI (Precipitation Effectiveness Index)
- Var45 : WI (Warmth Index)

PC3

- Var3 : Isothermality (%)

ISODATA clustering



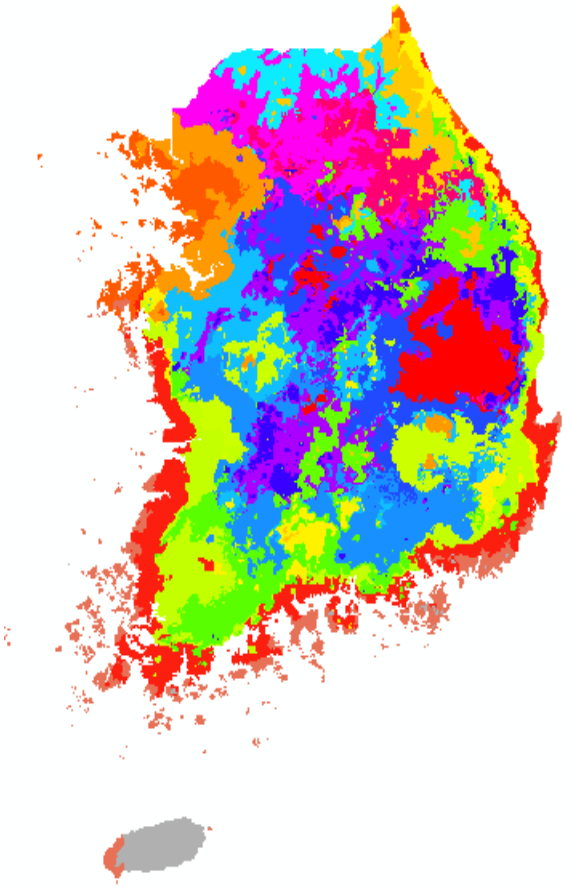
- **PC1 : Red band**
- **PC2: Green band**
- **PC3: Blue band**

- **ISODATA**

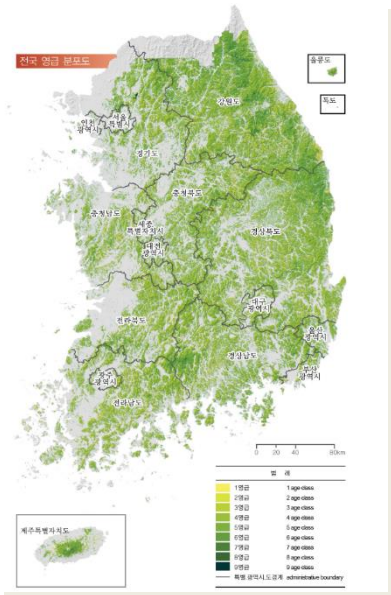
(The Iterative Self-Organizing Data Analysis Technique)

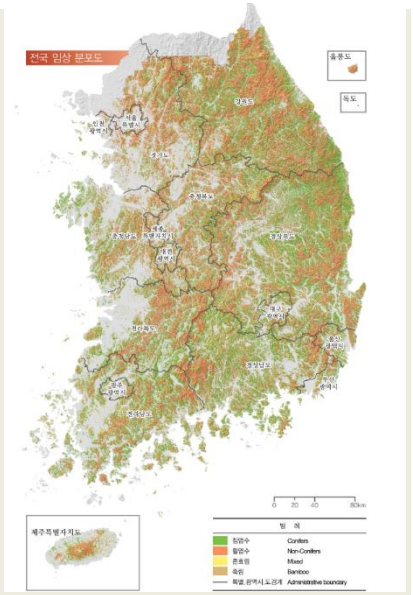
- ✓ This technique is used widely in image analysis fields, such as remote sensing
- ✓ ISODATA is iterative in that it repeatedly performs an entire classification and recalculates statistics
- ✓ Self-organizing refers to the way in which it locates clusters within minimum user input

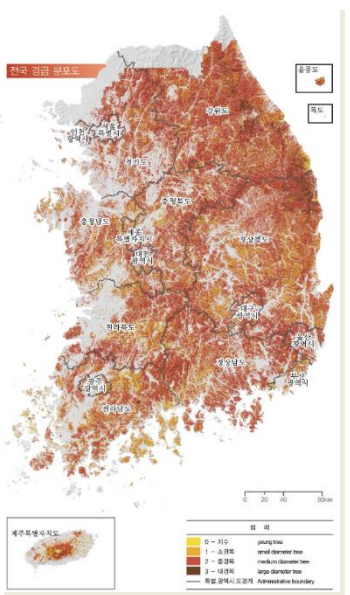
20 bio-climatic zones of South Korea



- Sensitivity analysis by various bio-climatic zones
- Compare with existed reference vegetation map and forest map

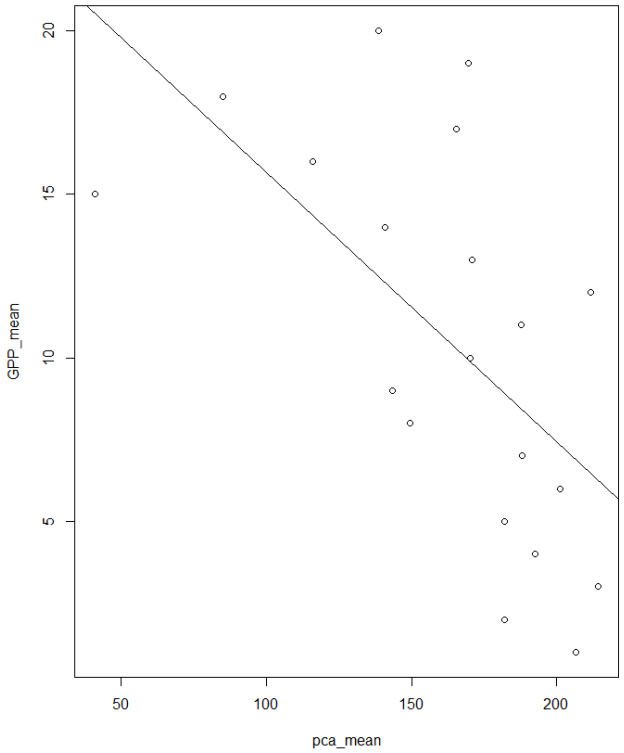




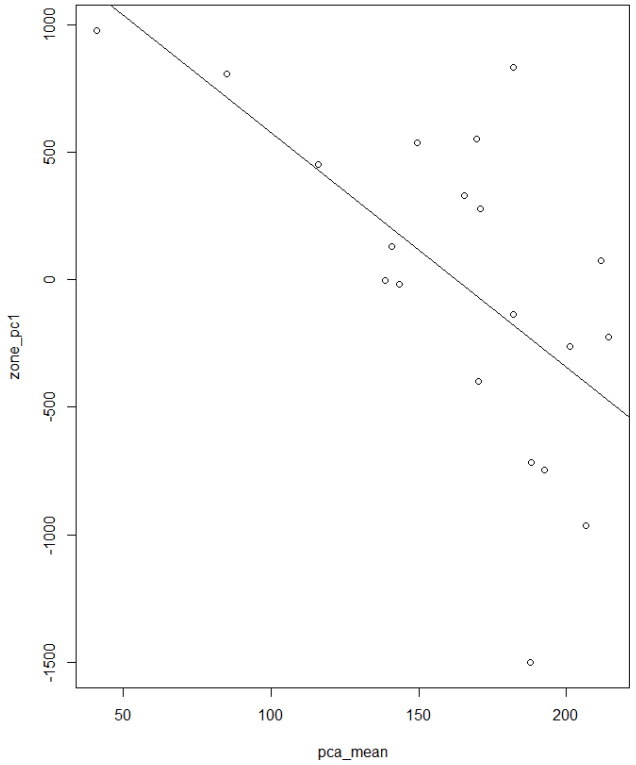


Verification

Correlation analysis with Gross Primary Productivity & PCA of vegetation area

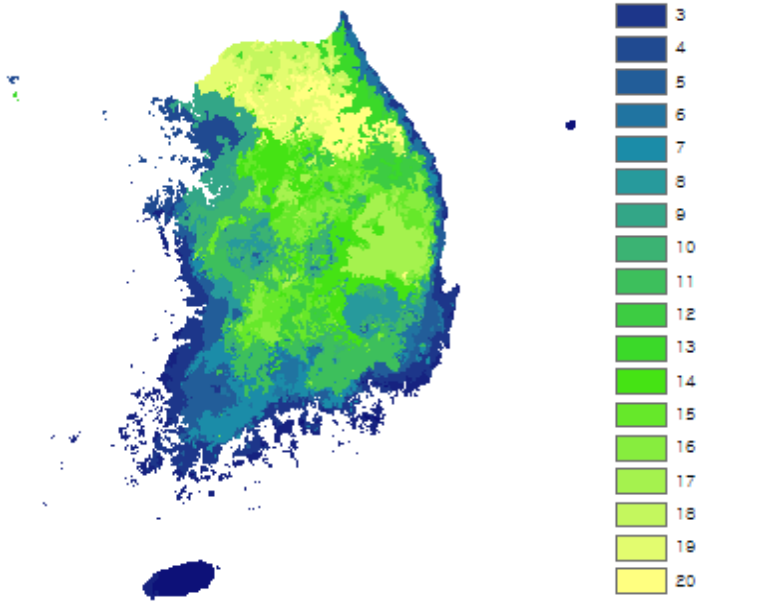


Pearson Correlation coefficient : -0.6074



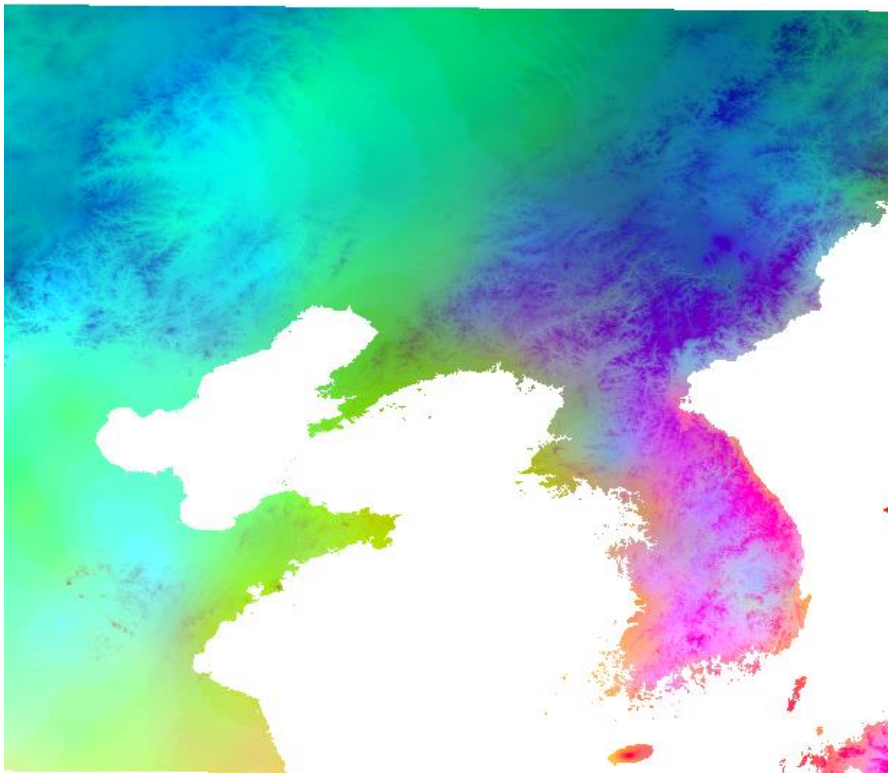
Pearson Correlation coefficient : -0.6243

Bioclimatic map of South Korea – Regional Characteristics

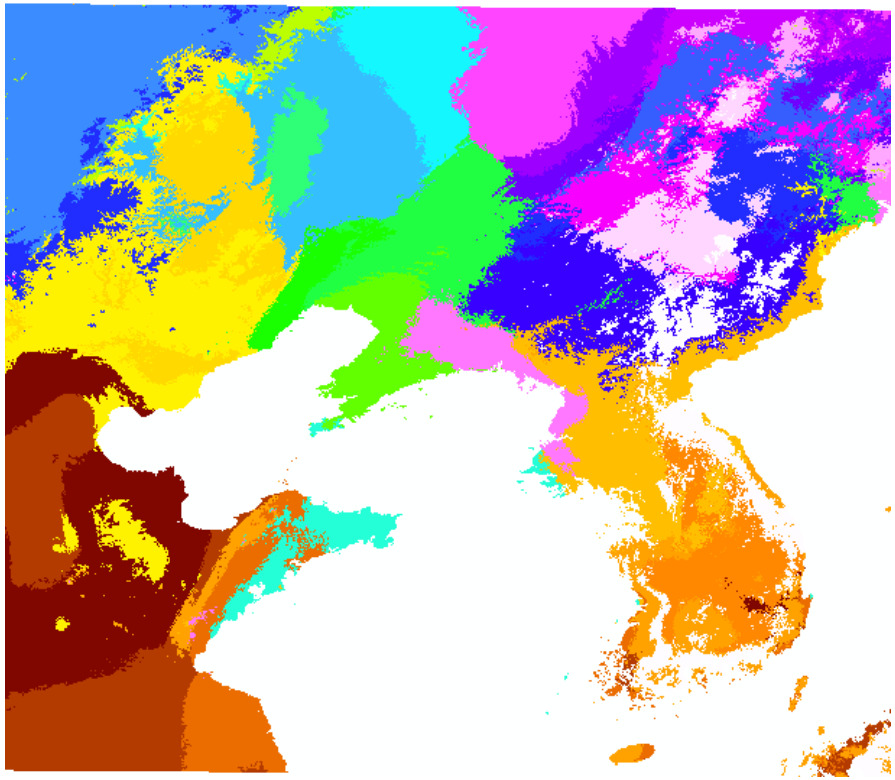


Zone	AREA (100 만 km²)	DEM (m)	Annual Mean Temp (℃)	Summer Mean Temp (℃)	Winter Mean Temp (℃)	Summer highest Temp (℃)	Winter lowest Temp (℃)	Annual Precipi-tation (mm)	Summer Precipi-tation (mm)	Winter Precipi-tation (mm)
1	4439	158.51	13.44	23.49	3.14	28.50	-1.89	1359.50	602.07	135.69
2	4192	56.09	12.81	24.13	0.97	29.75	-4.64	1205.16	608.16	111.62
3	4021	77.18	13.49	23.97	2.40	29.55	-3.45	1223.65	577.23	107.48
4	4042	44.57	11.51	23.79	-1.94	29.47	-8.50	1291.87	750.36	72.58
5	4372	246.49	12.40	22.74	1.53	28.07	-4.13	1510.72	690.69	134.78
6	4018	200.06	12.48	23.58	0.71	29.35	-5.37	1305.43	660.06	109.43
7	3587	91.10	11.79	23.51	-0.62	29.39	-6.86	1235.38	655.53	97.37
8	6012	188.82	12.46	23.14	1.14	28.97	-5.04	1375.67	669.74	117.83
9	4729	173.57	12.37	23.50	0.45	29.40	-6.39	1214.32	633.03	90.18
10	6710	140.86	12.09	23.76	-0.43	29.79	-7.28	1073.59	578.16	75.57
11	6991	300.93	11.62	23.08	-0.54	29.22	-7.40	1396.09	760.73	103.97
12	5239	138.43	11.06	23.59	-2.55	29.51	-9.80	1263.65	711.82	81.15
13	8654	216.59	11.39	23.26	-1.28	29.25	-7.97	1252.16	684.92	93.89
14	5155	284.46	10.34	22.69	-3.06	28.76	-10.38	1266.83	711.59	85.81
15	3376	166.16	10.53	23.15	-3.36	28.88	-10.79	1429.55	869.05	71.00
16	3926	601.20	8.56	20.50	-4.35	26.20	-11.32	1396.51	757.50	104.49
17	4647	311.00	9.60	22.27	-4.29	28.18	-12.06	1343.84	780.90	79.47
18	4014	538.97	9.99	21.17	-1.96	26.89	-8.28	1483.69	765.06	124.35
19	3074	566.83	7.91	20.48	-5.85	26.07	-13.37	1443.83	843.56	84.77
20	4098	888.58	6.68	18.40	-5.99	23.70	-12.69	1568.19	820.01	129.87

Expansion to Northeast Asia

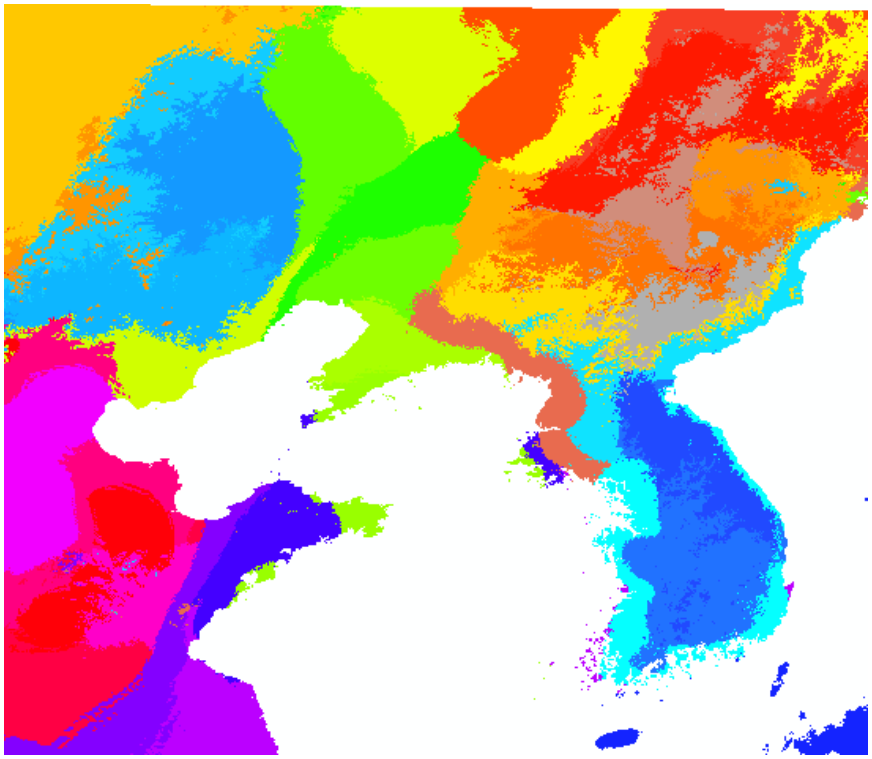


<PCA stack>

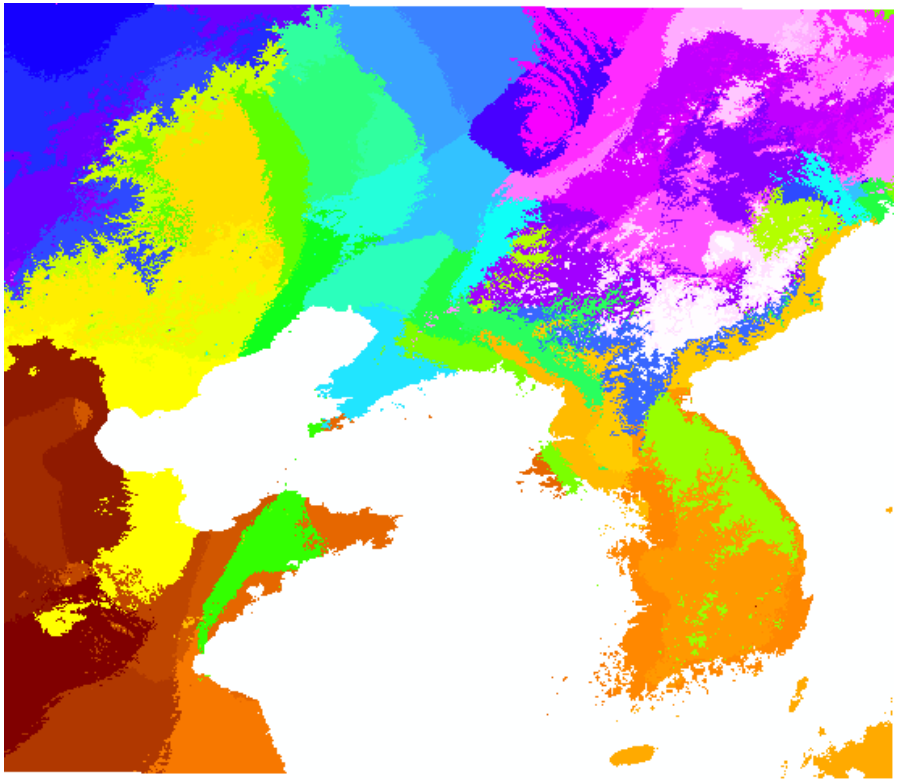


<29 zones>

Expansion to Northeast Asia

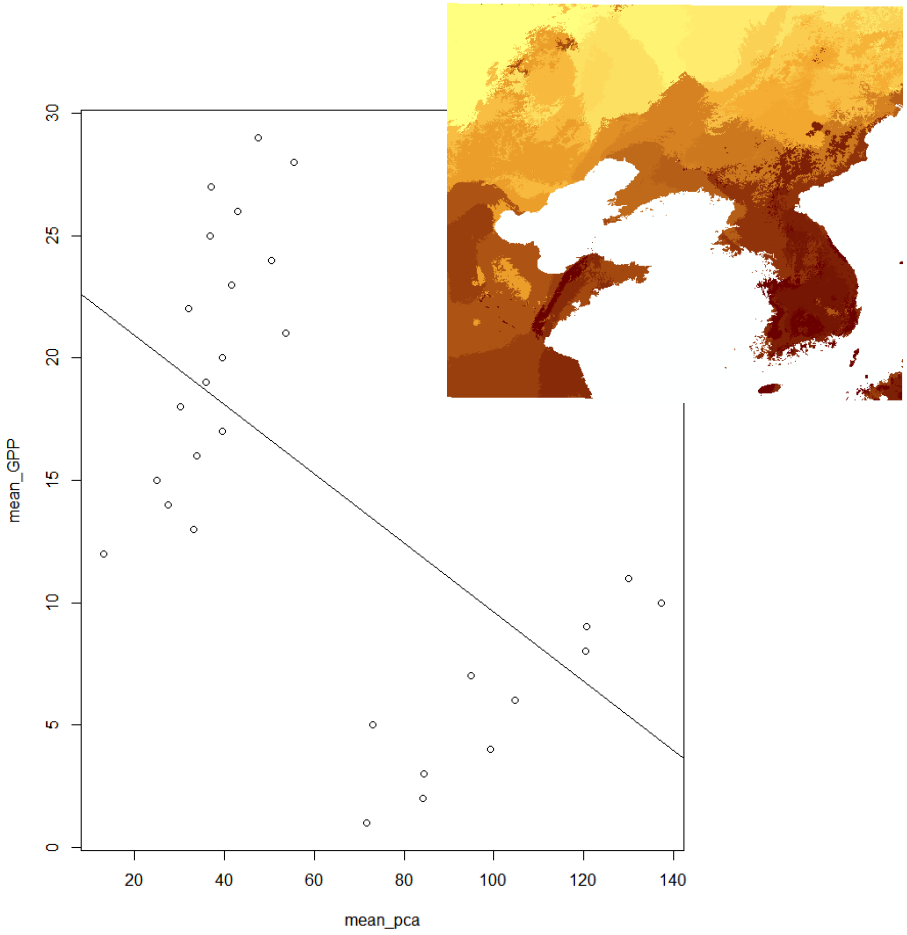


<35 zones>

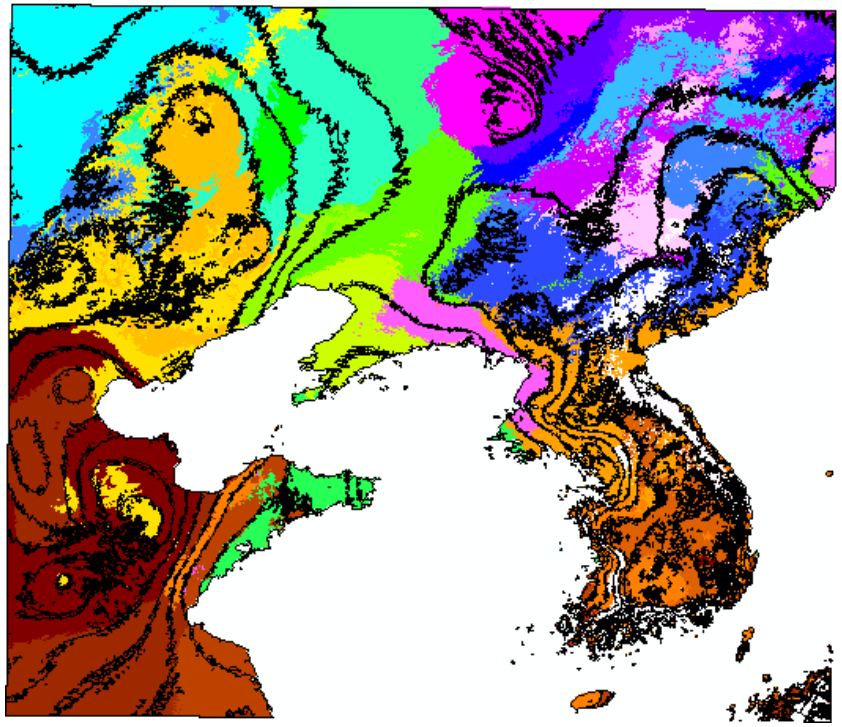


<55 zones>

Expansion to Northeast Asia

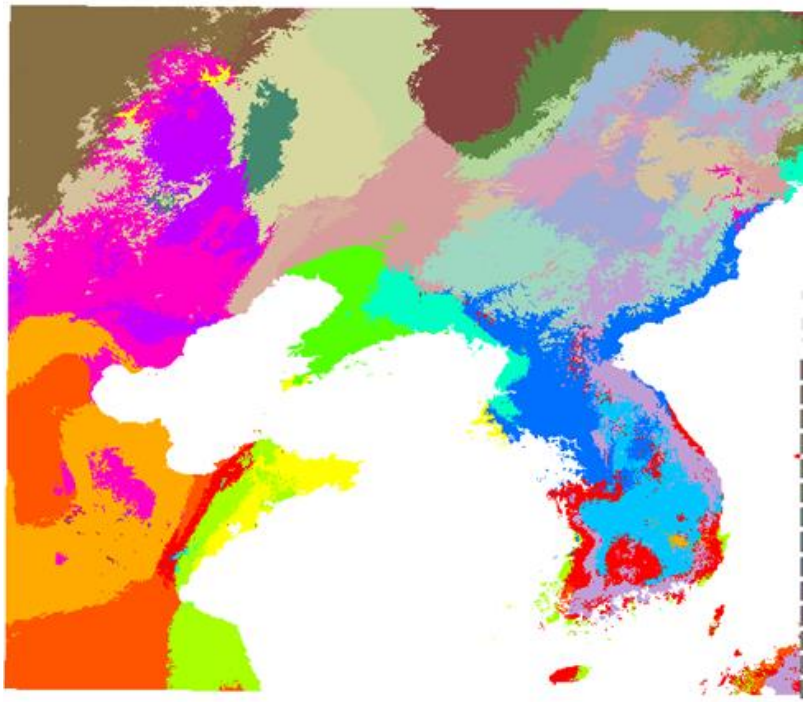


Pearson Correlation coefficient : -0.5894

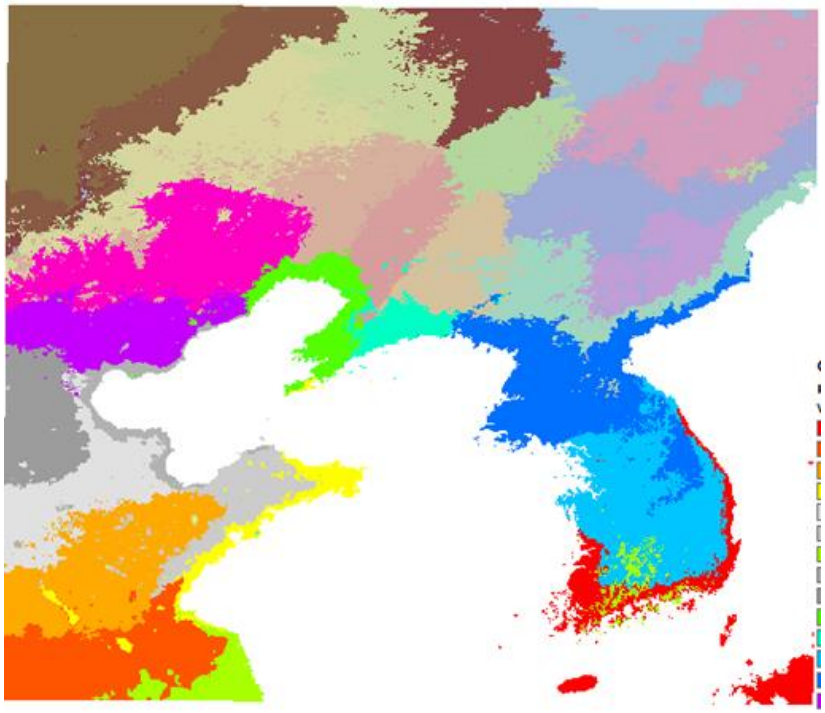


Overlay with Isothermality (%)

Examples of application

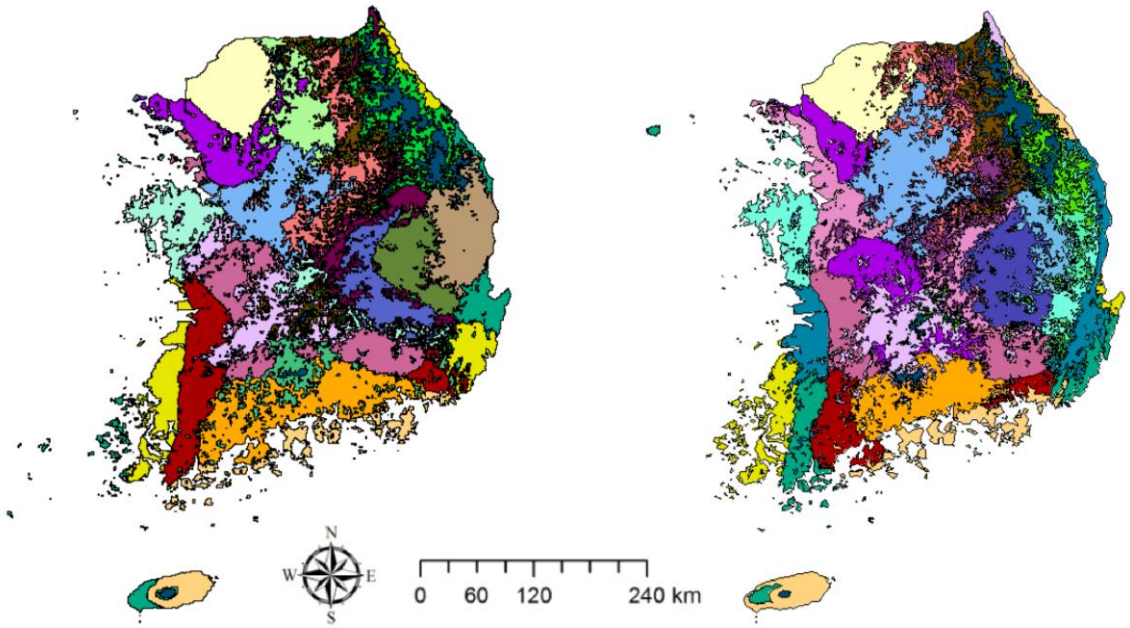


<mean of 1960-1990>



<mean of 1970-2000>

Change detection



Bioclimatic zones of South Korea (Left: current, Right: future)

- To observe changes in the region due to climate change, future scenario data of HadGEM2-AO(RCP8.5, 2070s) was used.
- Further study should be needed for quantitative comparison of each zonal changes and then this could be used more effectively to support decision making on climate change adaptation.

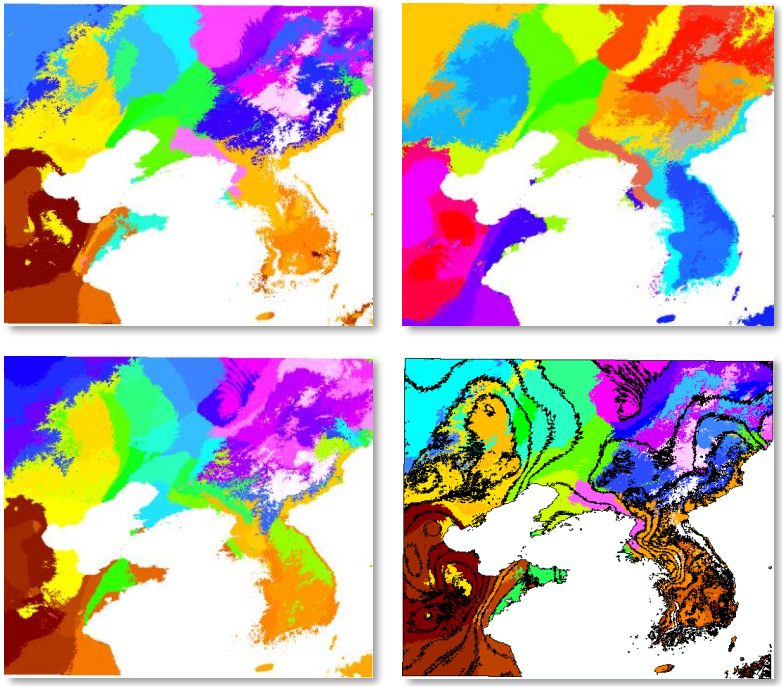
Significance and limitations

Providing scientific data for Adaptation Policy making

- Providing scientific data for VESTAP(Vulnerability assESSment tool To Build Climate Change Adaptation Plan)

Future Research

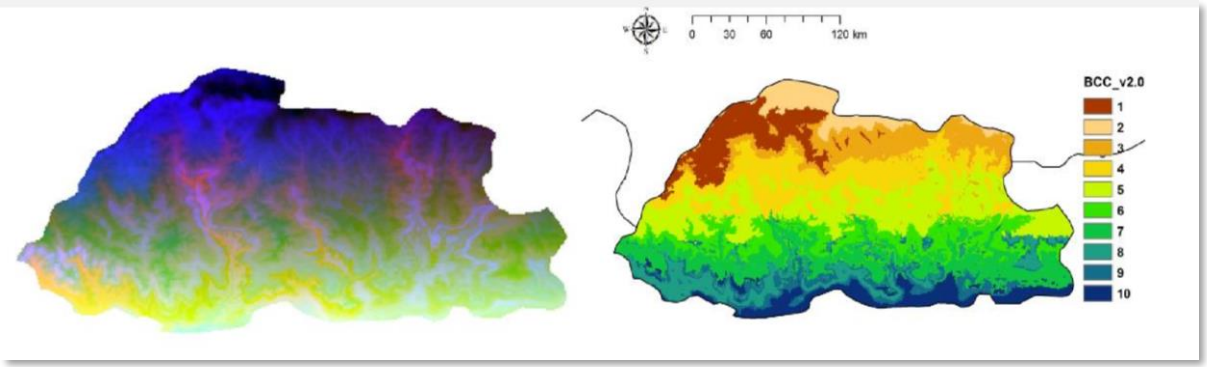
- ✓ Change detection by RCP Scenario
- ✓ Variable Selections (Environmenatal, Socio-Economic data)
- ✓ Number of clusters
- ✓ Validation

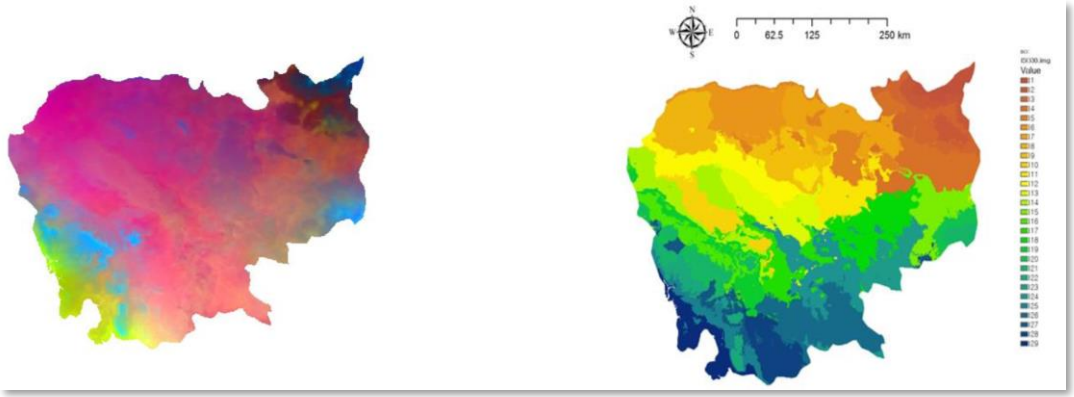


Research plan linked with UNCDF

Supporting Adaptation plan in Foreign countries

- Bhutan and Cambodia(Finished)





- Myanmar and Vanuatu(On going)

Thank you for your attention