8th AIM International Workshop

Impact Assessment of Forest Influenced by Changing Global Climate

2003. 03. 13

Korea Impact Project Team

- Jeon, Seong-Woo(KEI)
- Jung, Hui-Cheul(KEI)
- Lee, Dong-Kun(SNU)

CONTENTS

1. Introduction

1) Backgrounds

- All creatures on the earth are threatened by climatic change, and this dangerous situation drives a study for predictable effects all over the world.
- They say that forest eco-system would be the most serious damaged part, therefore development of the model which is applicable to the internal level is needed.

2) Objectives

- To Prepare primary data and conduct the modeling of the forest distribution assessment using AIM impact model
- To assess the change in economical value of the forest through climate change

2. Study Area

1) Study Area

❖ The Korean Peninsula is separated into 4 small regions regarding climate and forest type.

- longitude : 120°~ 135°
- latitude : 30°~ 45°

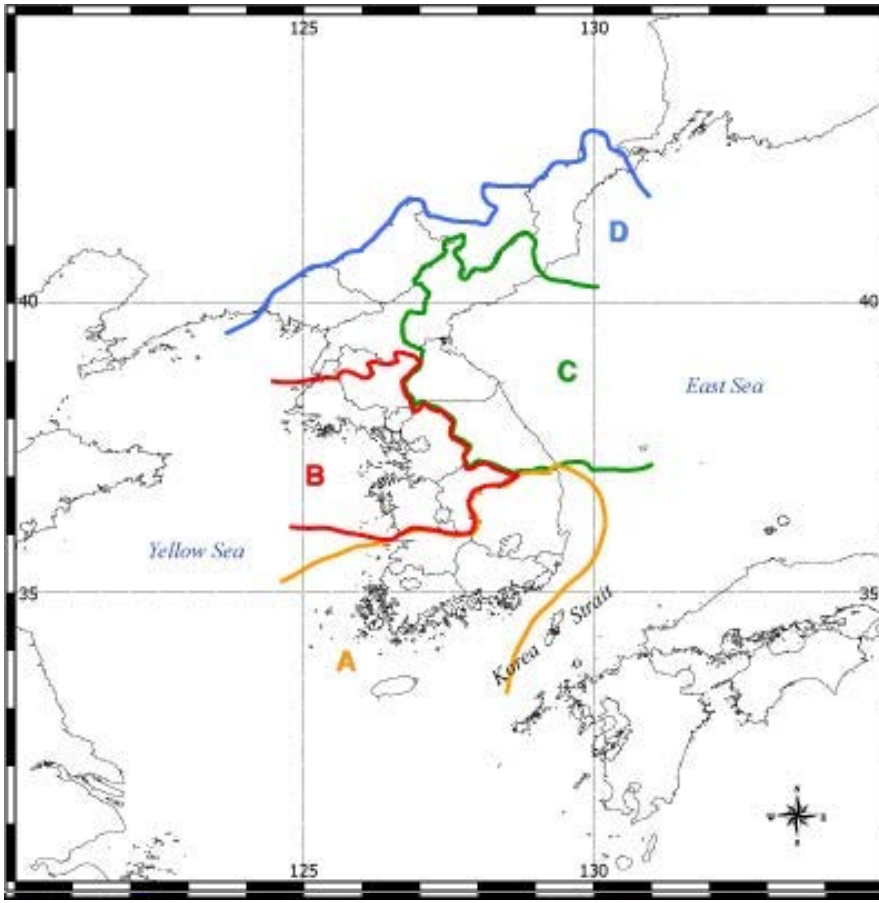
2) Weather Station

❖ GHCN

- Temperature : 197stations
- Precipitation : 119stations

❖ Meteorological Administration

- 80stations



Weather station : Prepcipitation
Weather station : Temperature

3. Data Preparation

1) Outline

❖ IPCC Data Distribution Center

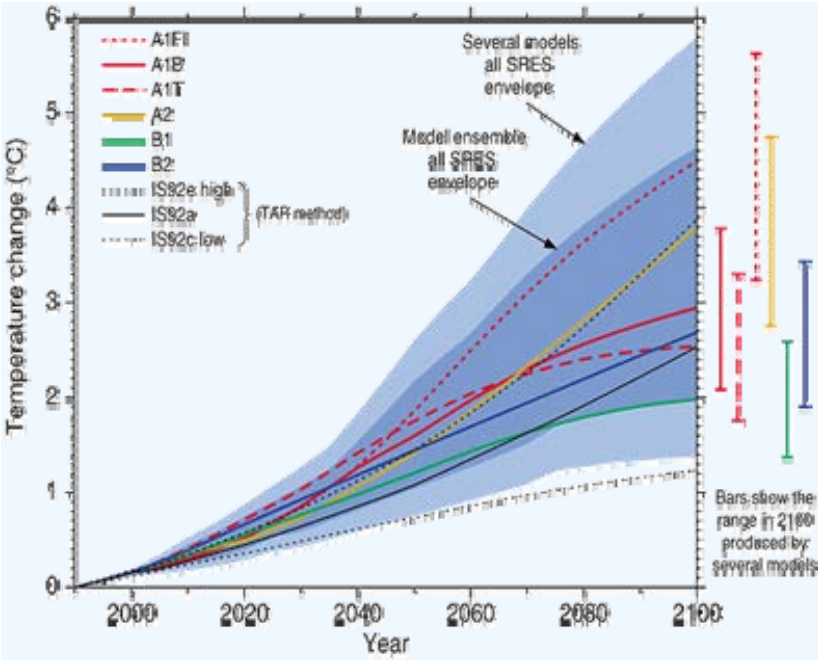
❖ SRES Senarios

❖ GCM
- MPIfM(ECHAM4/OPYC3)
- HCCPR(HadCM3)
- CSIRO(CSIRO-Mk2)
- NCAR(NCAR-CSM, NCAR-PCM)
- CCCma(CGCM2)
- CCSR/NIES(CCSR/NIES AGCM+CCSR OGCM)

3. Data Preparation

2) SRES Senarios

❖ IPCC recommends SRES scenario improving the limitations of IS92 scenario



Storyline	Summary
A1	· Very rapid economic growth rate · Global population that peaks in mid-century and declines thereafter · Rapid introduction of new and more efficient technologies (A1FI – fossil intensive, A1T-non-fossil energy sources, A1B-balance across all sources)
A2	· A very heterogeneous world · Self-reliance and preservation of local identities · Continuously increasing global population · Regionally oriented economic development
B1	· Rapid changes in economic structures toward a service and information economy · Reductions in material intensity · Introduction of clean and resource-efficient technologies
B2	· emphasis on local solutions to economic, social and environmental sustainability · Continuously increasing global population at a rate lower than A2 · Intermediate levels of economic development

3. Data Preparation

3) GCM

Center	Acronym	Model	SRES Scenario Runs						Time Period
Max Plank Institute Fur Meteorologie	MPIfM	ECHAM4/ OPYC3				A2		B2	1990-2100
Hadley Centre for Climate Prediction and Research	HCCPR	HadCM3				A2		B2	1950-2099
Australia's Common Wealth Scientific and Industrial Research Organization	CSIRO	CSIRO-Mk2	A1			A2	B1	B2	1990-2100
National Centre for Atmospheric Research	NCAR	NCAR-CSM				A2		B2	2000-2099
		NCAR-PCM				A2		B2	A2:1980-2099 B2:2000-2099
Canadian Center for Climate Modeling and Analysis	CCCma	CGCM2				A2		B2	1900-2100
Center for Climate Research Studies (CCSR) National Institute for Environmental Studies (NIES)	CCSR/NIES	CCSR/NIES AGCM +CCSR OGCM	A1	A1F1	A1T	A2	B1	B2	1890-2100

3. Data Preparation

4) Temperature Interpolation

❖ Temperature lapse rate by altitude and Spatial Interpolation Model using Observatory level(Nalder and Wein,1998; Yoon, Jin-Il, 2000)

$$|\Gamma| = 0.0068 + 0.0015 * COS\{0.072(Day - 60)\}$$

❖ Monthly mean Temperature Interpolation, The Korean Peninsula(m/C)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.0080	0.0083	0.0083	0.0079	0.0073	0.0065	0.0058	0.0054	0.0055	0.0058	0.0065	0.0073

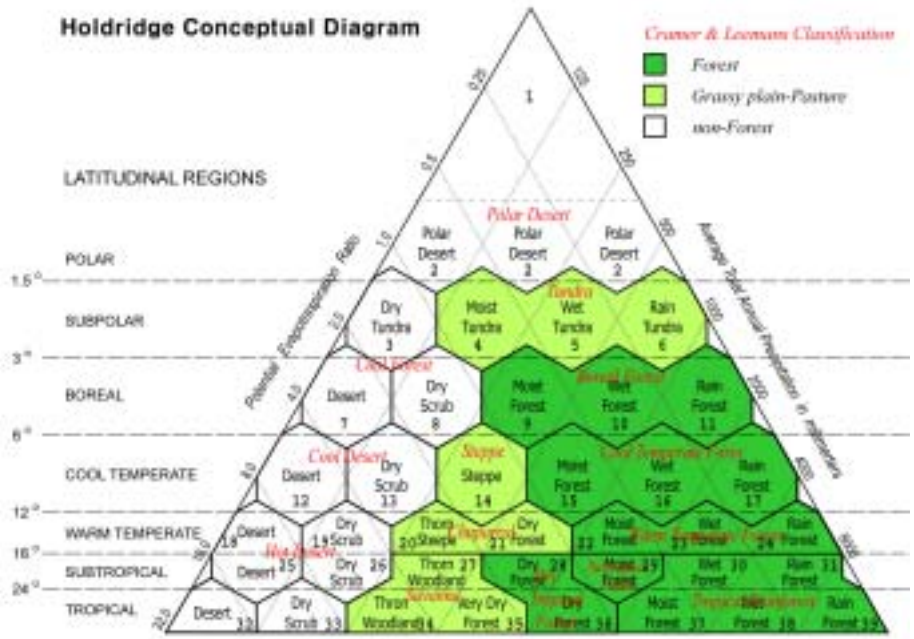
❖ Spatial Interpolation using Inverse Distance Squared Weighting(IDSW)

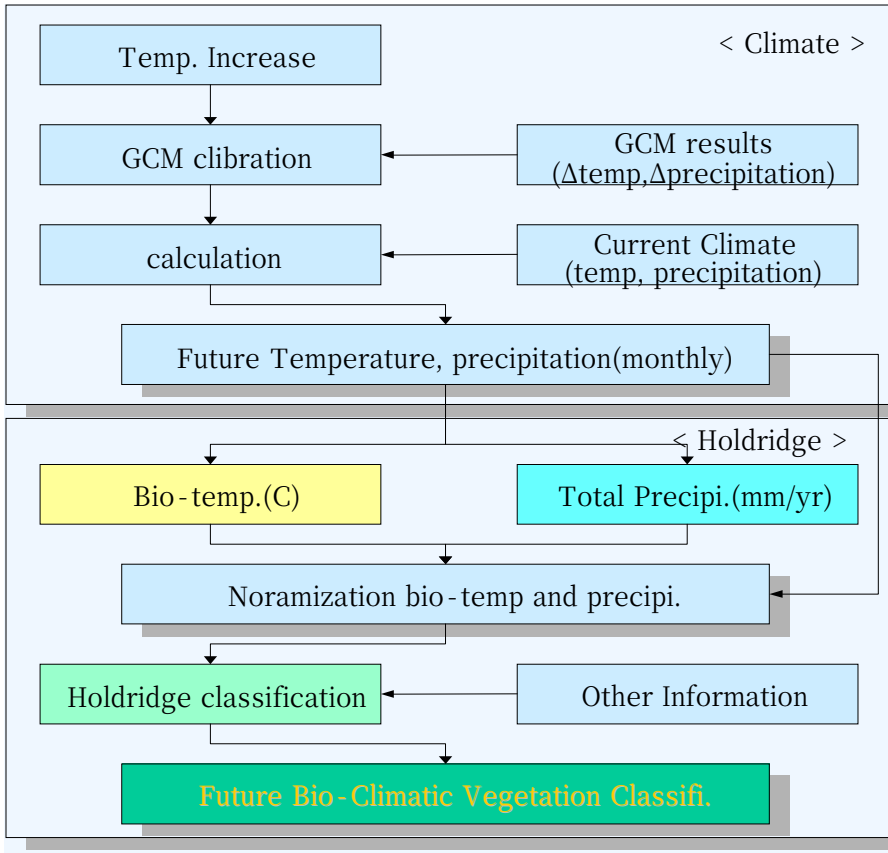
3. Data Preparation

5) Impact Assessment Model

❖ Bio-Climatic Classification using Holdridge Model(39 Classes)

❖ Applying Bio-Temperature and Yearly Mean Precipitation

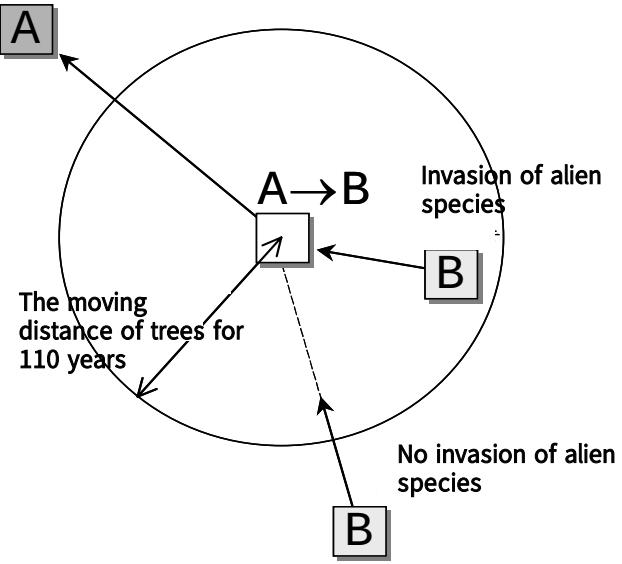




3. Data Preparation

6) Estimating adaptability

- ❖ Considering moving velocity of Trees (Davis,1989)
- ❖ Forest adaptation scenario by moving velocity (7 Classes)



< possible movement of trees >
(Munesue Y. and Takahashi K.,2000)

Change Pattern		Effects on vegetation
1990	2100	
Forested Areas	No Change	(a) No change to current forest distributions
	Invasion of alien species	(b) Invasion of alien species by bio-climatic change
		(c) No invasion of alien species, but bio-climatic zones remain no-change
	Deforestation	(d) Deforestation or desertification
Non-Forested Areas	Change to Forested Areas	(e) Changes to forested areas by the invasion of alien species
		(f) No invasion of alien species while existing forest remains
	No Change	(g) Not applicable in this study

4. Data Preparation

7) Estimation of economic loss

- National Center for Ecological Analysis and Synthesis Model
- 16 Bio-region, estimating the economic value of 17 eco-system services
- Estimating the value of Eco-system by an Willingness to Pay for environment improvement

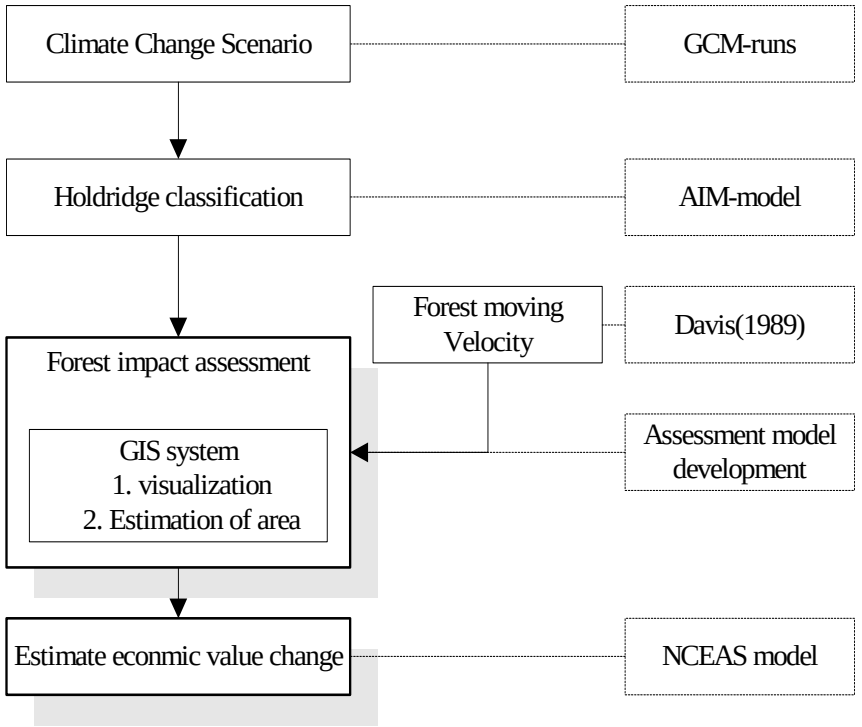
Classification	Area(Mha)	Eco. value($/ha/yr)	World(a billionU.S.$/yr)
Tropical forest	1,900	2,007	3,817
Warm temp., subtropical	2,955	302	894
glassland, grazing land	3,898	232	906

Ref. : Costanza, R. *et al.* 1997. The Value of the world's ecosystem services and natural capital, *NATURE*, 387:253-260.

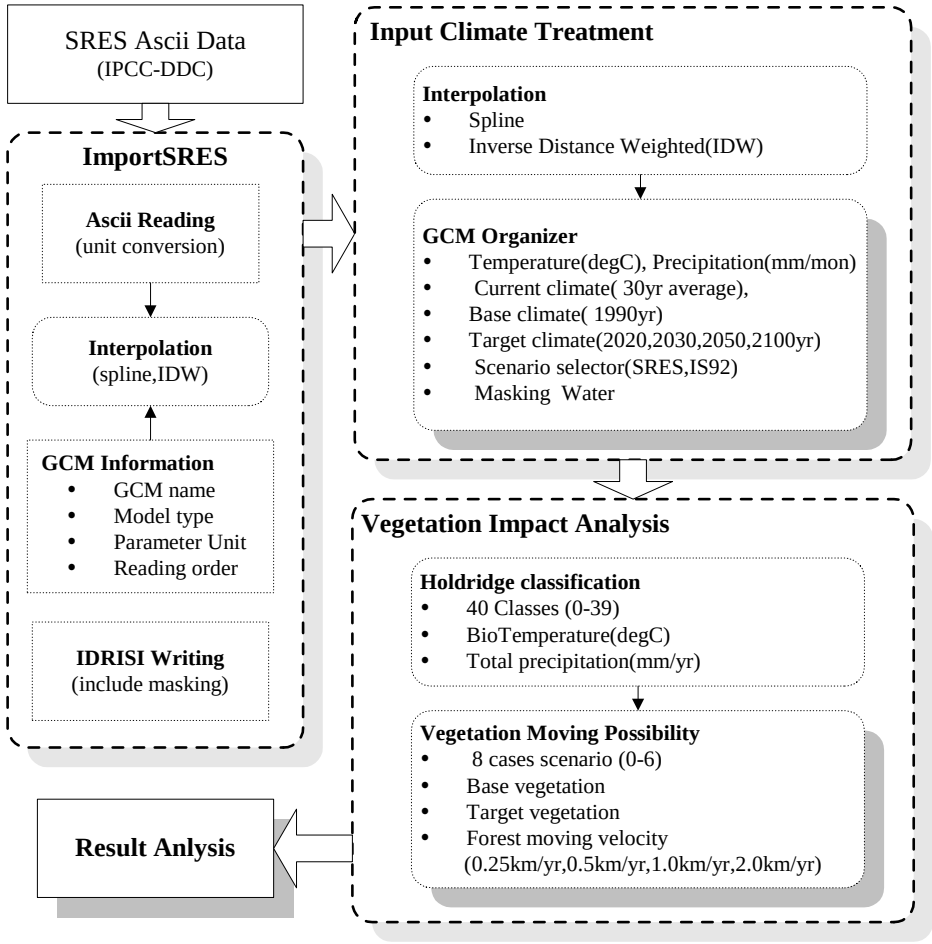
4. Data Analysis

1) Process of Impact analysis

< process of impact analysis >



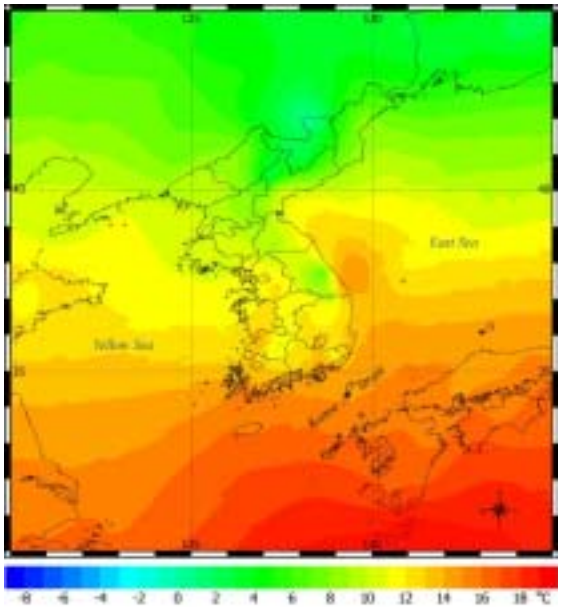
< process of impact analysis model >



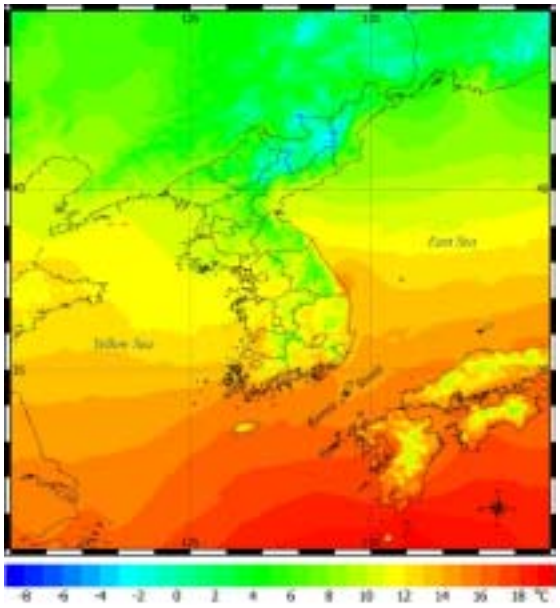
4. Data Analysis

2) Current climate

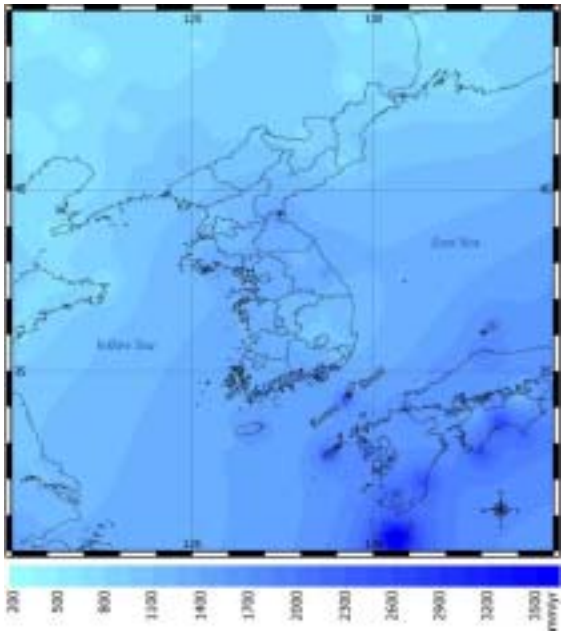
❖ Using 30 Yearly mean data(1969-1999)



< Temp. distribution >



< Temp. distribution considering temperature lapse rate >



< Prep. distribution >

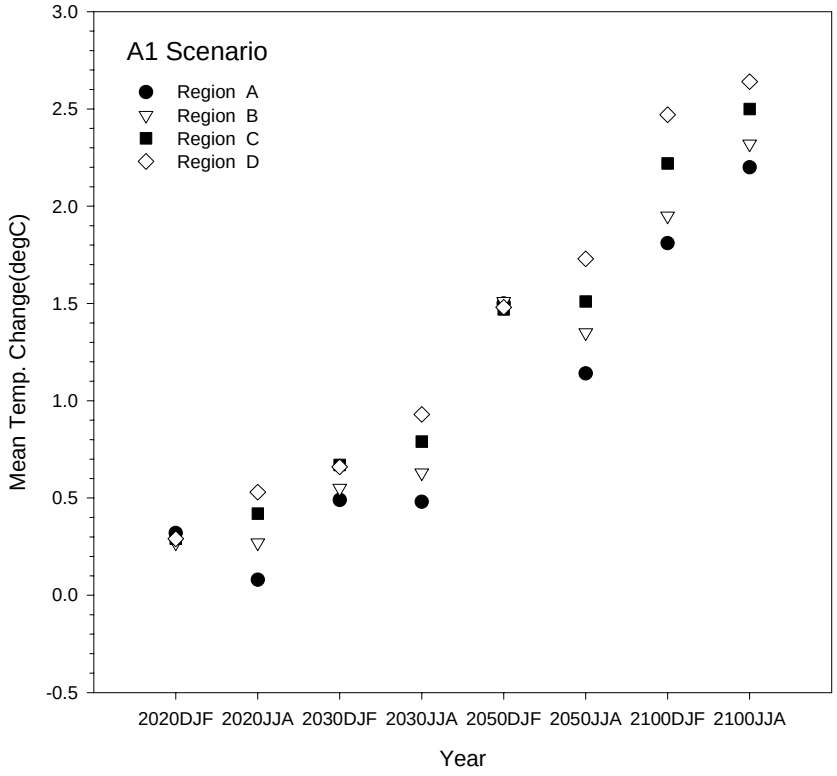
5. Results and proposals

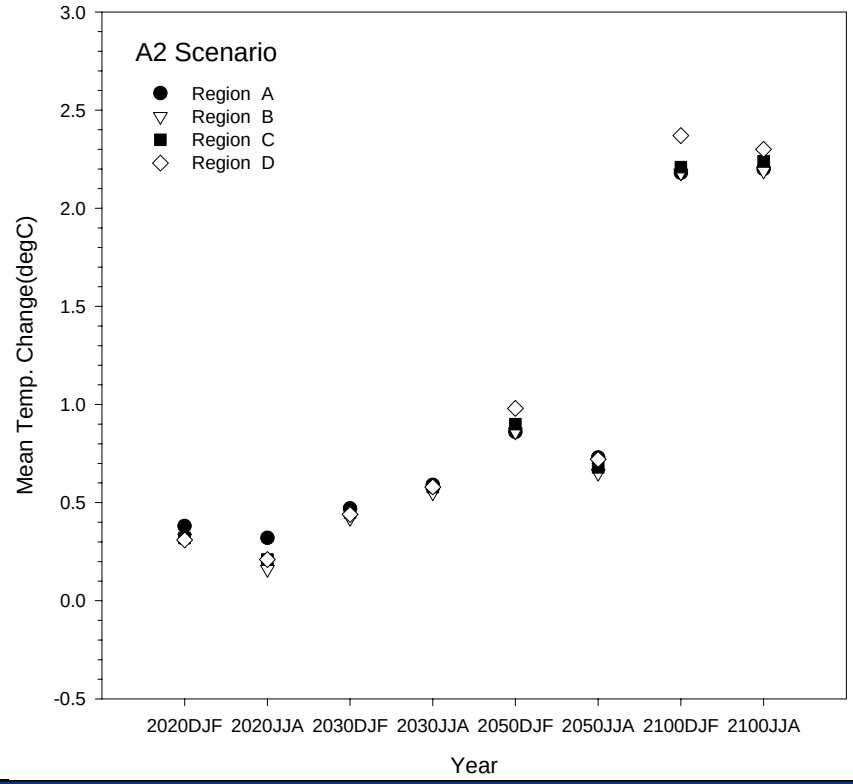
1) Predicted results

❖ Mean temp. change by scenario(A1, A2 scenario)

A1	A	B	C	D
DJF	1.81℃	1.95 ℃	2.22 ℃	2.47 ℃
JJA	2.20℃	2.32 ℃	2.50 ℃	2.64 ℃

A2	A	B	C	D
DJF	2.18 ℃	2.18 ℃	2.21 ℃	2.37 ℃
JJA	2.20 ℃	2.19 ℃	2.24 ℃	2.30 ℃





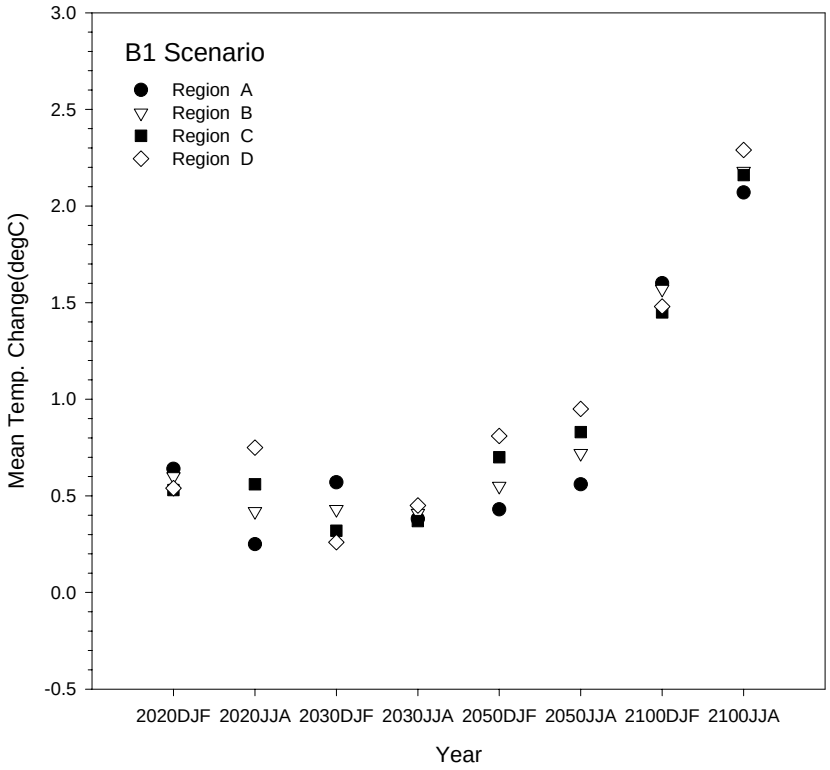
5. Results and proposals

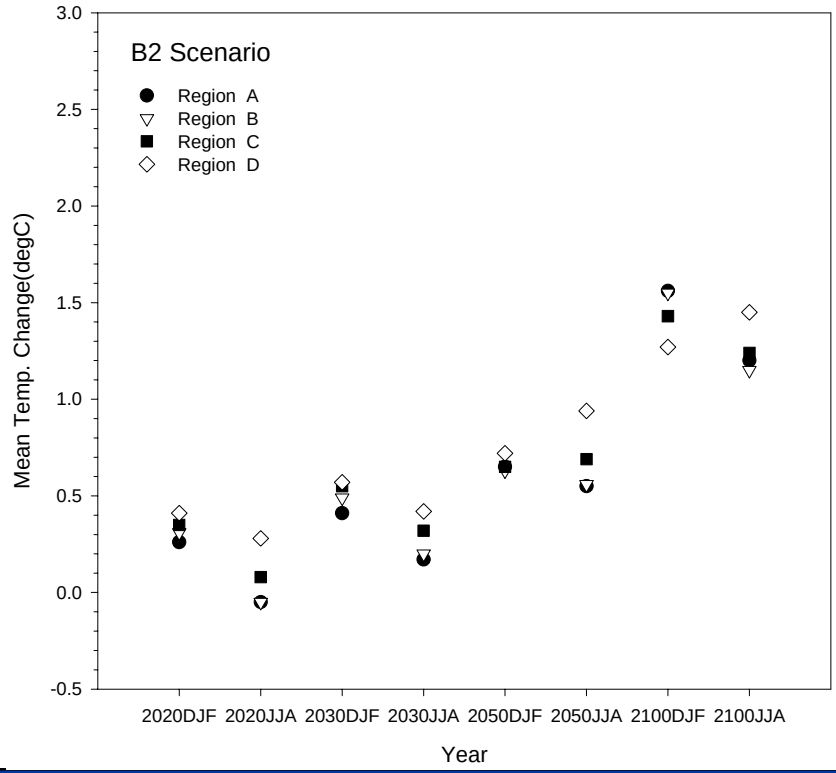
1) Predicted results

❖ Mean temp. change by scenario(B1, B2 scenario)

B1	A	B	C	D
DJF	1.60 ℃	1.57 ℃	1.45 ℃	1.48 ℃
JJA	2.07 ℃	2.18 ℃	2.16 ℃	2.29 ℃

B2	A	B	C	D
DJF	1.56 ℃	1.55 ℃	1.43 ℃	1.27 ℃
JJA	1.20 ℃	1.15 ℃	1.24 ℃	1.45 ℃





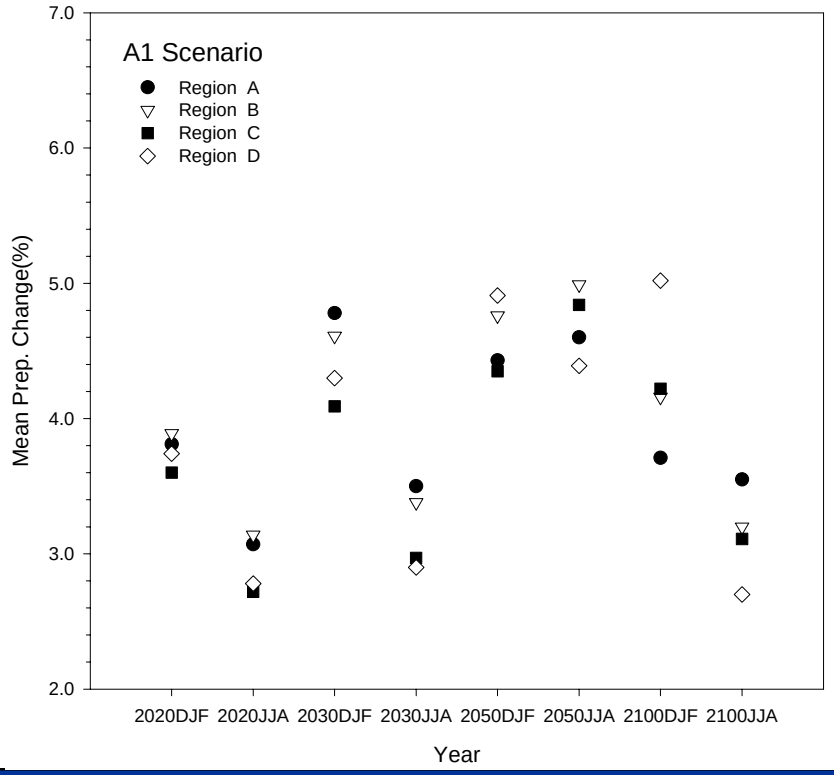
5. Results and proposals

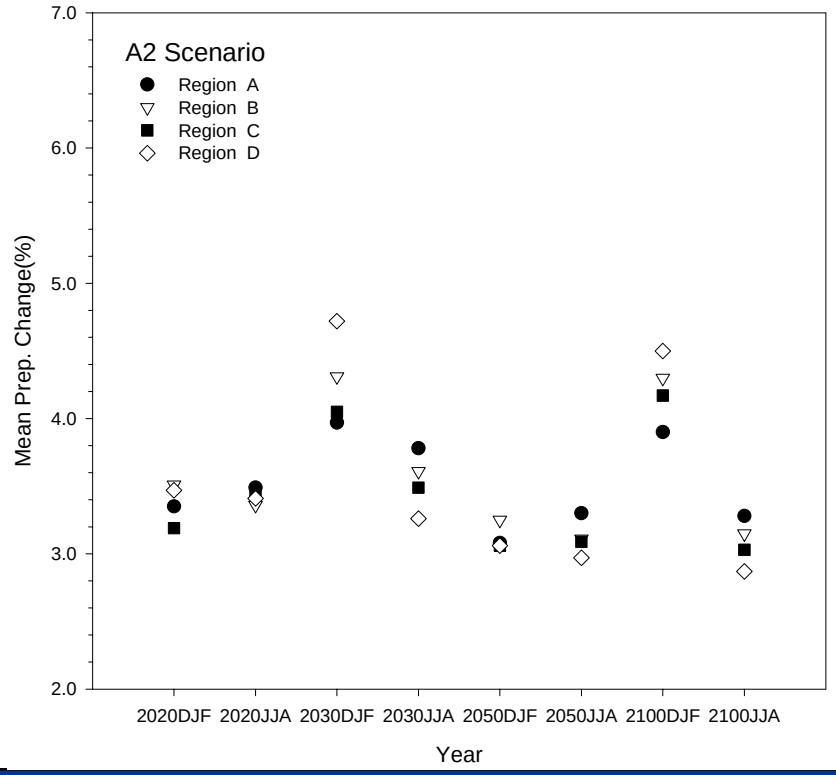
1) Predicted results

❖ Mean precipitation change by scenario(A1, A2 scenario)

A1	A	B	C	D
DJF	3.71%	4.16%	4.22%	5.02%
JJA	3.55%	3.20%	3.11%	2.70%

A2	A	B	C	D
DJF	3.90%	4.30%	4.17%	4.50%
JJA	3.28%	3.15%	3.03%	2.87%





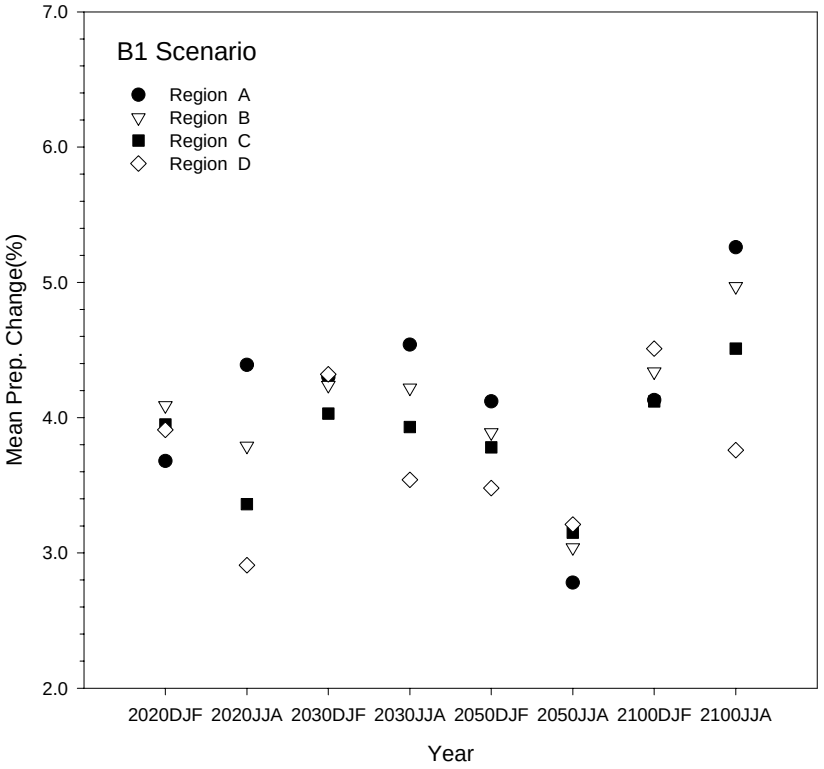
5. Results and proposals

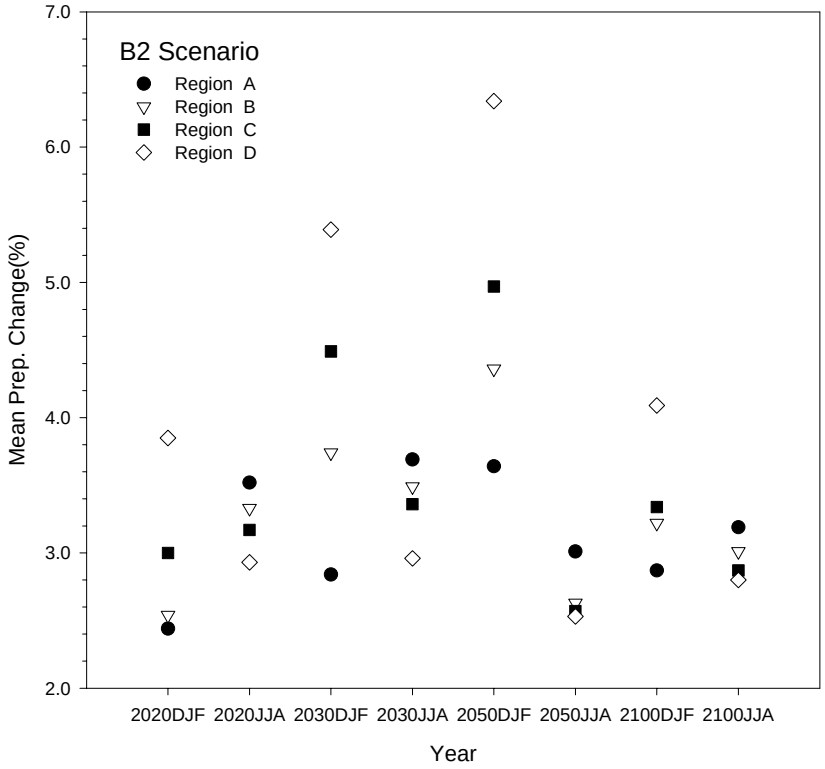
1) Predicted results

❖ Mean precipitation change by scenario(B1, B2 scenario)

B1	A	B	C	D
DJF	4.13%	4.34%	4.12%	4.51%
JJA	5.26%	4.97%	4.51%	3.76%

B2	A	B	C	D
DJF	2.87%	3.22%	3.34%	4.09%
JJA	3.19%	3.01%	2.87%	2.80%



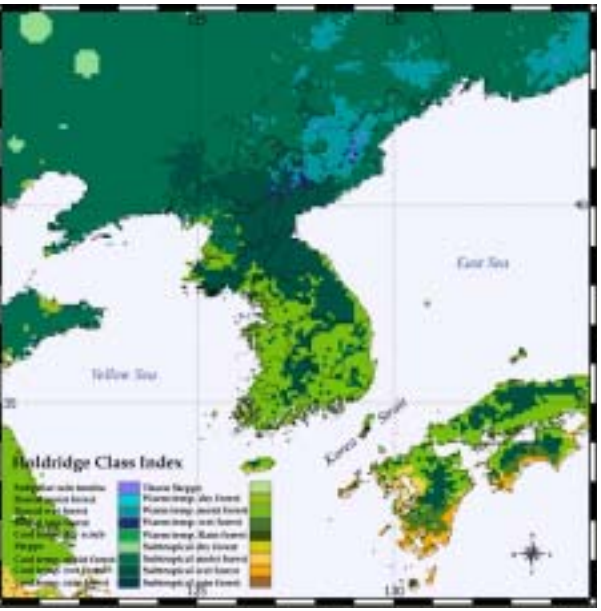


5. Results and proposals

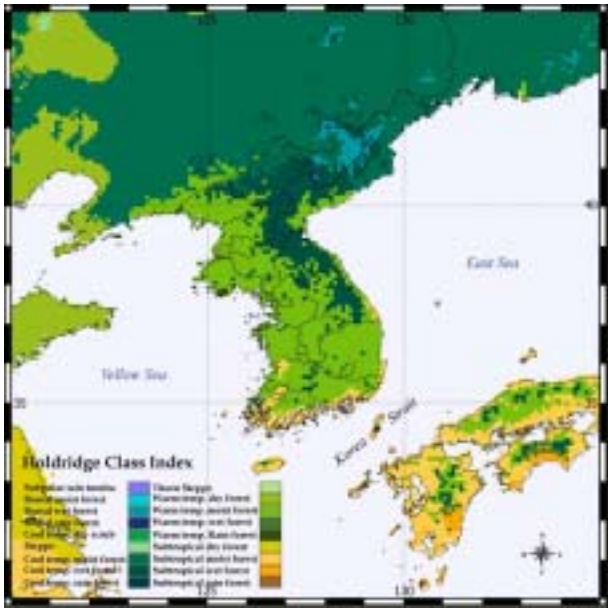
2) bio-climatic classification

❖ 2100yr Climatic zone applying HadCM3 model(A2, B2 scenario)

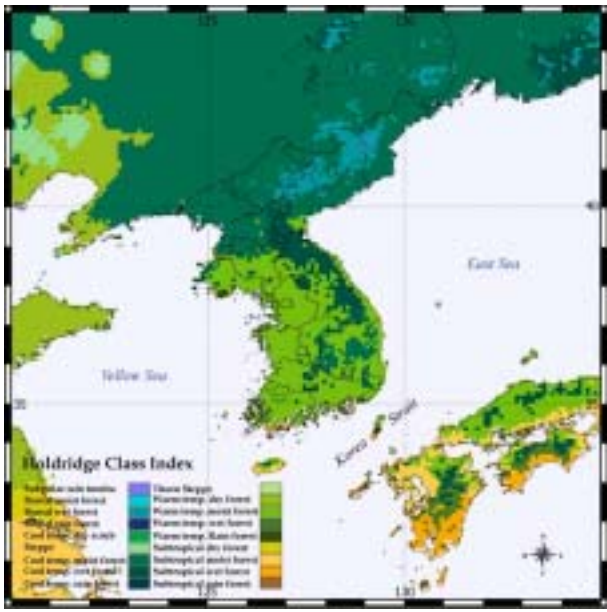
- Warm Temperate Moist Forest : Most mid-latitude areas except the Great *Baekdu* Ranges and the Southern coastal areas
- Cool Temperate Wet Forest : Most areas of the Great *Baekdu* Ranges and the Northern parts



< current climatic zone >



< A2 scenario >

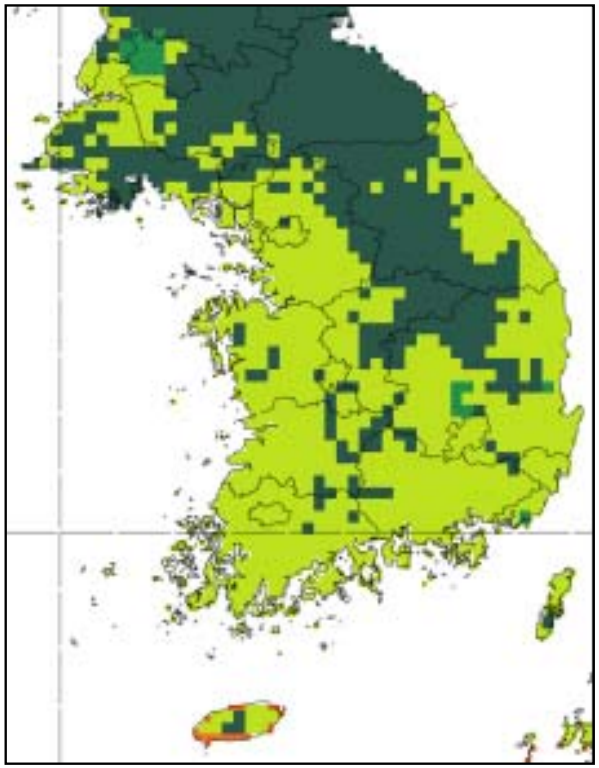


< B2 scenario >

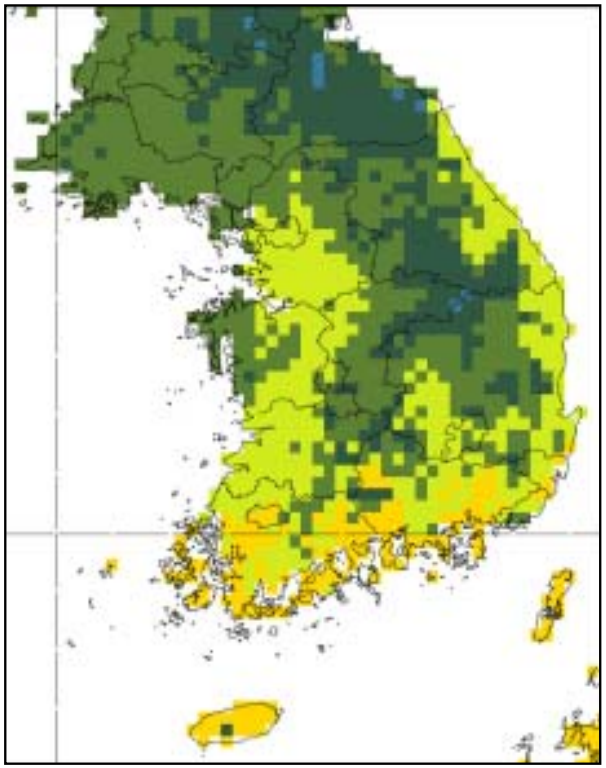
5. Results and proposals

3) Verification of results

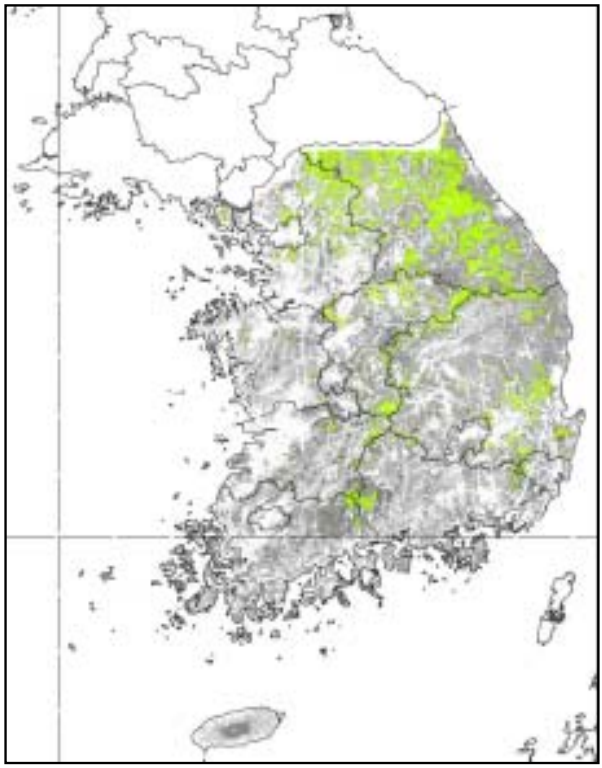
❖ Verification of Holdridge classification using warmth index and vegetation map(The middle part of cold-warm latitudes)



< Holdridge classification >



< Warmth index classification >



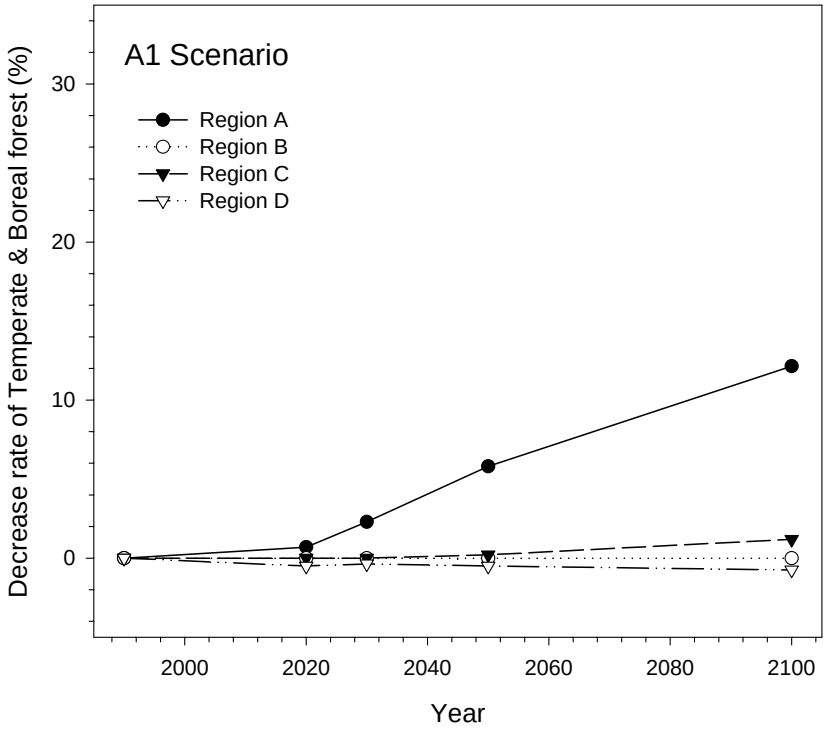
< Vegetation map(Mongolica) >

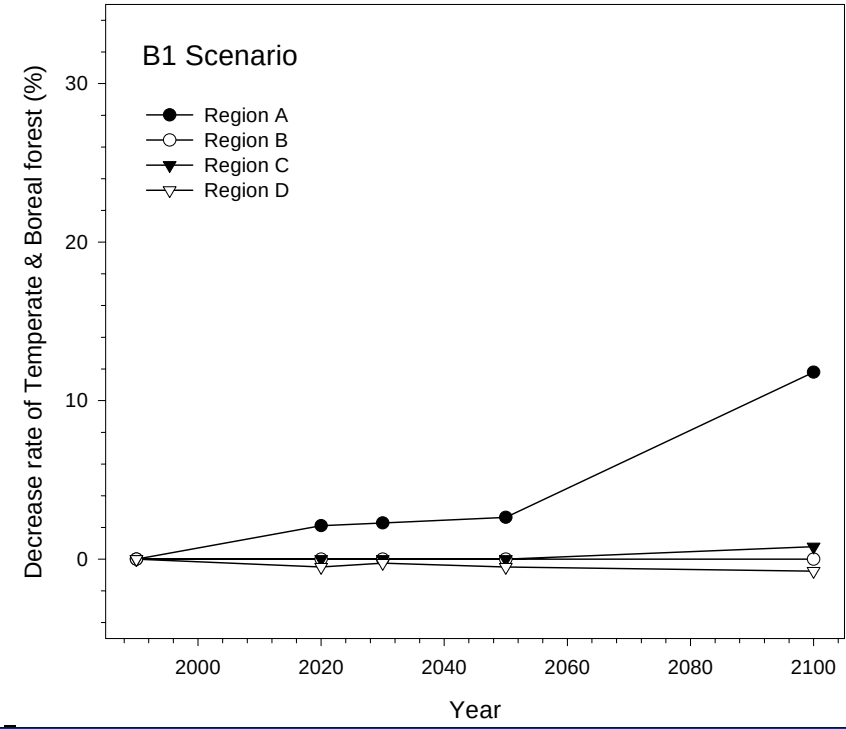
5. Results and proposals

4) Decrease rate of area

❖ Decrease rate of temp. and Boreal forest by scenario(A1, B1 scenario)

- A 12.15% decline of the boreal and temperate forests of the Southern part under A1 scenario
- A 11.80% decline of the boreal and temperate forests of the Southern part under B1 scenario



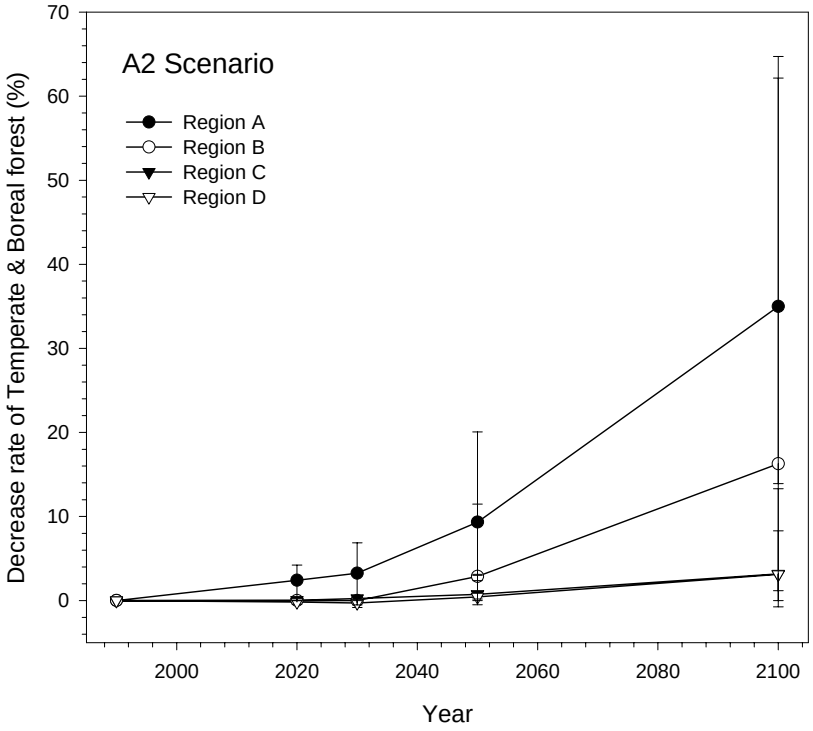


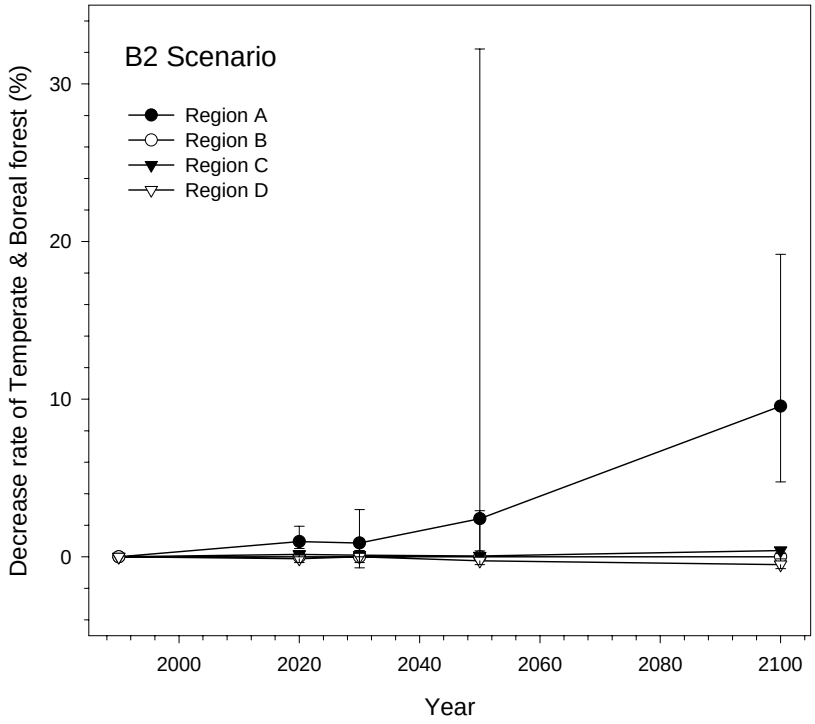
5. Results and proposals

4) Decrease rate of area

❖ Decrease rate of temp. and Boreal forest by scenarios (A2, B2 scenario)

- Scenario A2 : A minimum of 13.91% to a maximum of 62.15% decline of boreal and temperate forests of the Southern part (a 34.99% decline on average)
- Scenario B2 : A minimum of 4.75% to a maximum of 19.19% decline of boreal and temperate forests of the Southern part (a 19.19% decline on average)





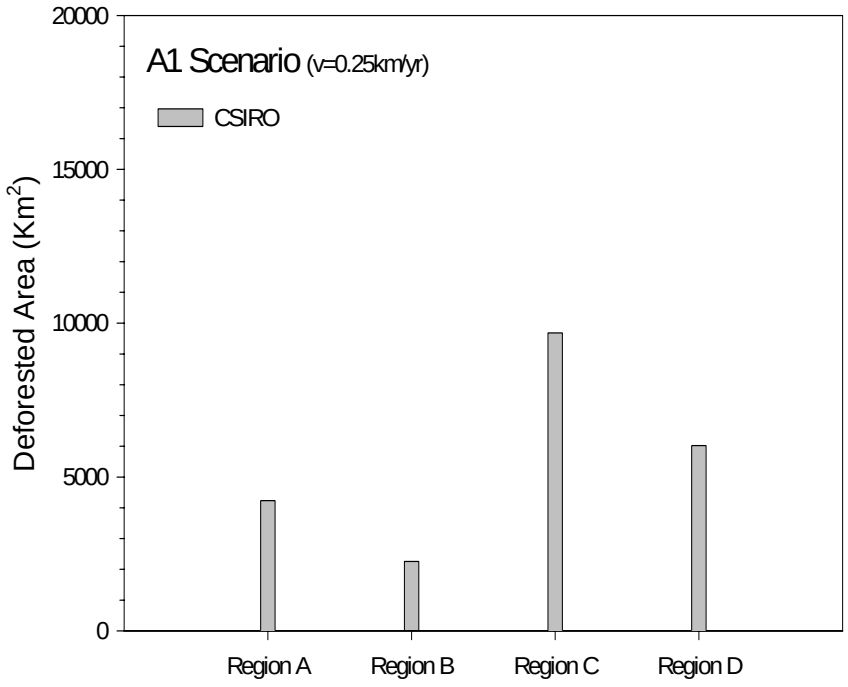
5. Results and proposals

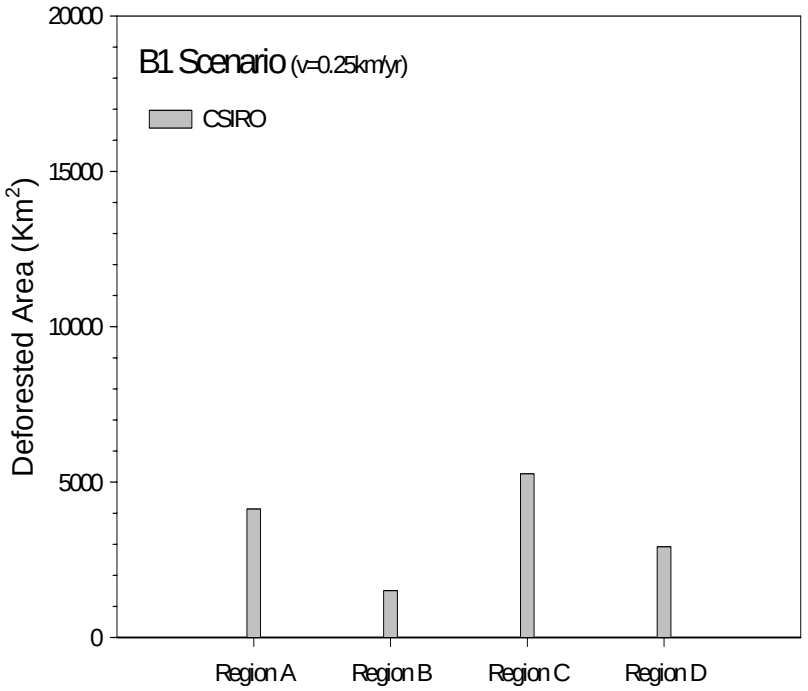
5) Deforested area(by region)

❖ Deforested area by scenario(A1, B1 scenario: using CSIRO GCM)

A1	A	B	C	D
stressed	1.90%	1.01%	4.48%	2.58%
deforest	0.00%	0.00%	0.00%	0.00%

B1	A	B	C	D
stressed	1.86%	0.68%	2.70%	3.89%
deforest	0.00%	0.00%	0.00%	0.00%





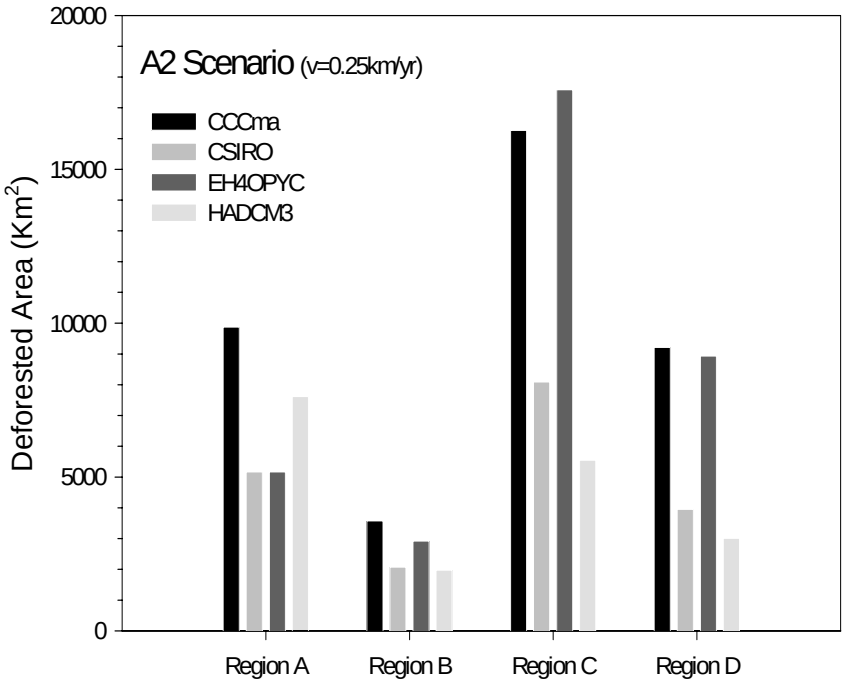
5. Results and proposals

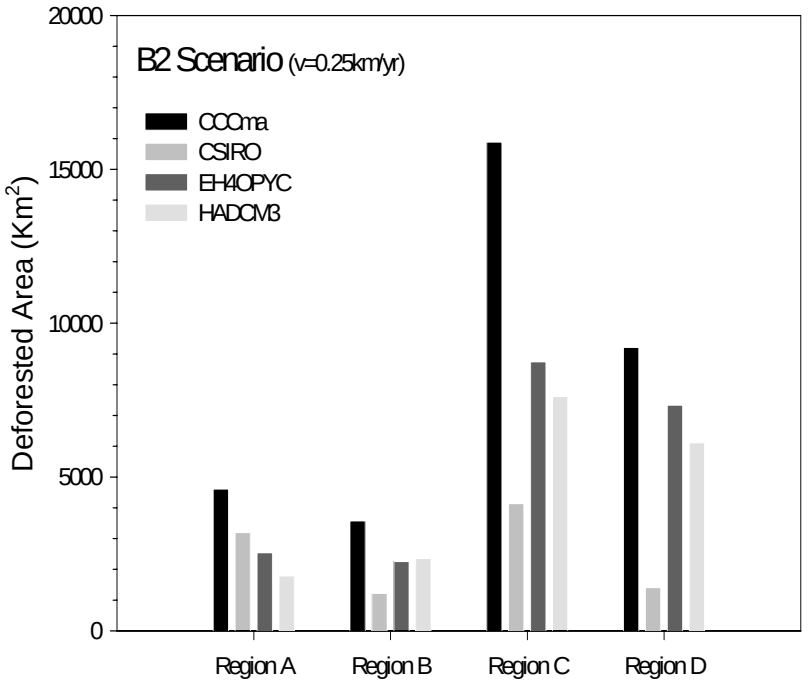
5) Deforested area(by region)

❖ Deforested area by scenario(A2, B2 scenario: using CCCma, CSIRO, EH4OYPC, HADCM3)

A2	A	B	C	D
stressed	3.13%	0.65%	2.73%	2.66%
deforest	3.28%	3.30%	0.41%	1.31%

B2	A	B	C	D
stressed	1.36%	0.70%	1.57%	1.01%
deforest	0.39%	3.30%	0.41%	0.05%



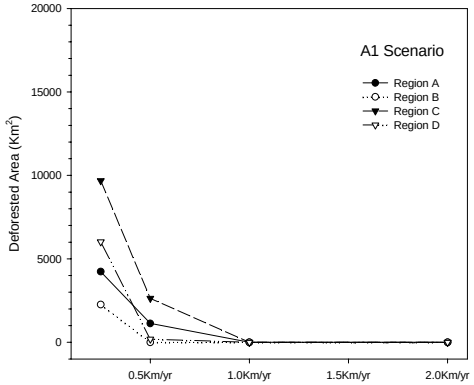


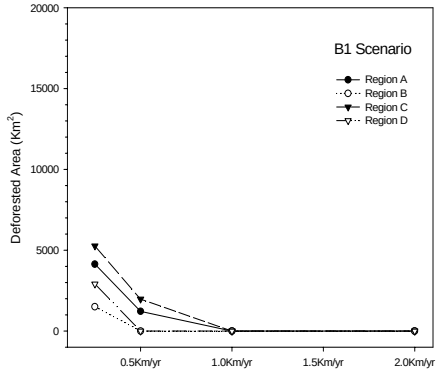
5. Result and proposals

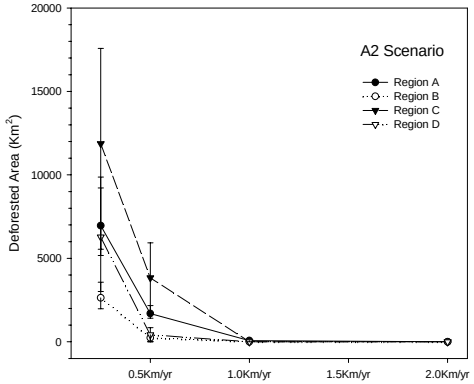
6) Deforested area(by moving velocity)

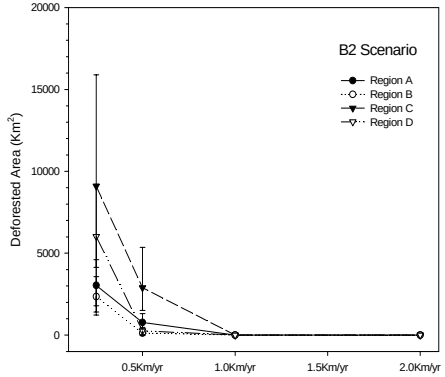
❖ Deforested area by scenario and moving velocity

- Region A and region C are predicted to be most impacted among 4 regions
- If tree moving velocity reaches 1.0Km/yr, no area of deforestation is predicted under all 4 scenarios







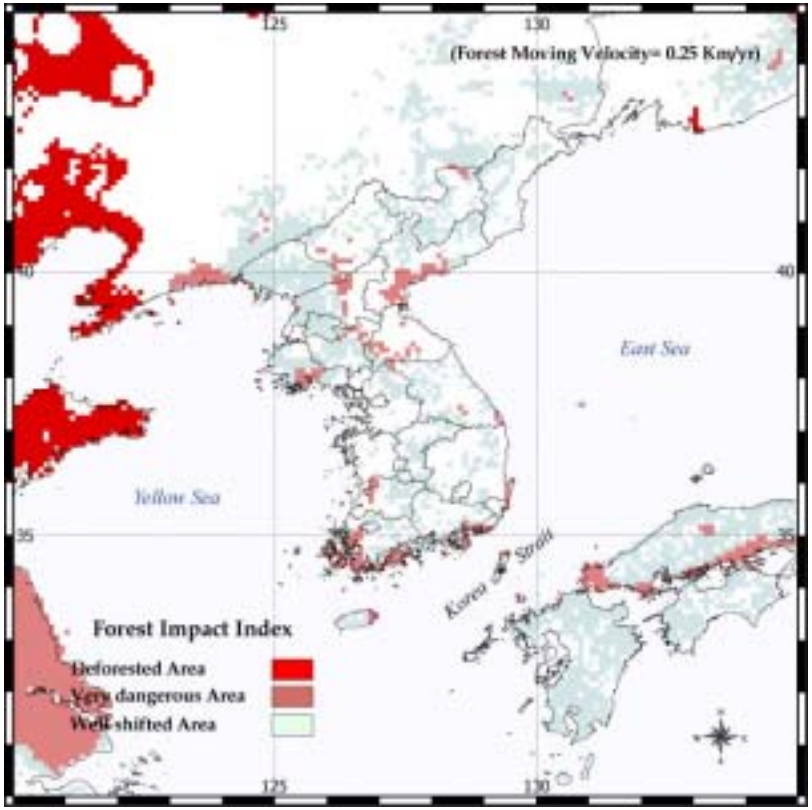


5. Results and proposals

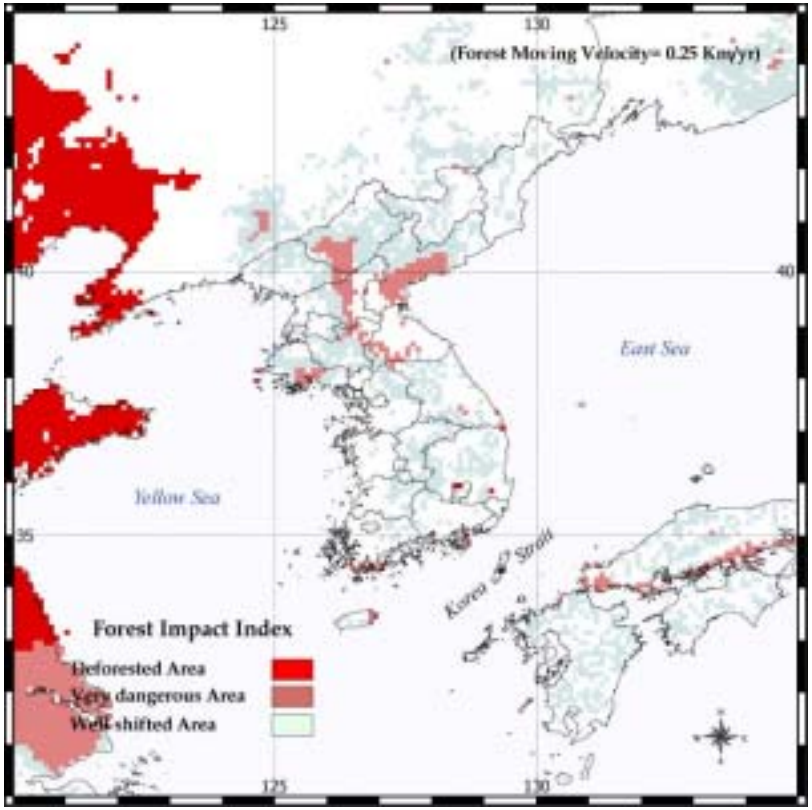
7) Distribution of affected area

❖ 2100yr Climatic zone applying HadCM3 model(A2, B2 scenario)

❖ Moving velocity of Trees(0.25 Km/yr)



< A2 scenario >



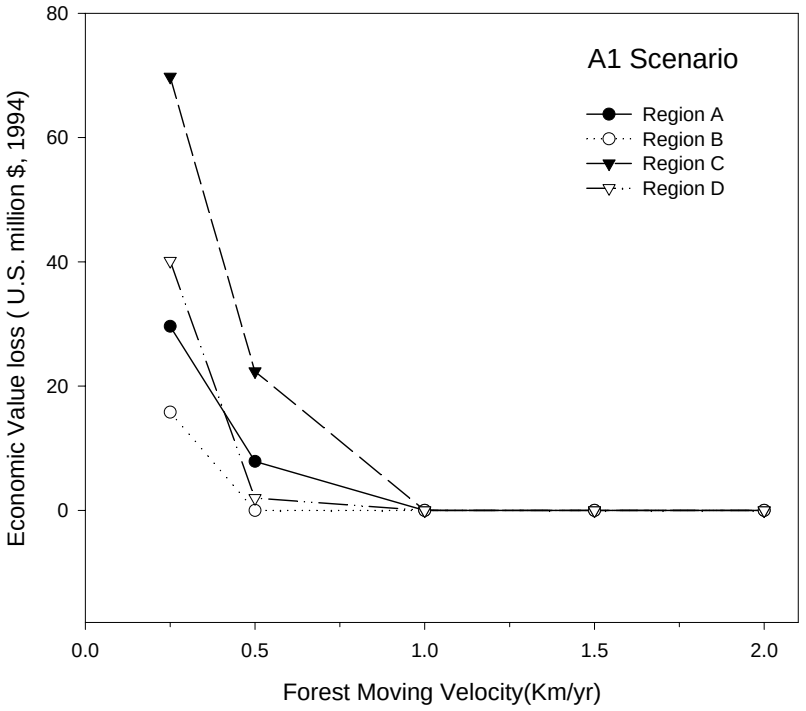
< B2 scenario >

5. Results and proposals

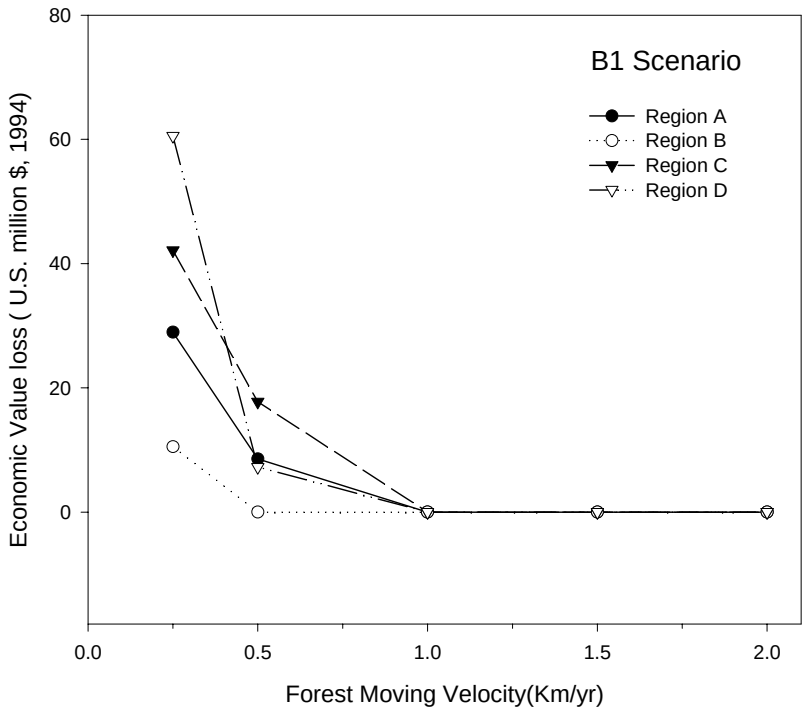
8) Estimation of economic loss

❖ Economic value loss by moving velocity of Trees(US Million$/yr, 1994)

A1	A	B	C	D	Total
0.25km	29.62	15.80	69.77	40.15	155.34
2.0km	0.00	0.00	0.00	0.00	0.00



B1	A	B	C	D	Total
0.25km	28.96	10.53	42.12	60.55	142.16
2.0km	0.00	0.00	0.00	0.00	0.00

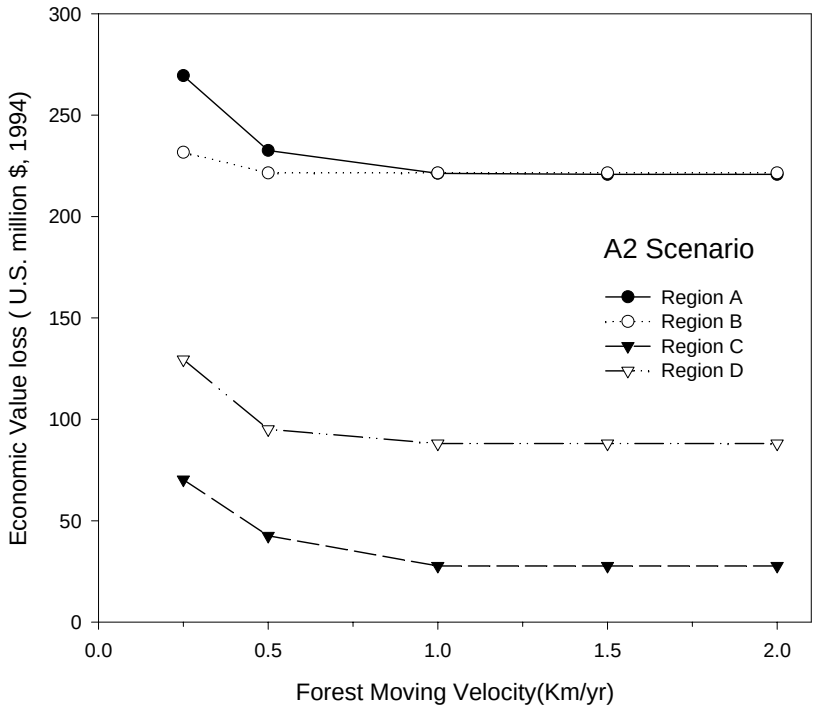


5. Results and proposals

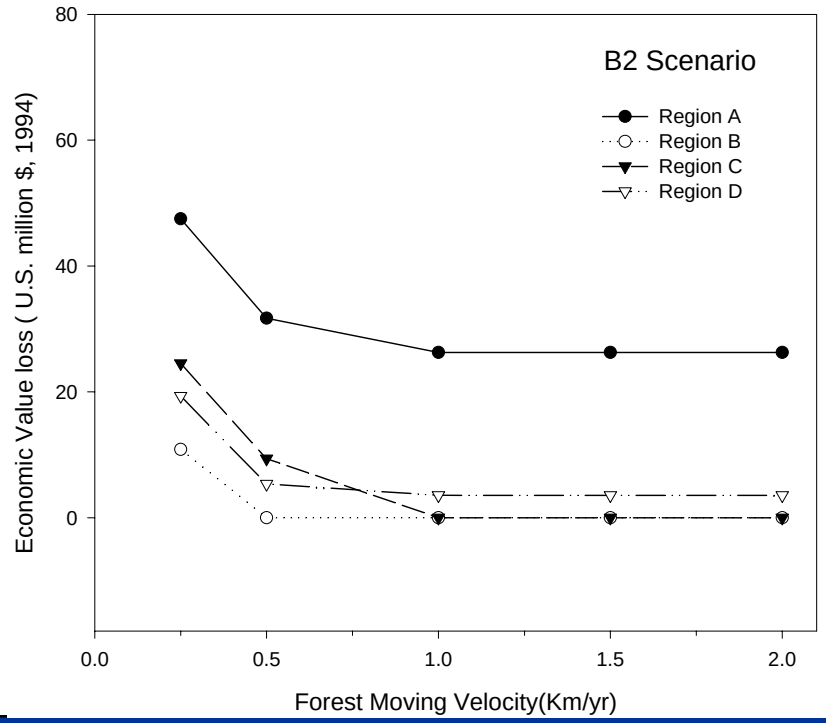
8) Estimation of economic loss

❖ Economic value loss by moving velocity of Trees

A2	A	B	C	D	Total
0.25km	269.49	231.69	70.30	129.49	700.97
2.0km	220.78	221.49	27.69	88.03	557.99



B2	A	B	C	D	Total
0.25km	47.49	10.86	24.52	19.35	102.22
2.0km	26.27	0.00	0.00	3.55	29.82



6. Further Studies

- Development of emission scenario for Korea
- Forest impact assessment using RCM
- Development of forest distribution change by community types
- Economic analysis on forest distribution change by community types
- Initial studies for water resources

Thank You