



# Estimation of socio-economic impacts of climate change using indicator based approach

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# 1. Introduction

- Estimation of socio-economic impacts of climate change could save future damage by implementing appropriate measures
- Currently several studies aimed to estimate economic impacts of climate change (Stern review, 2007; Garnault review, 2008; ADB, 2009).

## Indicator based approach



- Recently, indicator based socio economic impacts assessment has been carried out (EEA, 2012; UK, 2003; DARA, 2012)
- Compared to model based approach, indicator based approach could analyze impacts in the past, present, and future with less resources.

## 2. Major socio economic indicators by sector

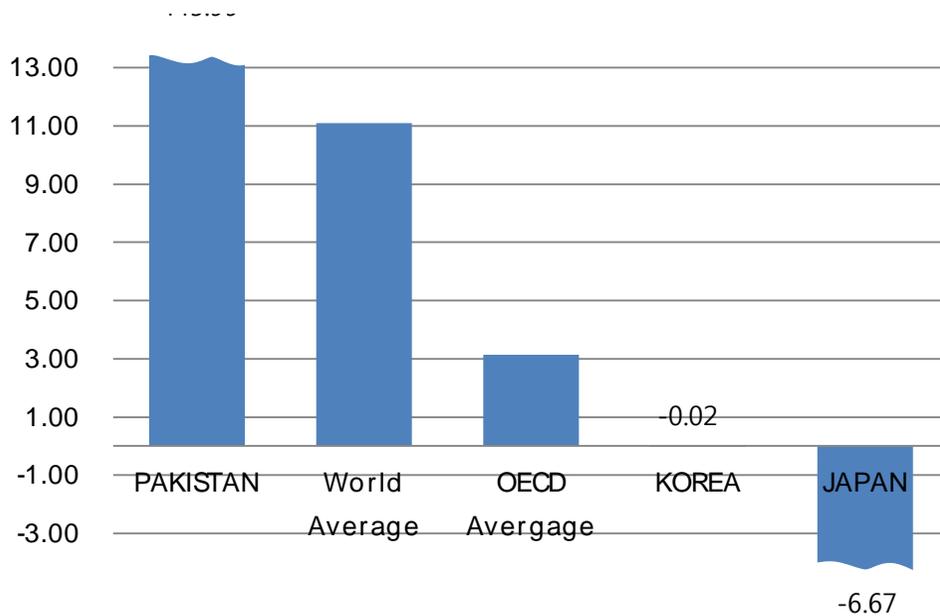
Sector	EEA	DARA	UK	Oxfam & WWF
Agriculture	Growing Season for agricultural crops Agrophenology water-limited Crop Productivity Irrigation water requirement	Agriculture	Irrigation water use Proportion of potato crop irrigated Non-irrigated potato yields Area of productive vines Area of forage maize Length of growing season	Impact on agriculture (Grain crops, Forage crops)
Forests and Forestry	Forest growth Forest Fire	Forestry	Number of outdoor fires	
Fisheries	Fisheries and aquaculture	Fisheries		
Human Health	Floods and health Extreme temperatures and health Air pollution by ozone and health vector-borne diseases Water-and food borne diseases	Diarrheal Infections Heat & cold illnesses Hunger Malaria & vector-borne Meningitis	Lyme disease occurrence Winter human mortality	Impacts on health
Energy	Heating degree days Cooling degree days Electricity demand and production	Hydro energy Heating and Cooling	Domestic gas supply	Energy poverty
Transport services and infrastructure	Impacts of distribution patterns Damage to road traffic safety	transport		
Tourism	General tourism Winter sport tourism	Tourism	Skiing industry Domestic tourism	
Climate/Disaster		Drought Floods & Landslides Storms Wildfires	Number of hot/Cold days Annual mean temperature Percentage of precipitation falling in winter	Extreme weather events and their social consequences
Biodiversity		Biodiversity Desertification Permafrost Sea-level rise Water	Annual river flows Dry and wet soil conditions Sea level rise Groundwater storage Frequency of low and high river flows	water
others		Labour productivity	Domestic property insurance	Impacts on regional features and social consequences

### 3. Socio-economic indicators for national level

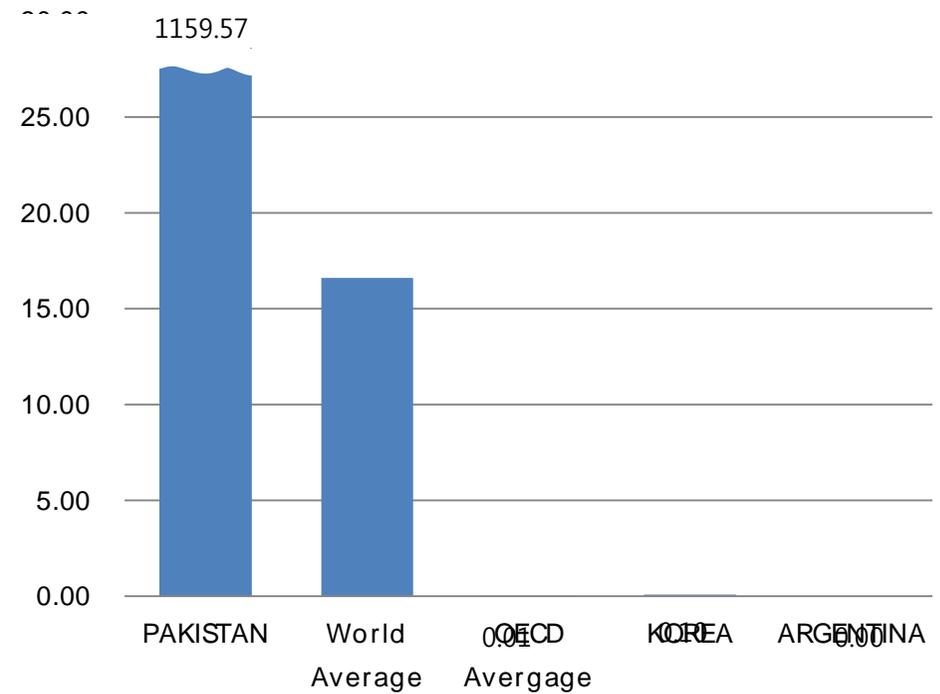
sector	indicator
health	Diarrheal Infections
	Heat&Cold Illnesses
	Hunger
	Malaria&Vector-Borne
	Meningitis
ecosystem	Biodiversity
	Contradiction of Biological Zone_Cumulative
	Decline in Biological Richness
energy	Change Energy Load
	Heating&Cooling
labour	Labour Productivity
	Share of Workforce
Sea level rise	Sea-Level Rise
	Net Loss of Land
	Affected Population
Water resources	Loss in Water runoff
	Water demands
Agriculture/ forestry/ Fisheries	Agriculture/ forestry/ Fisheries damage

## 4. Socio-economic indicators for national level(health)

**Heat&Cold Illnesses**  
(Additional Mortality per million)

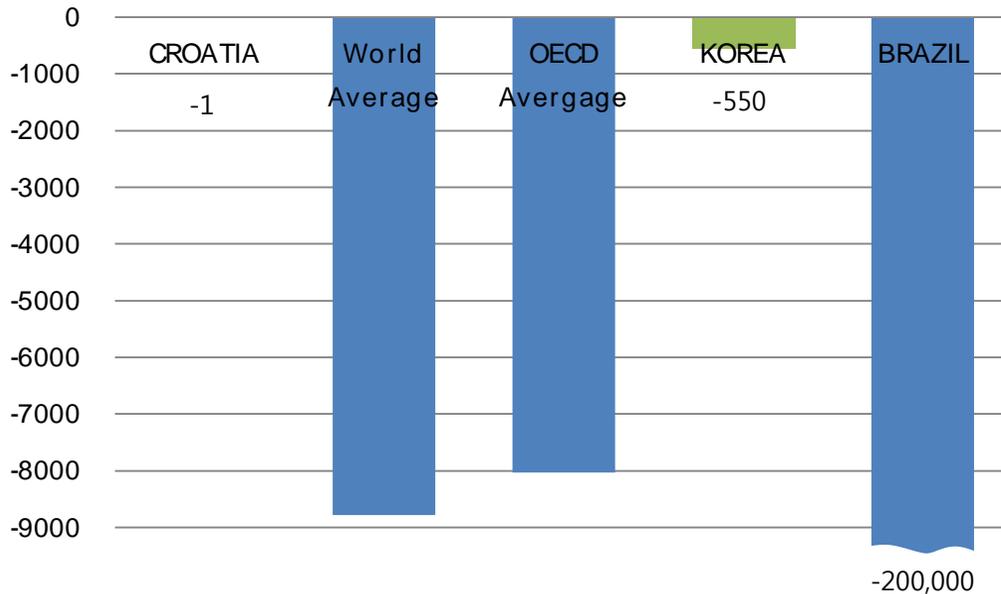


**Diarrheal Infections**  
(Additional Mortality per million)

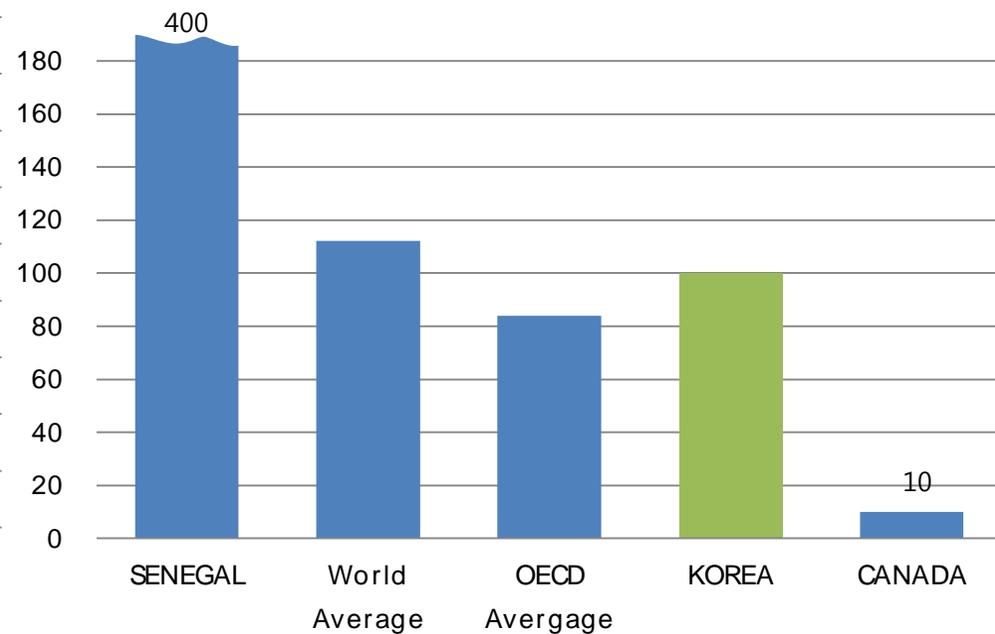


## 4. Socio-economic indicators for national level(ecosystem)

### Contraction of Biological zones(km<sup>2</sup>)

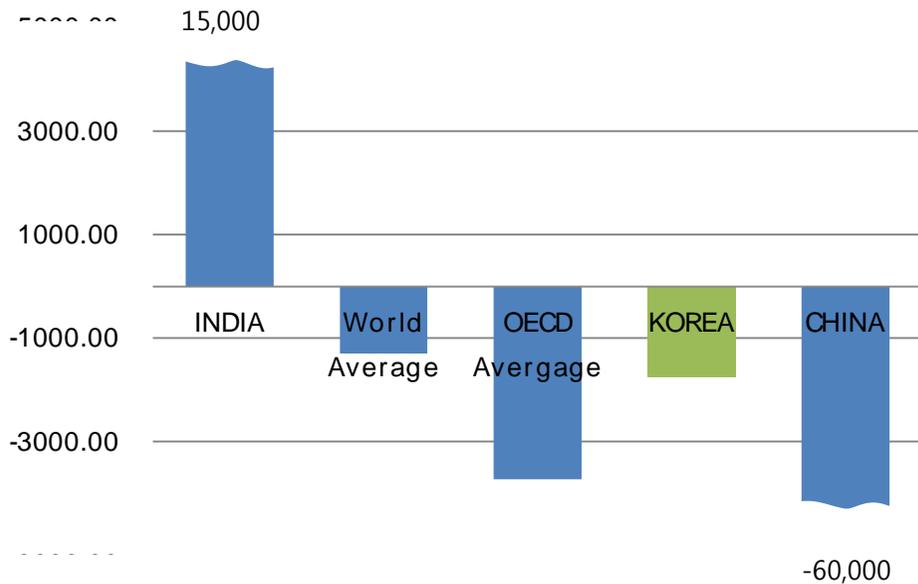


### DECLINE IN BIOLOGICAL RICHNESS

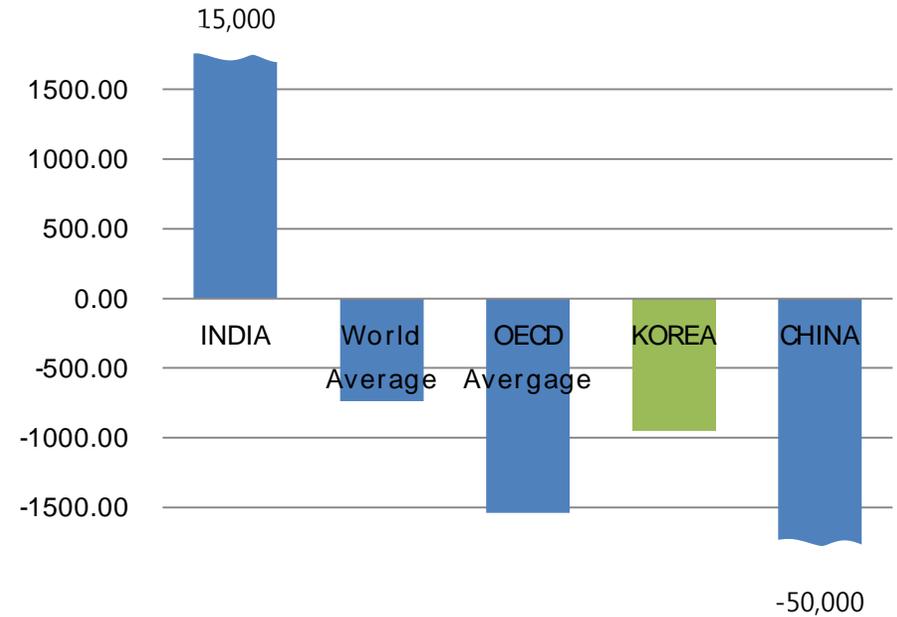


## 4. Socio-economic indicators for national level(energy)

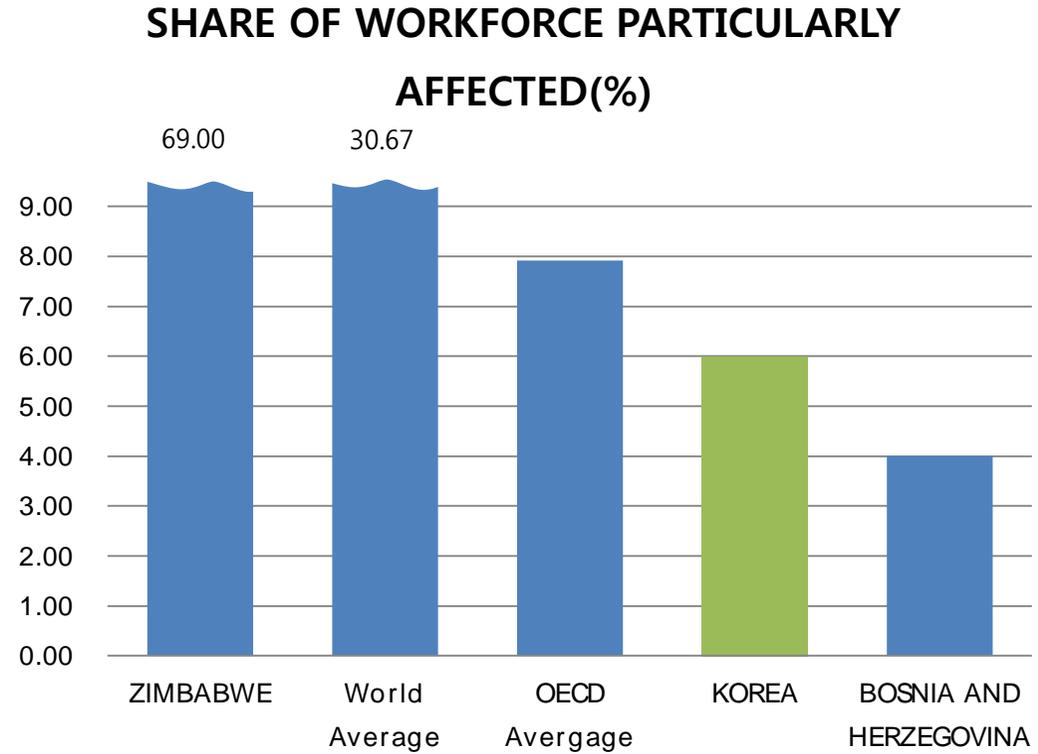
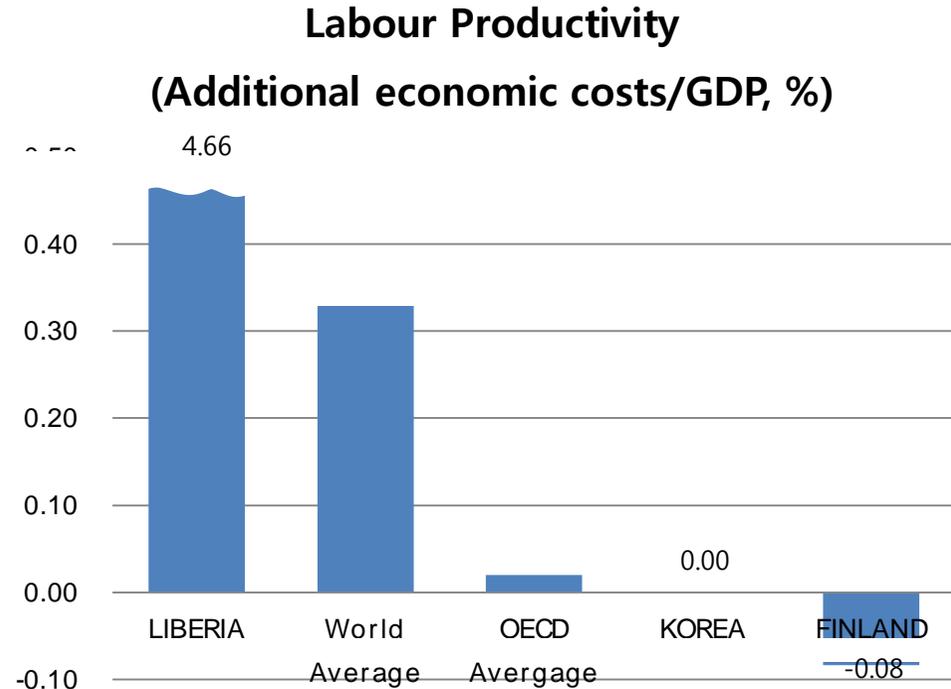
### Change in Energy Load(GWh)



### CO<sub>2</sub> Generated/Reduced(Kt CO<sub>2</sub>)

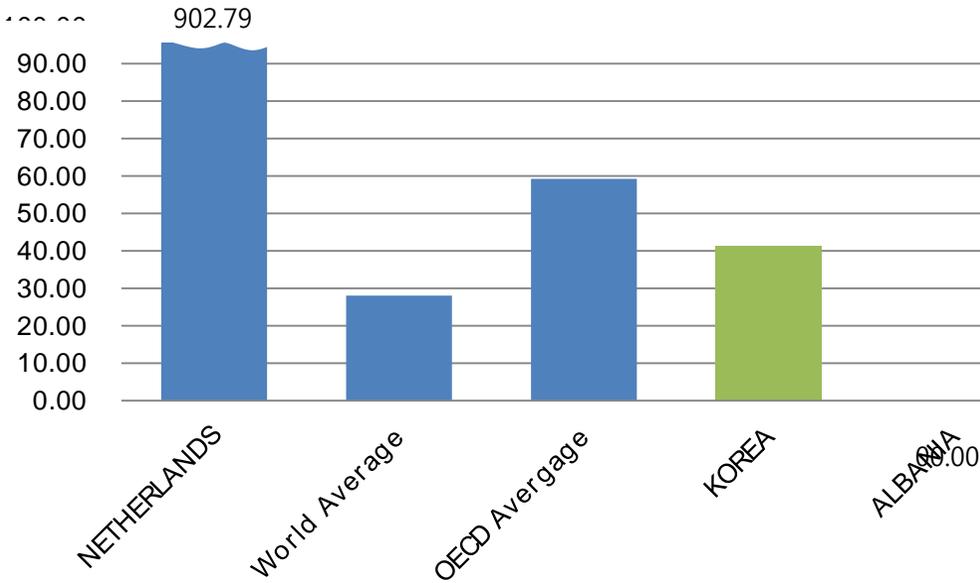


## 4. Socio-economic indicators for national level(labour)

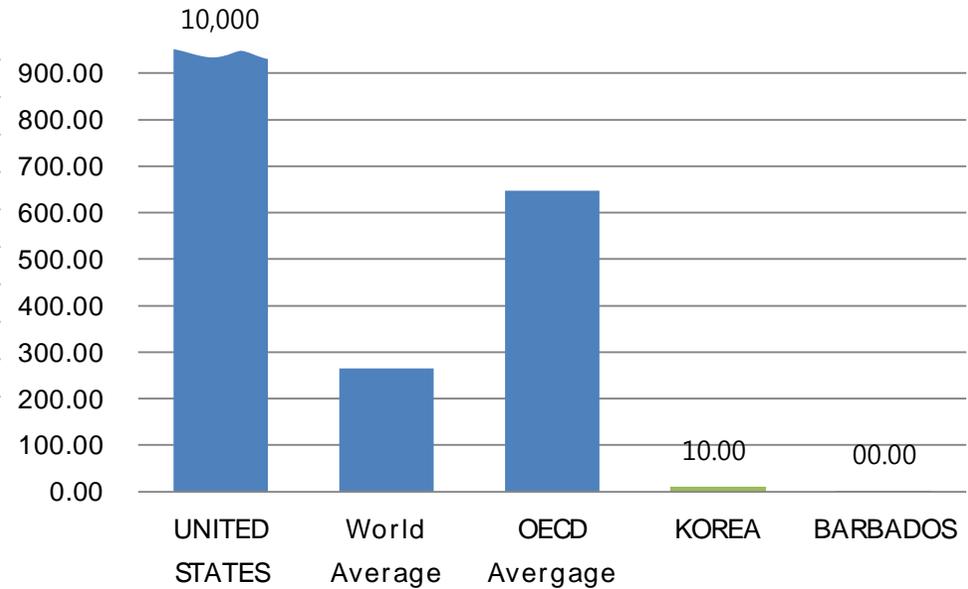


## 4. Socio-economic indicators for national level(sea level rise)

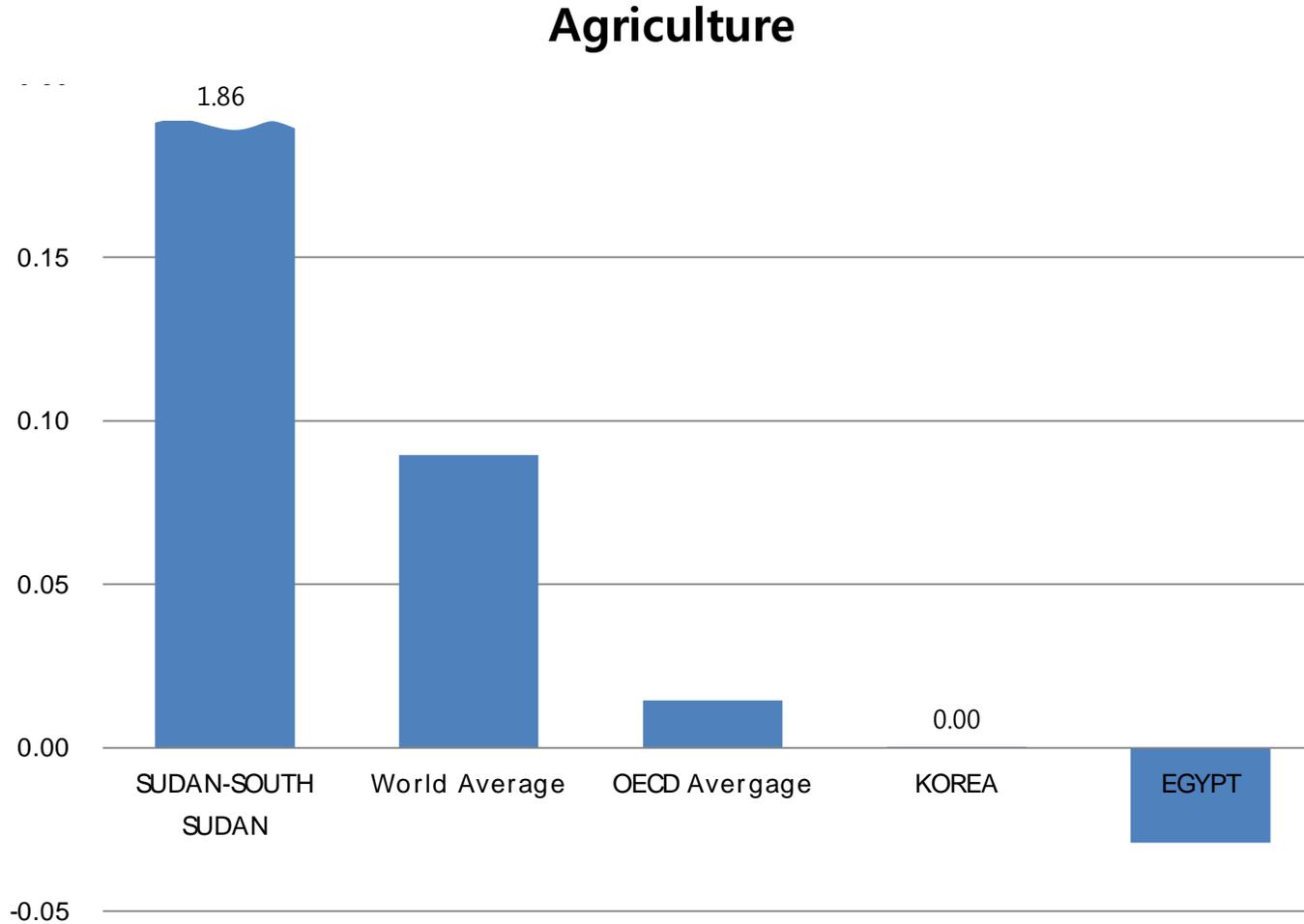
Sea-Level Rise(AFFECTED POPULATION per million)



Sea-Level Rise(Net loss of land, km<sup>2</sup>)



## 4. Socio-economic indicators for national level (agriculture)

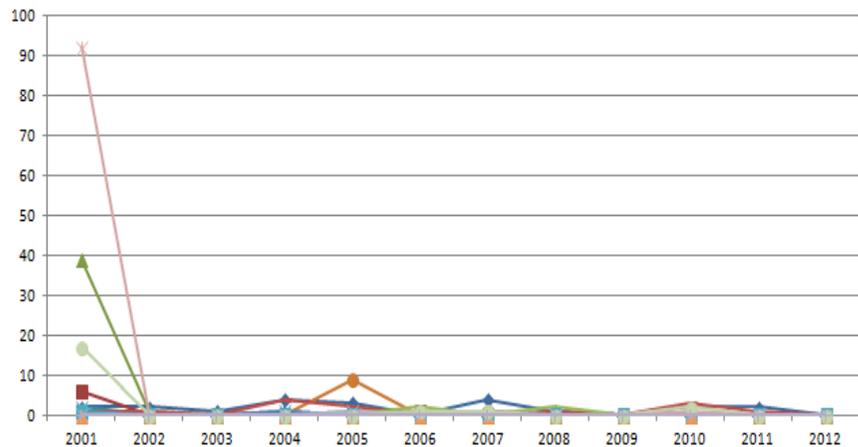


## 5. Socioeconomic indicator statistics in Korea

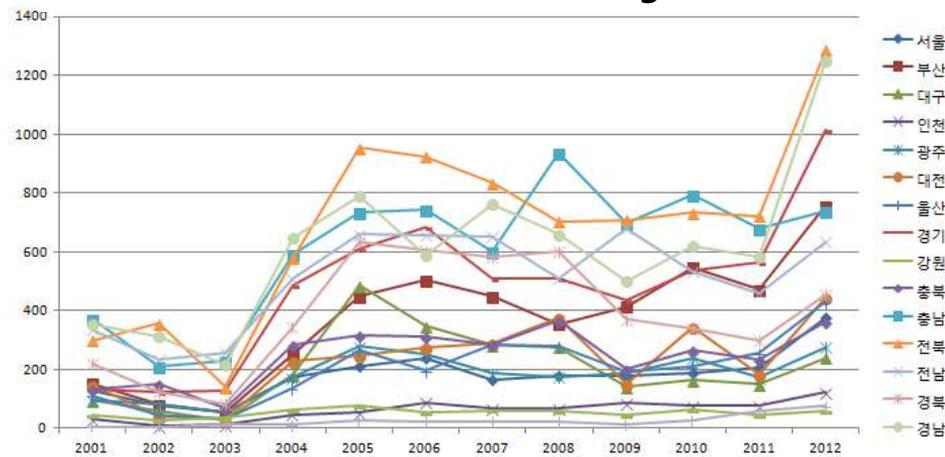
sector	indicator	statistics
health	Cholera, Japanese encephalitis, Scrub Typhus Dengue fever, heat&cold related disease	cdc (2007-2013)
		Cdc (2011-2013)
water	River, waterworks damage	nema (1979-2012)
energy	maximum energy demand	kemco (2004-2013)
transportation	Traffic congestion cost	<a href="http://koti.15440835.com/kor/cate01/page06010403.php">http://koti.15440835.com/kor/cate01/page06010403.php</a>
infrastructure	Damage on Building, roads, bridges, schools, railroads, communication, etc.	nema (1979-2012)
agriculture	Agricultural productivity	kostat (2008-2012)
	Damage on cropland, greenhouse, crop, livestock	
forestry	Forest product	Office of forestry (2001-2012)
	pest	mcst
tourism	# of visitors on beach and ski resort	mcst (2005-2013)
Life loss	# of mortality, morbidity, affected people	nema (2008-2012)

# 5. Socio-economic indicators for sub-national level(health)

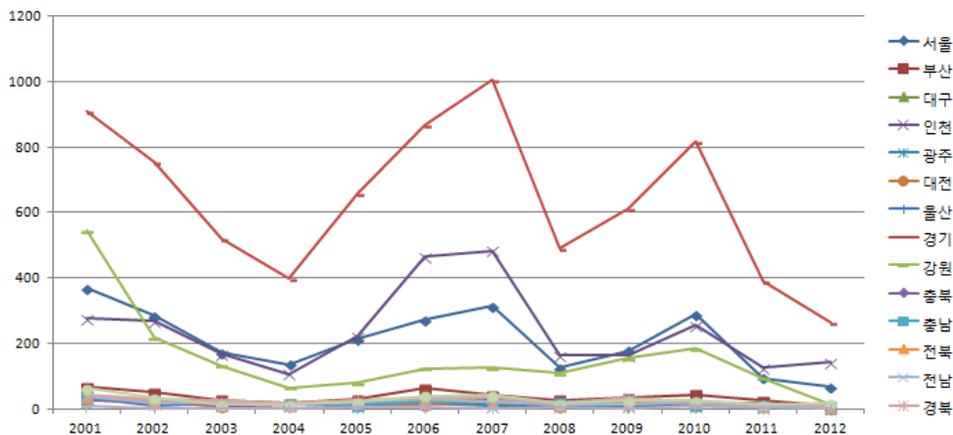
## Number of Patients of Cholera



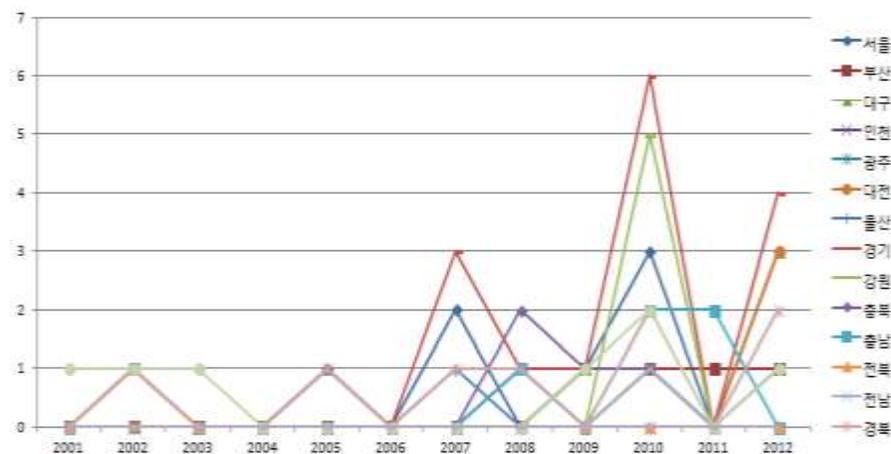
## Number of Patients of Tsutsugamushi



## Number of Patients Malaria

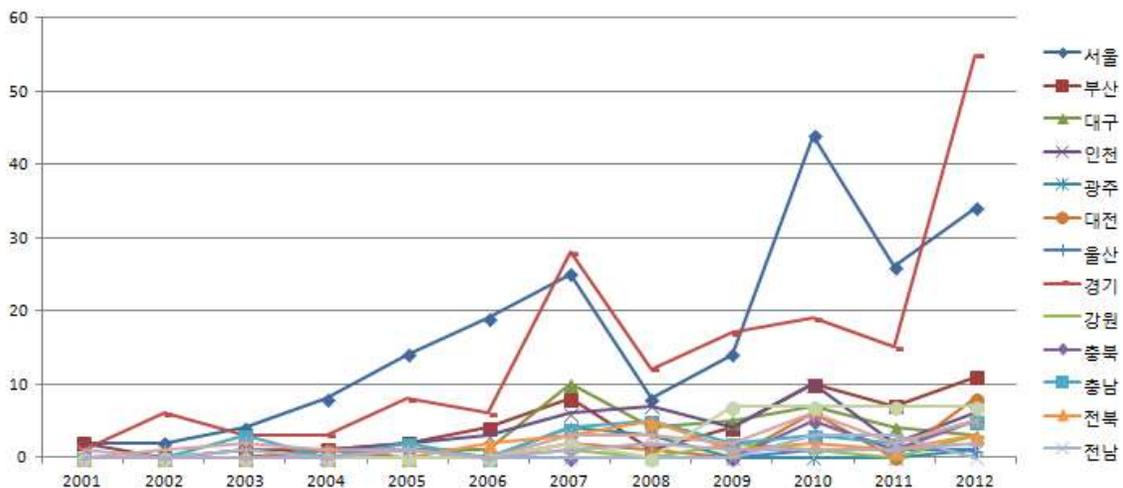


## Number of Patients of Japanese Encephalitis

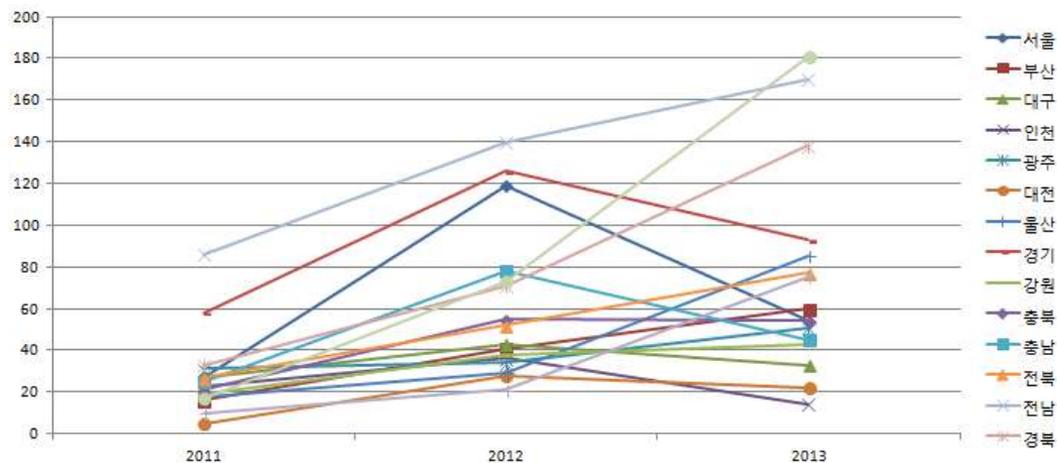


## 5. Socio-economic indicators for sub-national level(health)

### Number of Patients of Dengue

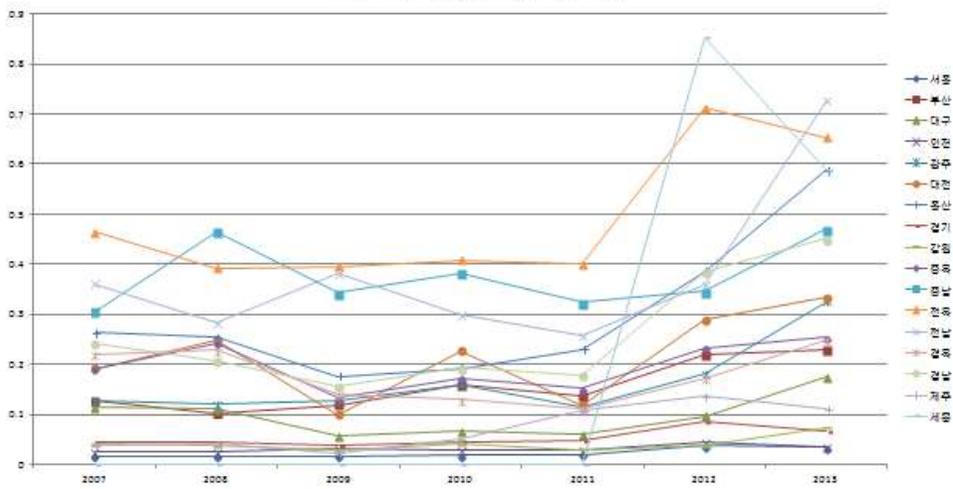


### Number of Patients of Heat Related Illness

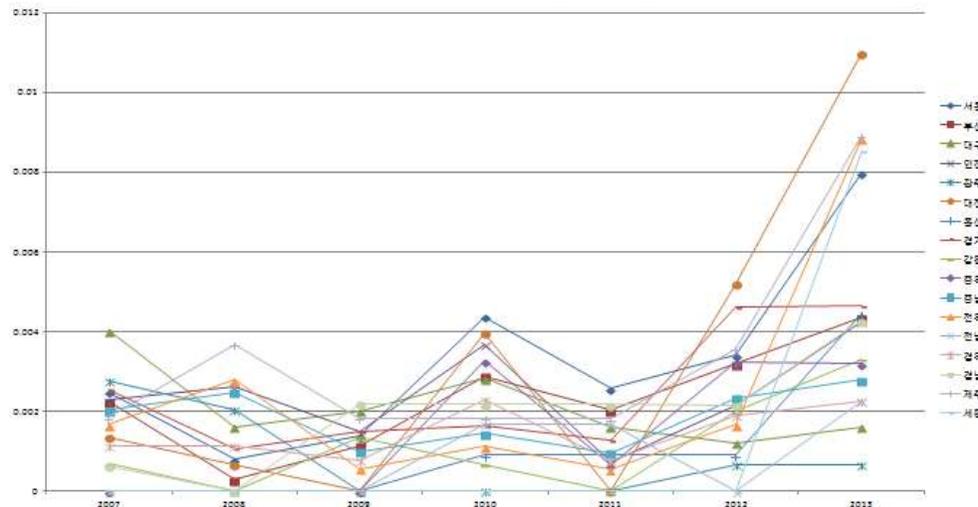


# 5. Socio-economic indicators for sub-national level(health)

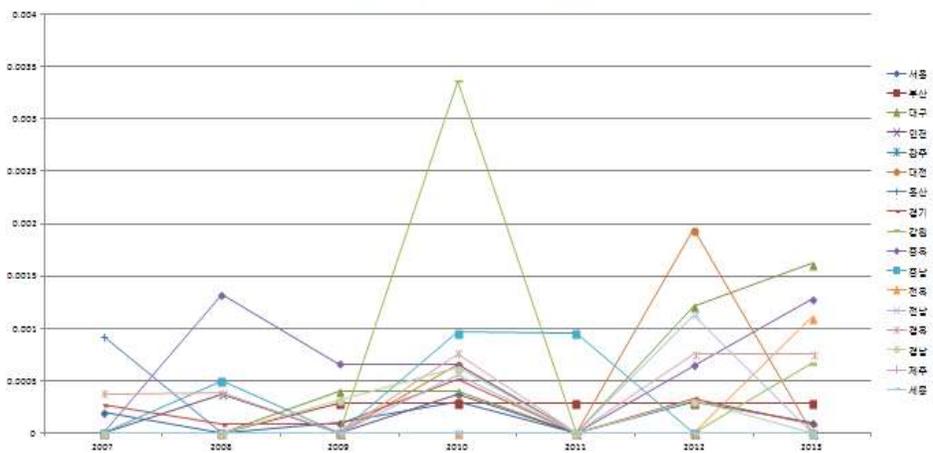
## Mortality Rate of Tsutsugamushi (per 1000)



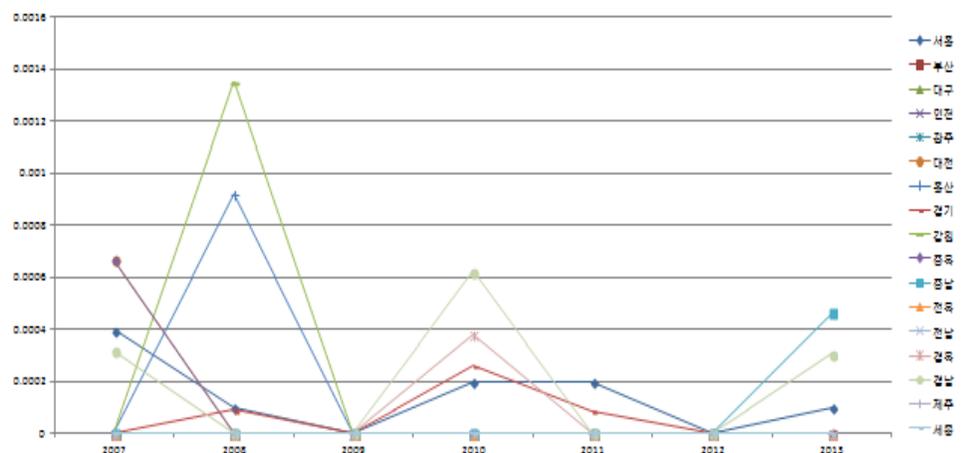
## Mortality Rate of Dengue (per 1000)



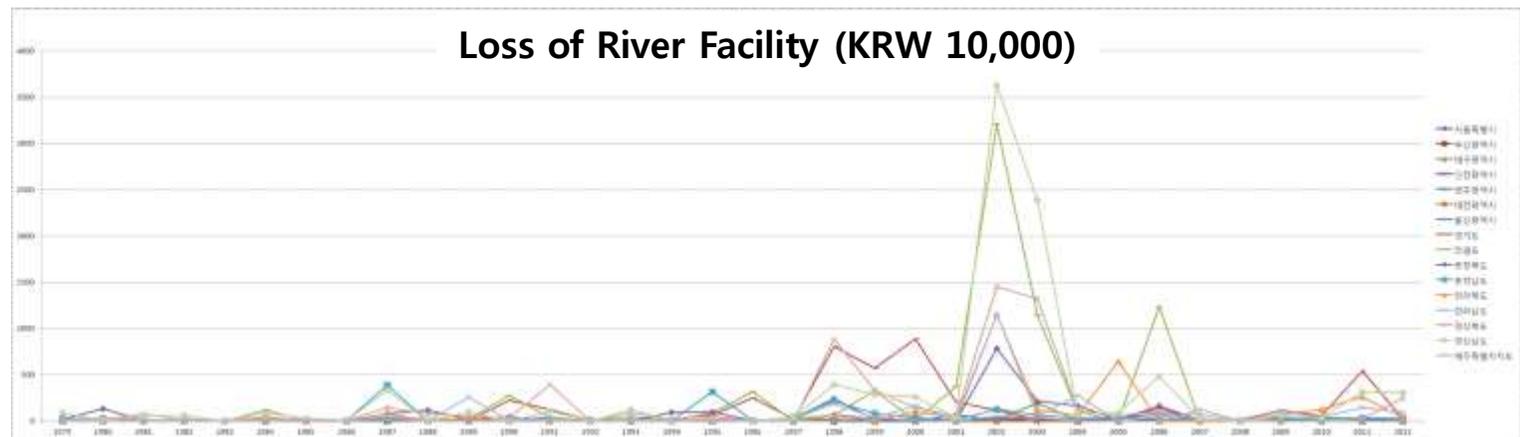
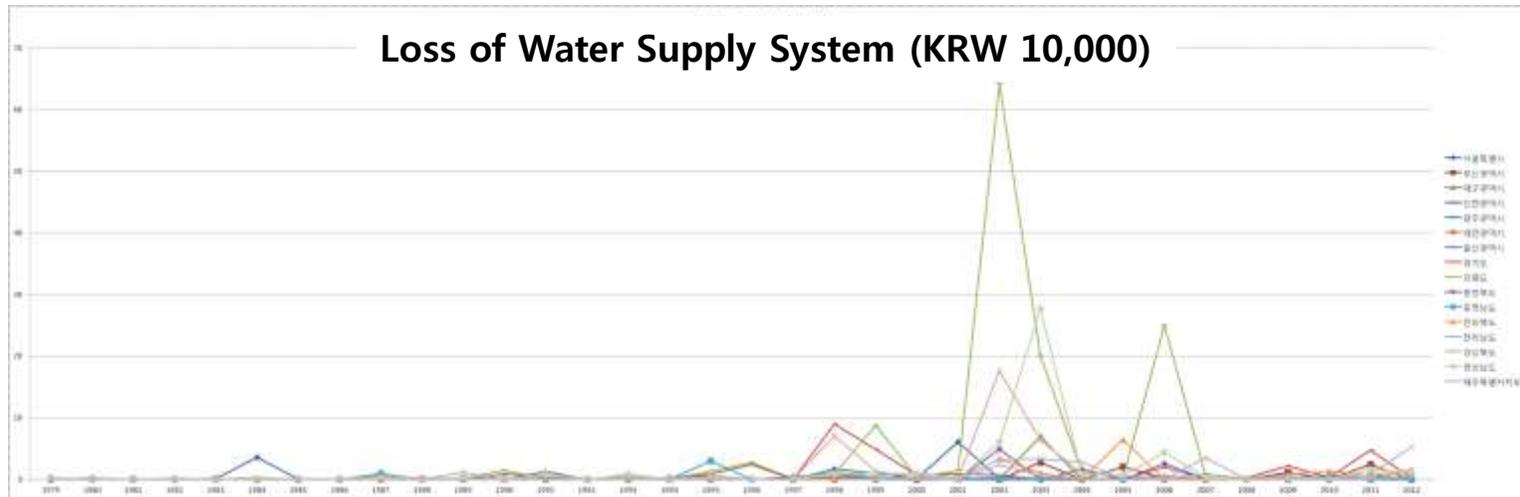
## Mortality Rate of Japanese Encephalitis (per 1000)



## Mortality Rate of Cholera (per 1000)

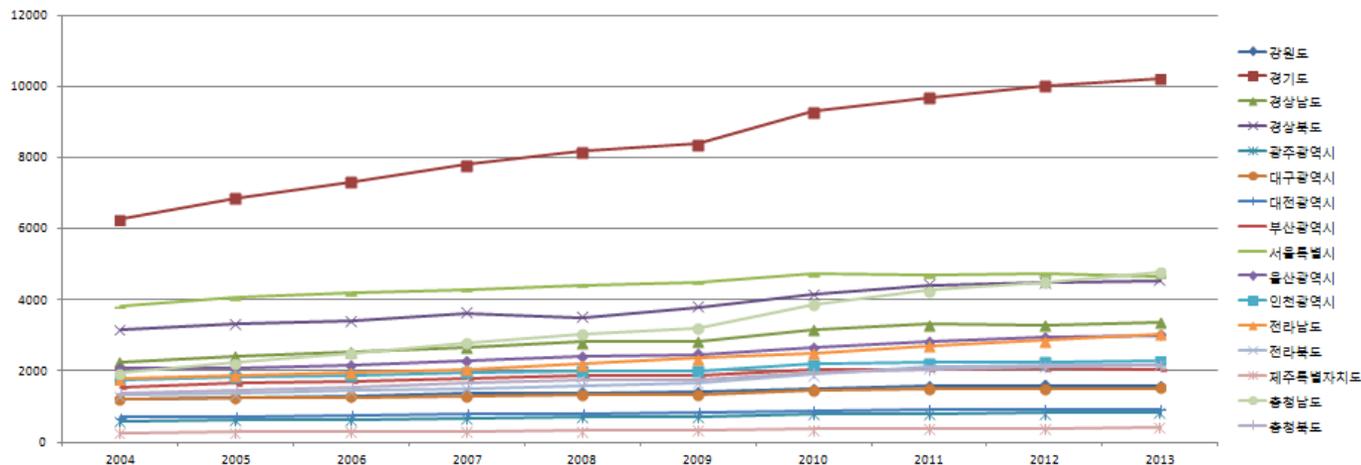


## 5. Socio-economic indicators for sub-national level(water resources)

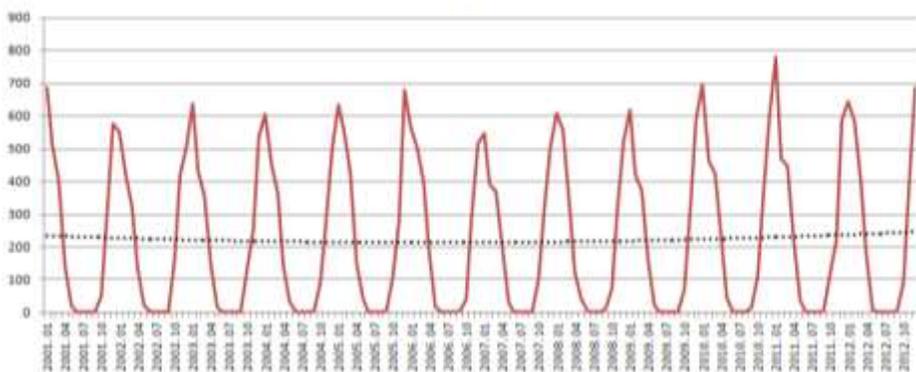


# 5. Socio-economic indicators for sub-national level(energy)

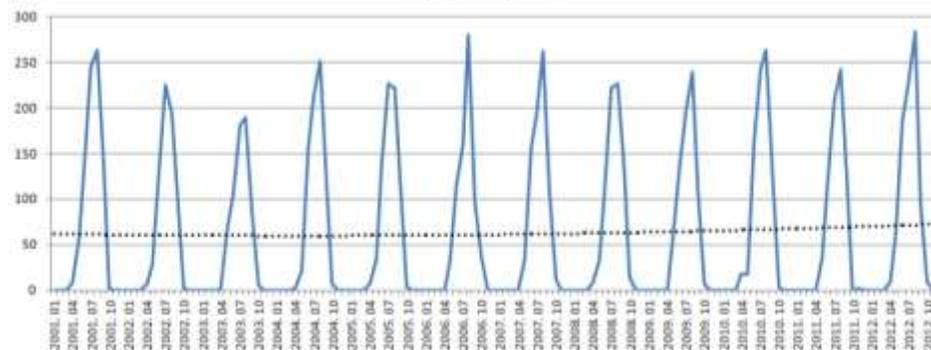
## Maximum Electric Load ( 10,000 KW)



## Heating Degree-Day

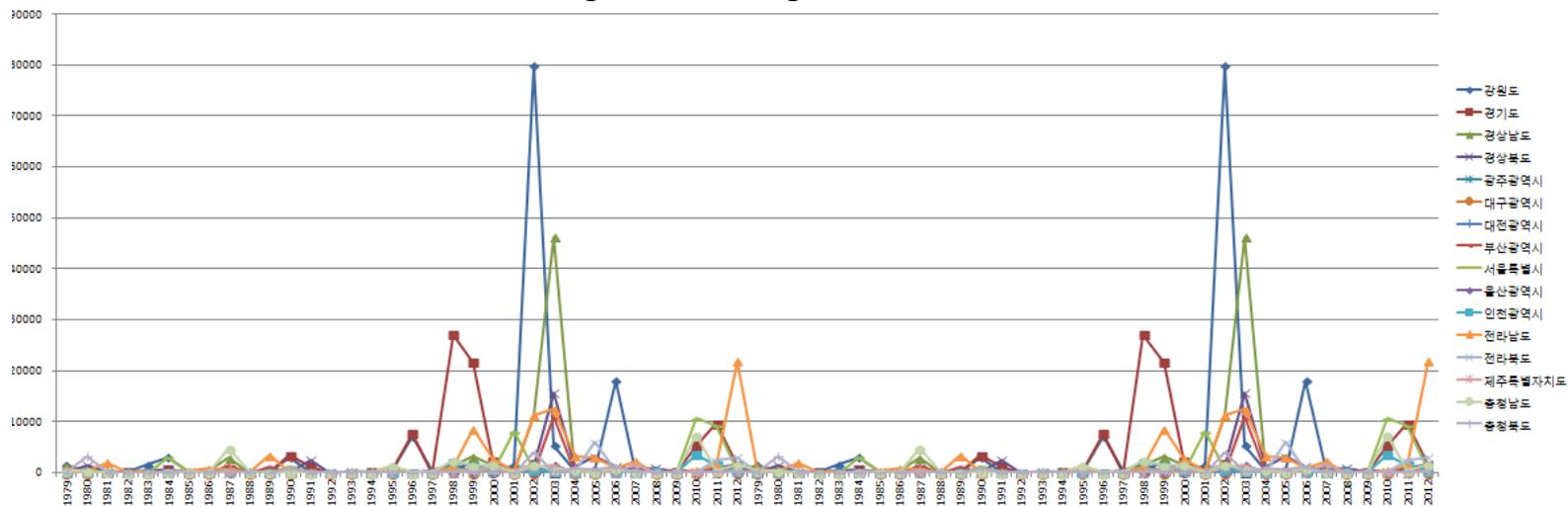


## Cooling Degree-Day

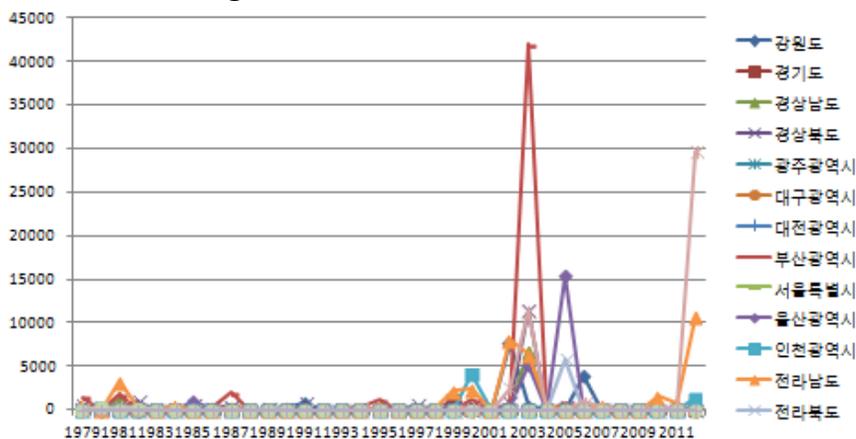


# 5. Socio-economic indicators for sub-national level(infrastructure)

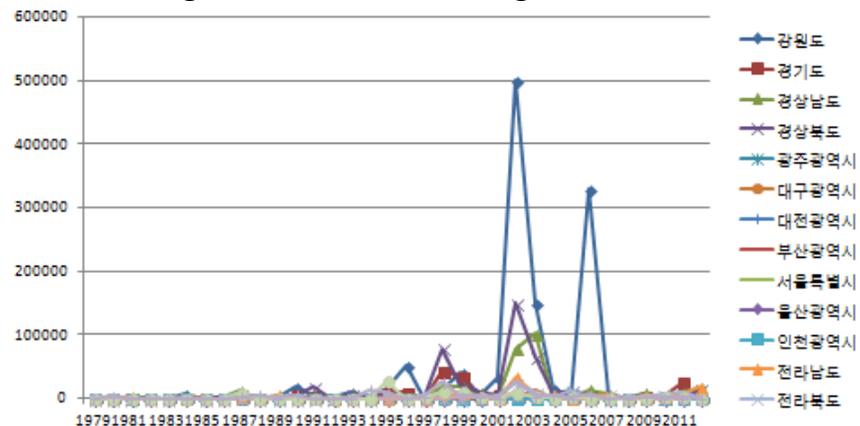
### Damage on Buildings (KRW 1000,000)



### Damage on Harbors (KRW 1000,000)

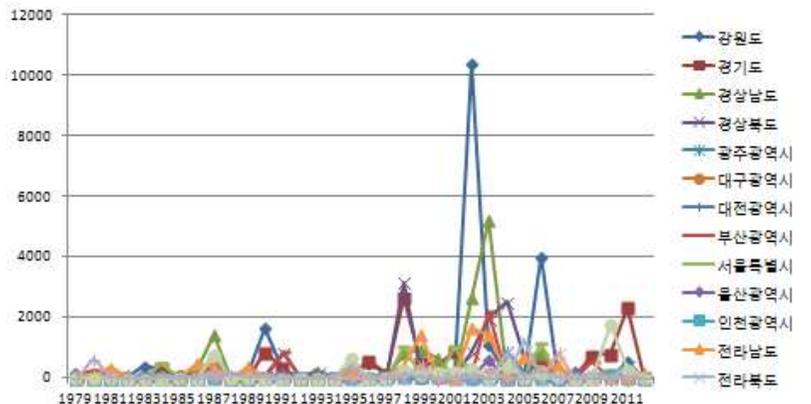


### Damage on Roads and Bridges (KRW 1000,000)

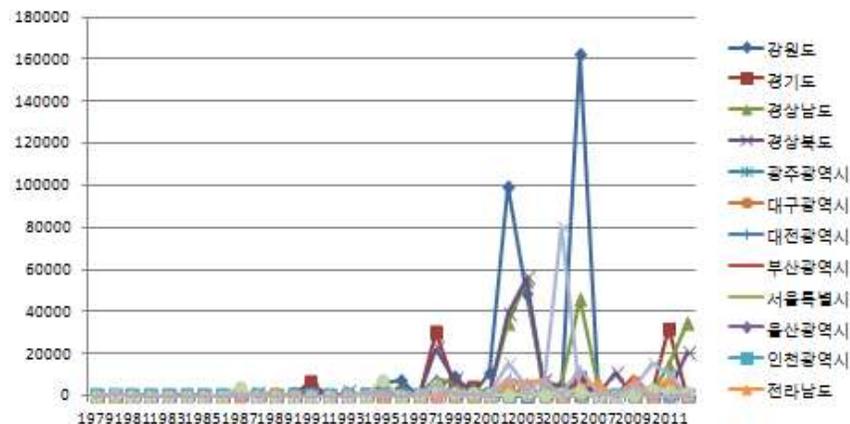


# 5. Socio-economic indicators for sub-national level(infrastructure)

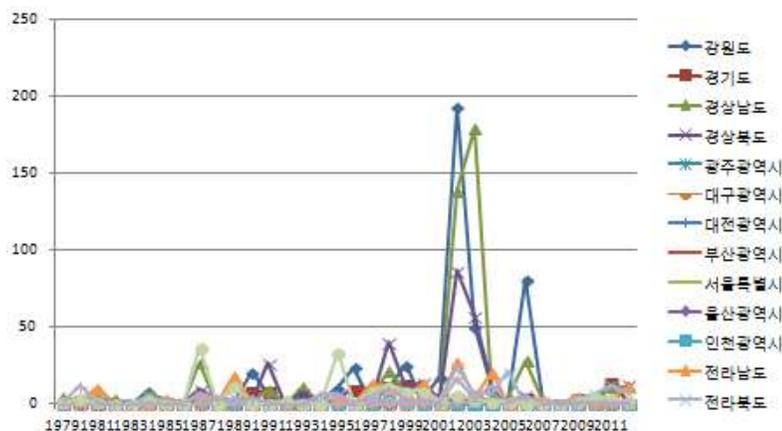
Damage on Schools (KRW 1000,000)



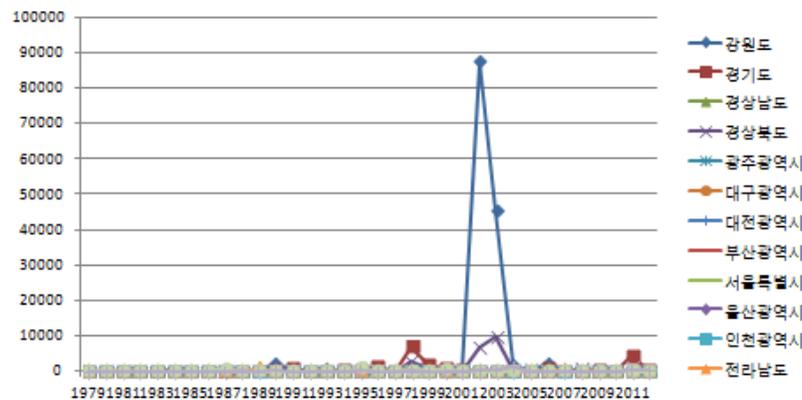
Damage on Forestry Roads (KRW 1000,000)



Damage on Irrigation Facilities(KRW 1000,000)

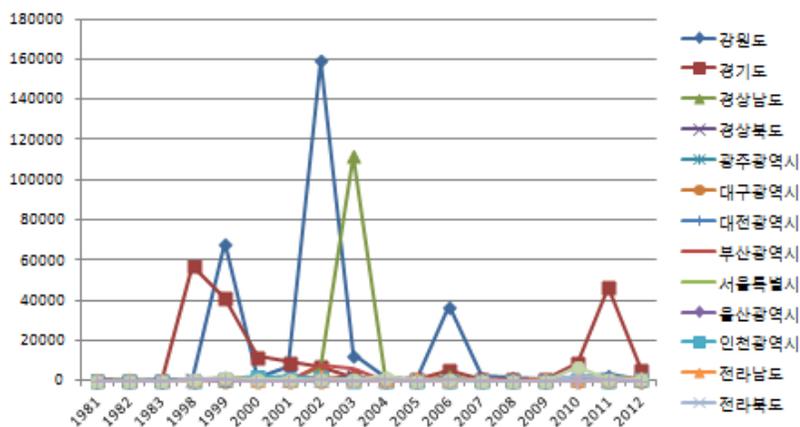


Damage on Railways (KRW 1000,000)

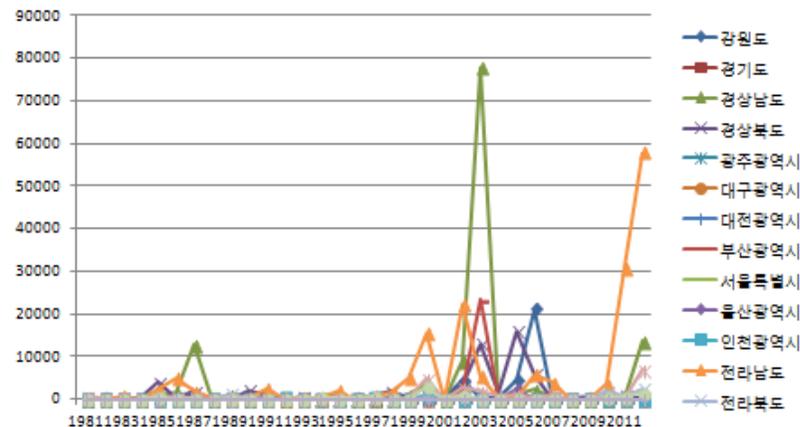


# 5. Socio-economic indicators for sub-national level(infrastructure)

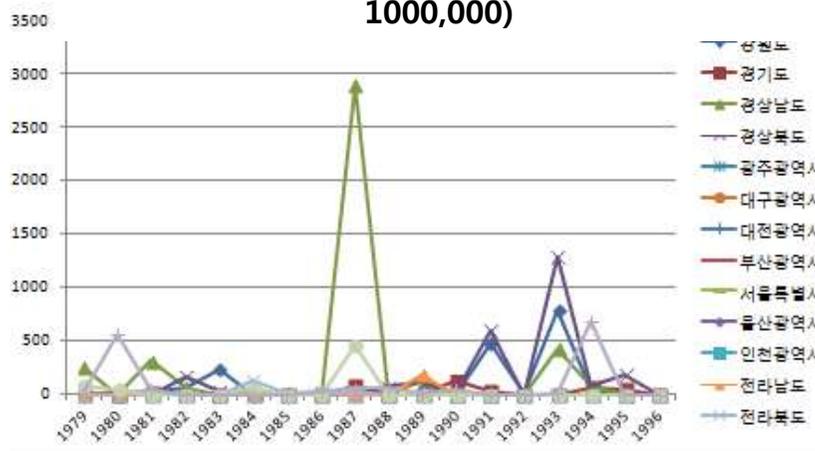
Damage on Military Facilities (KRW 1000,000)



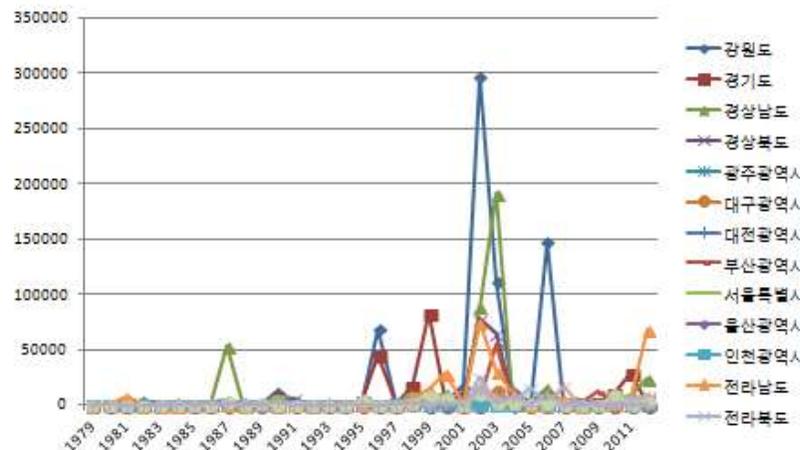
Damage on Fishing Ports (KRW 1000,000)



Damage on Forestation Facilities (KRW 1000,000)

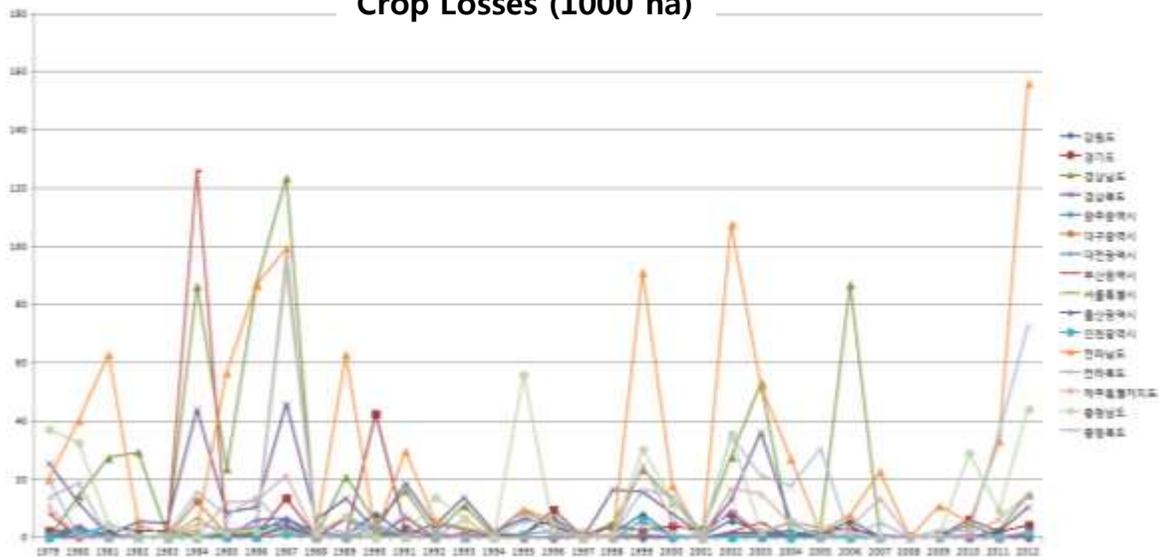


Damage on other Facilities (KRW 1000,000)

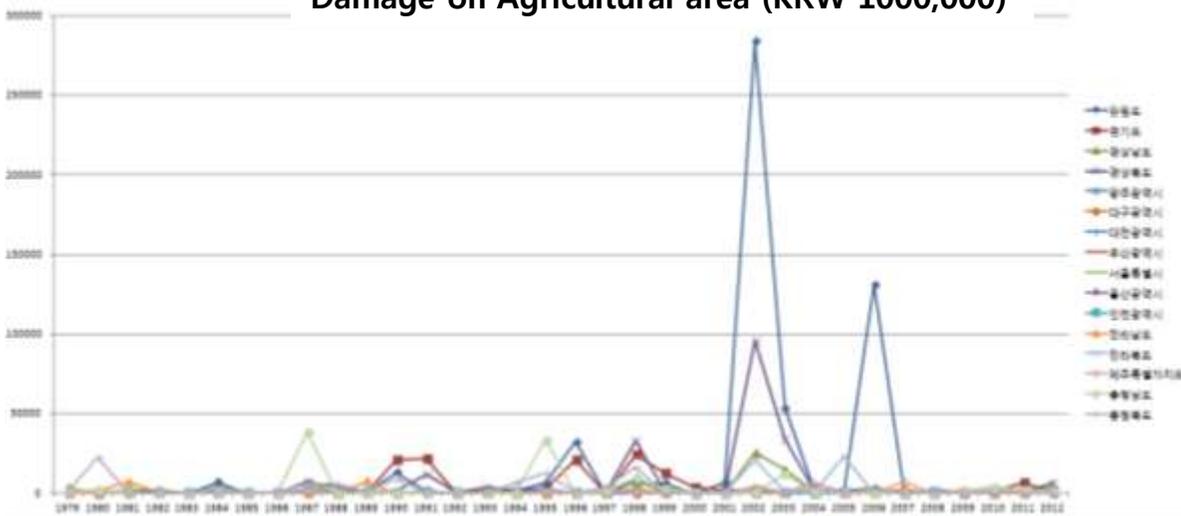


# 5. Socio-economic indicators for sub-national level(agriculture)

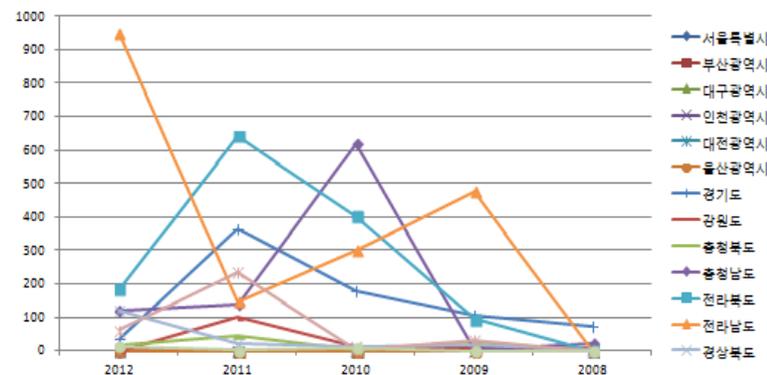
Crop Losses (1000 ha)



Damage on Agricultural area (KRW 1000,000)

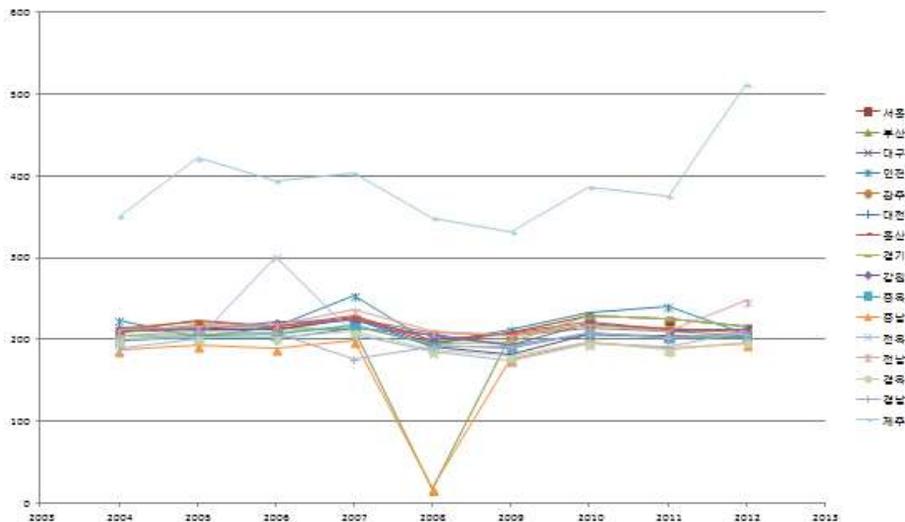


Livestock Death ( KRW 1000,000)

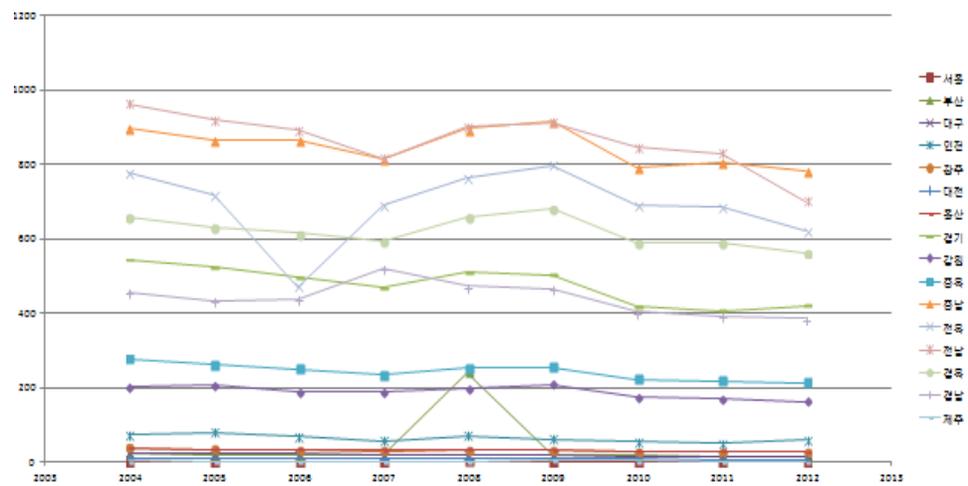


# 5. Socio-economic indicators for sub-national level(agriculture)

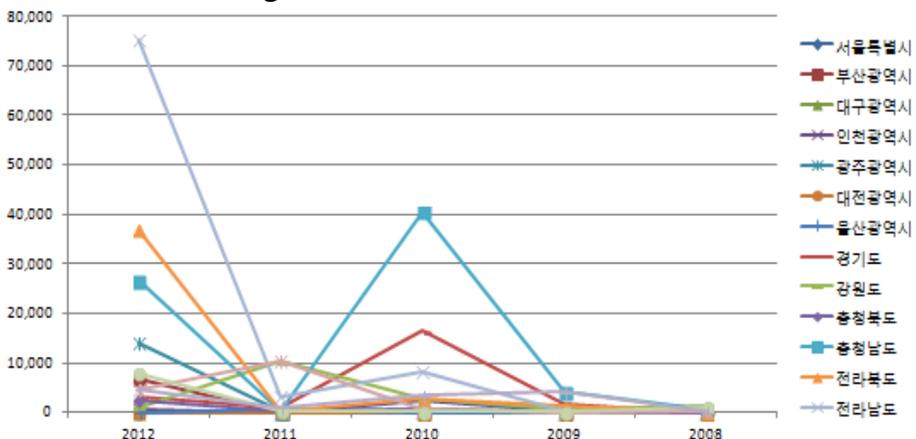
Gross Product of Crop (per Crop Area)



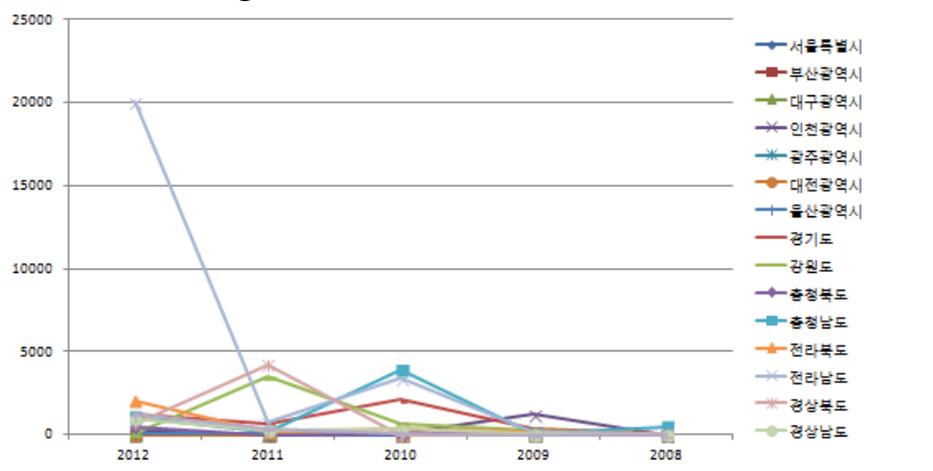
Gross Product of Crop (per 1,000 tons)



Damage on Green Houses (KRW 1000,000)

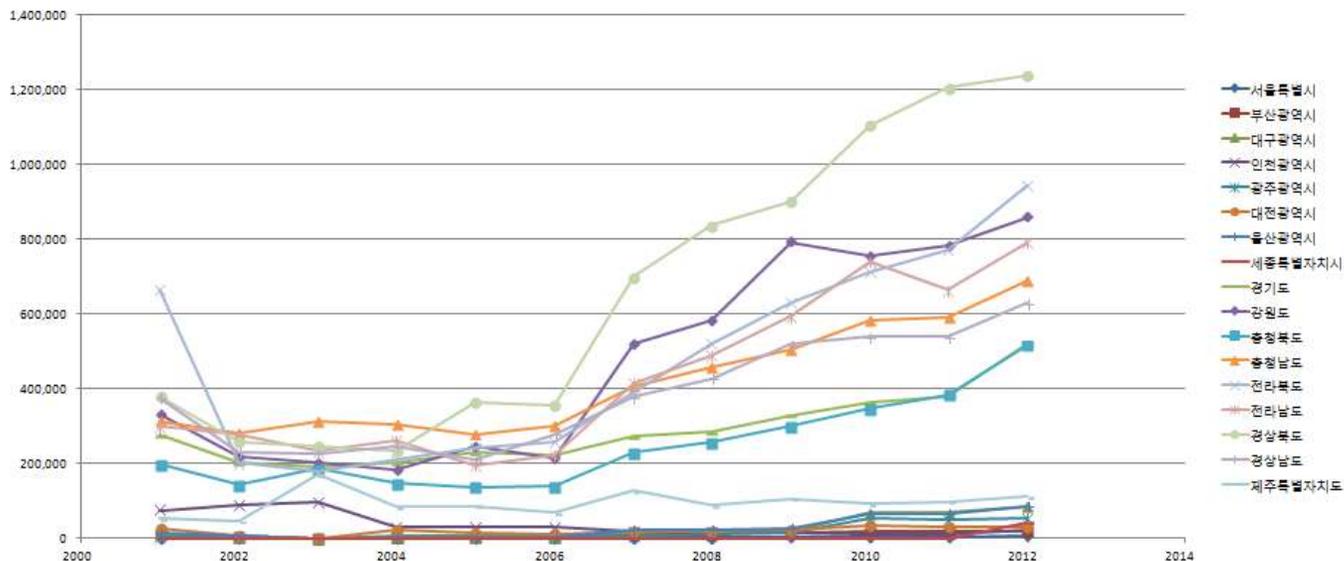


Damage on Livestock Sheds (KRW 1000,000)

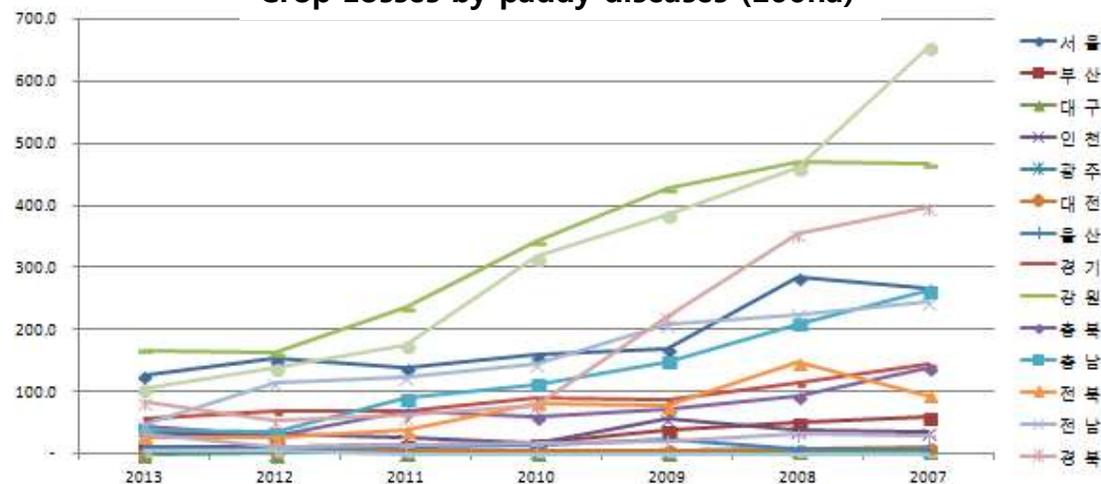


# 5. Socio-economic indicators for sub-national level(forestry)

Gross Product of Forest Products (KRW 1000,000)

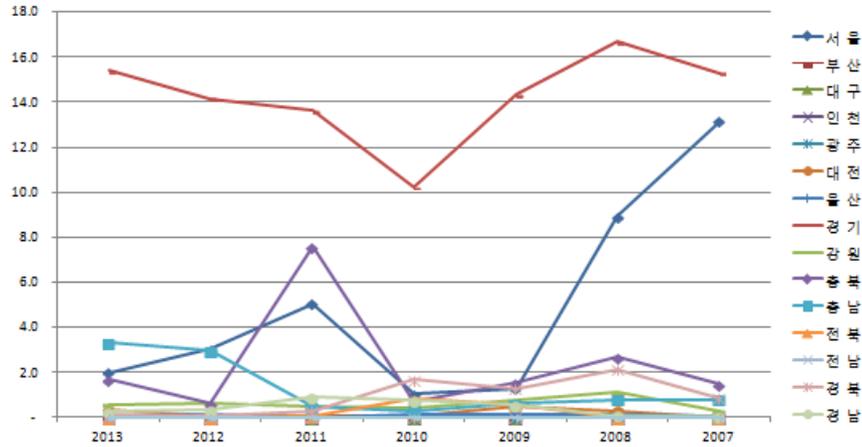


Crop Losses by paddy diseases (100ha)

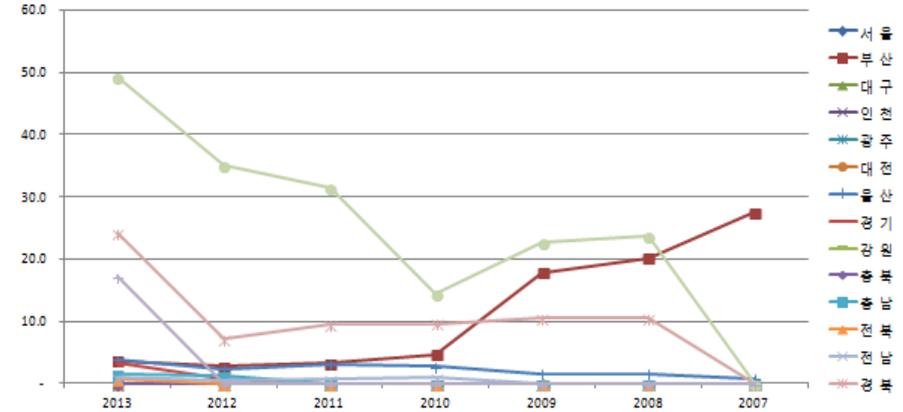


# 5. Socio-economic indicators for sub-national level(forestry)

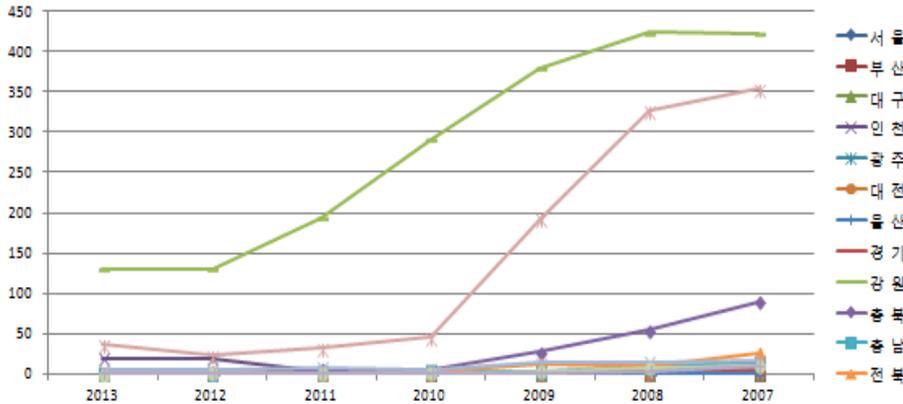
Cases of Oak Wilt (100ha)



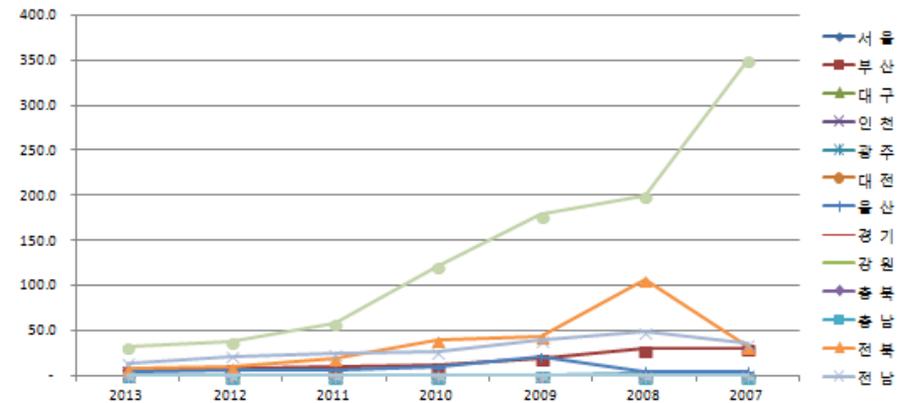
Cases of Pine wilt disease (100ha)



Cases of Pine Midge Pest (100ha)

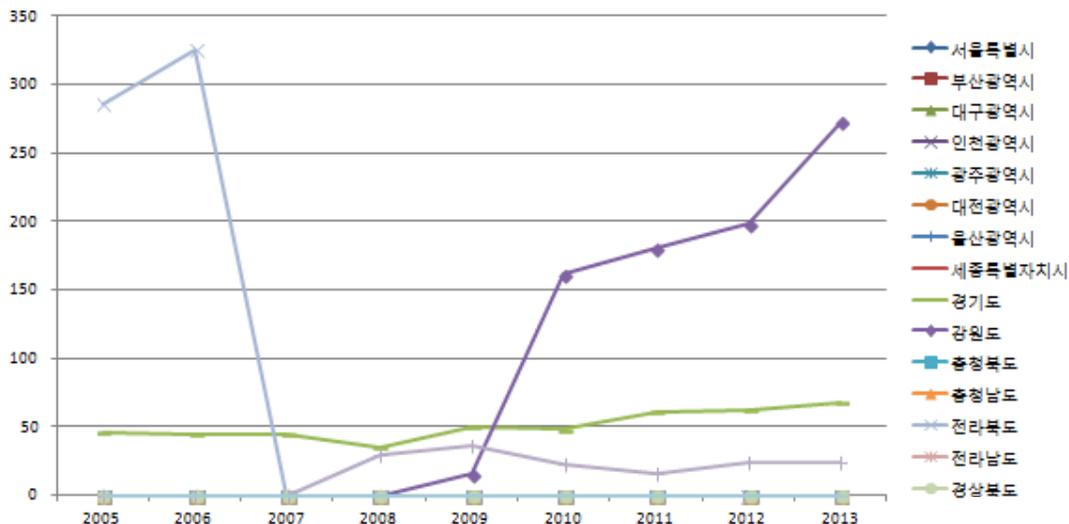


Cases of Matsucoccus Thunbergianae (100ha)

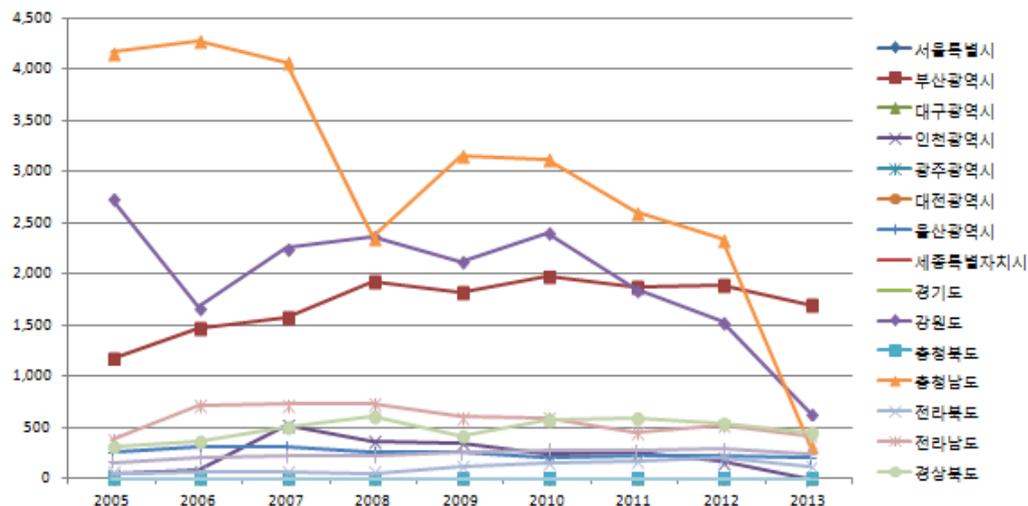


## 5. Socio-economic indicators for sub-national level(tourism)

Number of Ski Resort visitors (10,000)

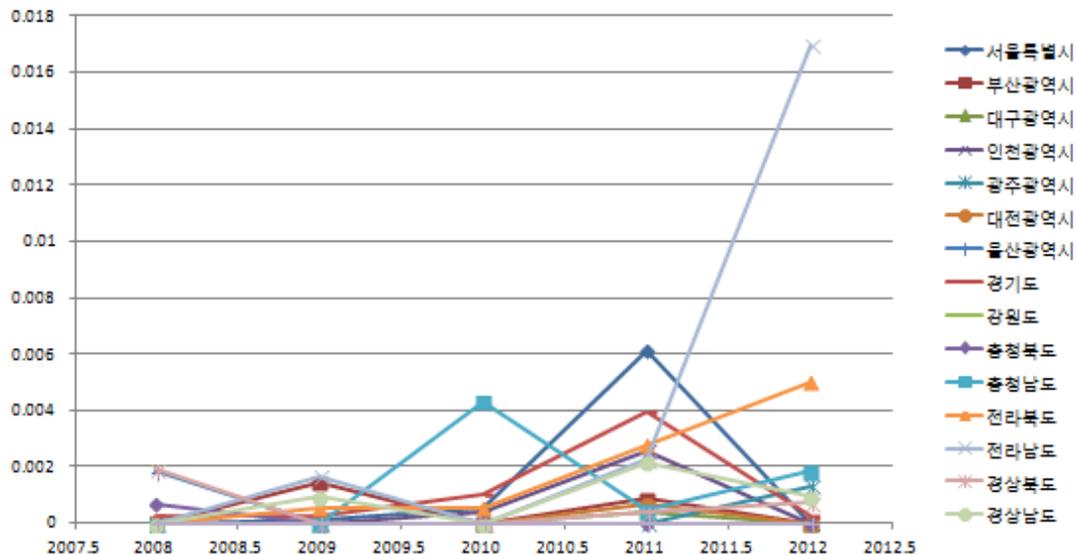


Number of Beach visitors (10,000)

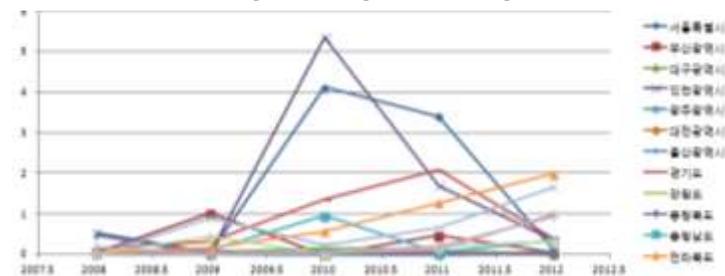


# 5. Socio-economic indicators for sub-national level(life loss)

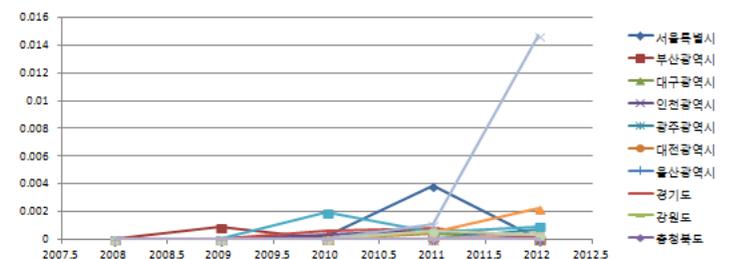
### Number of Disaster Victims (per 1,000)



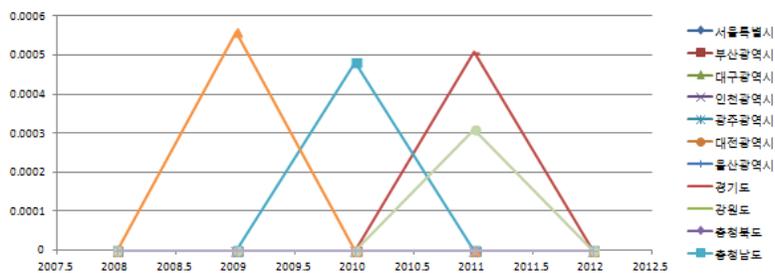
### Number of displaced persons (per 1,000)



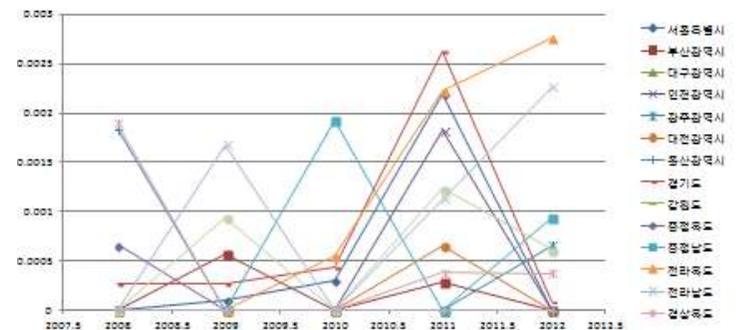
### Number of Injured persons(per 1,000)



### Number of Missing Persons (per 1,000)



### Number of Mortality (per 1,000)



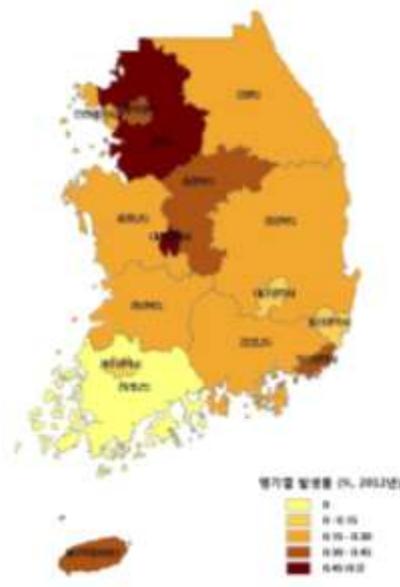
## 6. Regional distribution of health impacts



Number of Patients of Dengue Fever, 2013



Number of Patients of Japanese Encephalitis, 2013



Infection Rates of Dengue Fever, 2012



Infection Rates of Japanese Encephalitis, 2012

# 6. Regional distribution of health impacts

Number of Patients of Heat Related Illness, 2013



Number of Patients of Tsutsugamushi, 2013



Infection Rates of Malaria, 2012

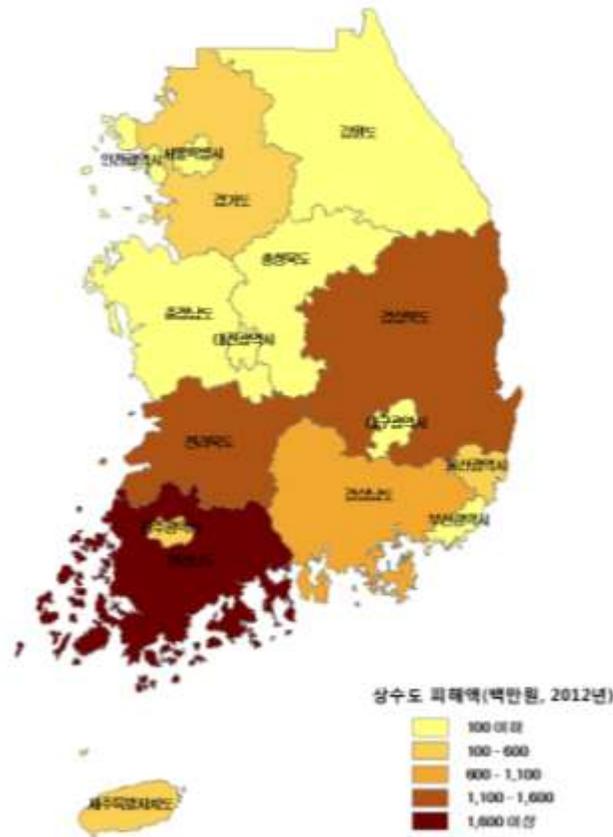


Infection Rates of tsutsugamushi, 2012



Infection Rates of Cholera, 2013

## 6. Regional distribution of water impacts

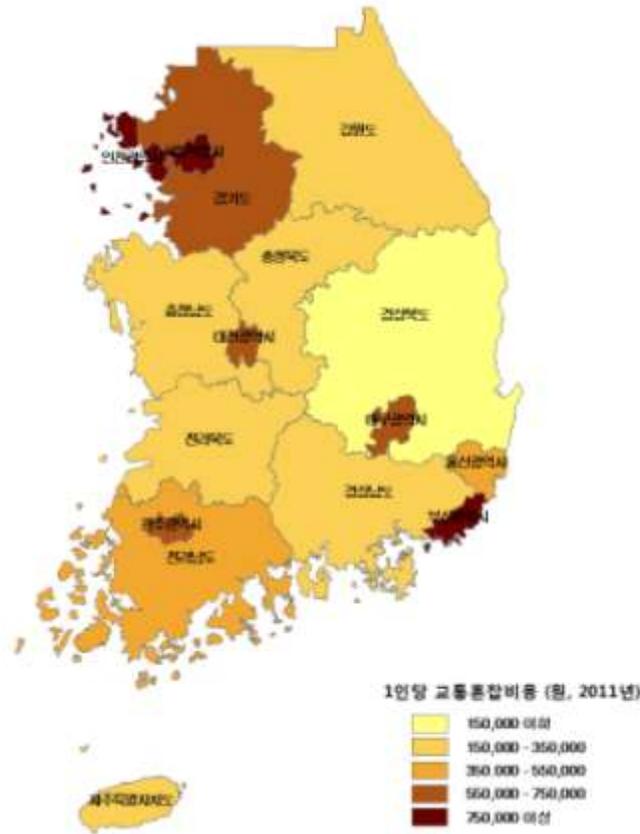


Loss of Water Supply System,  
2012

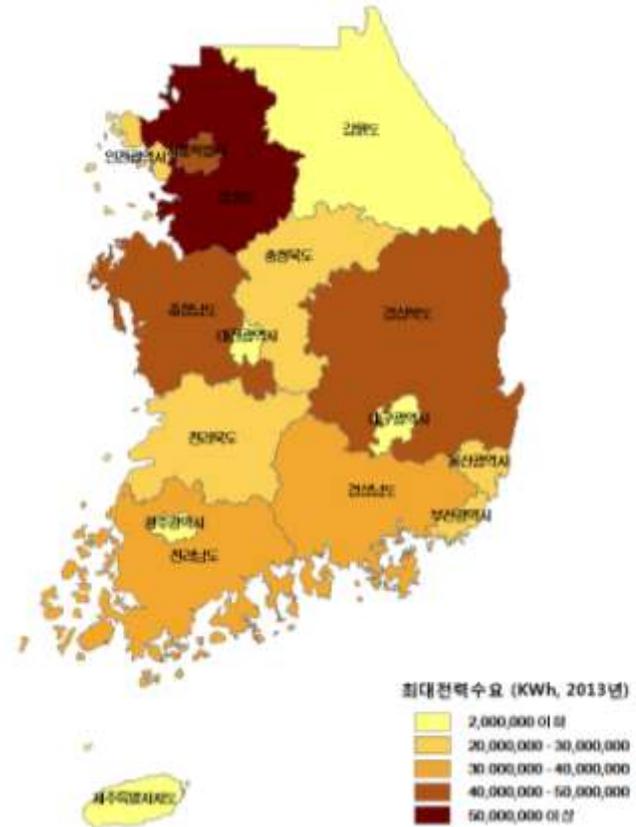


Loss of River Facility, 2012

## 6. Regional distribution of transportation and energy impacts



Traffic Congestion Costs per Capita, 2012

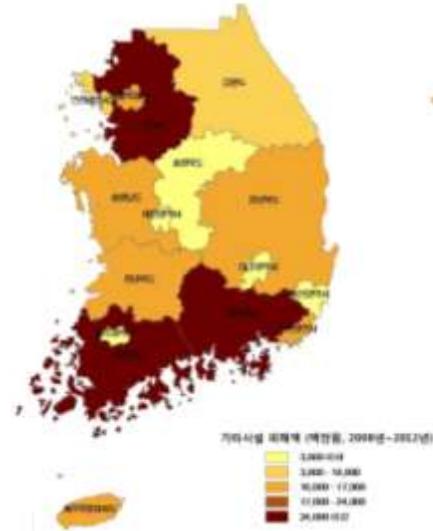


Maximum Electric Load, 2013

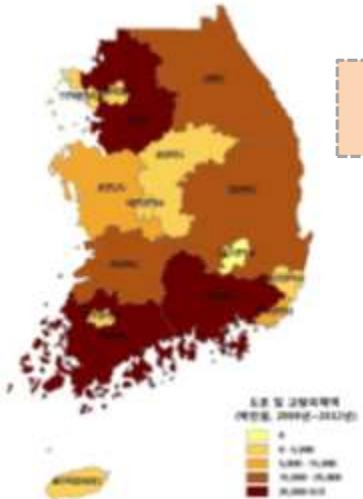
# 6. Regional distribution of infrastructure impacts



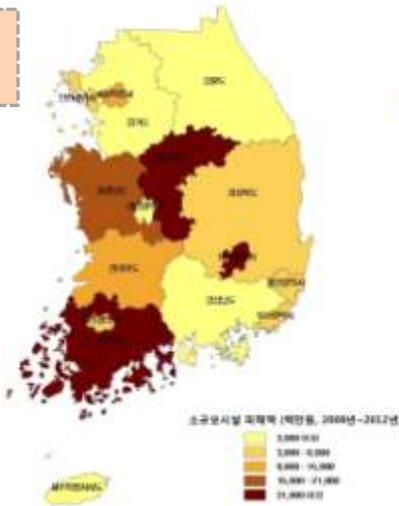
Loss of Military Facilities('08~'12)



Loss of other Facilities('08~'12)



Loss of Transportation Infrastructures ('08~'12)



Loss of Small-scaled Facilities('08~'12)



Loss of Forest-roads('08~'12)

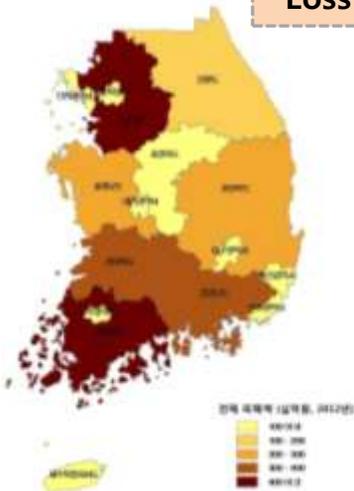
## 6. Regional distribution of infrastructure impacts



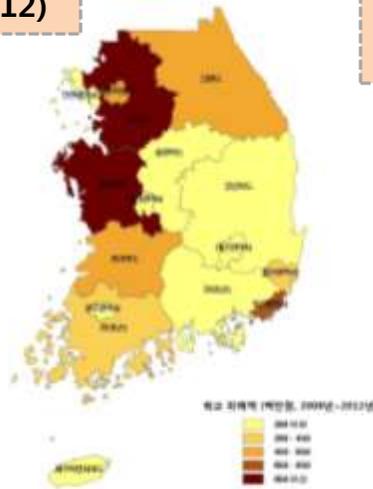
Loss of Fishing Ports ('08~'12)



Loss of Irrigation Facilities('08~'12)



Loss of Total Facilities('08~'12)

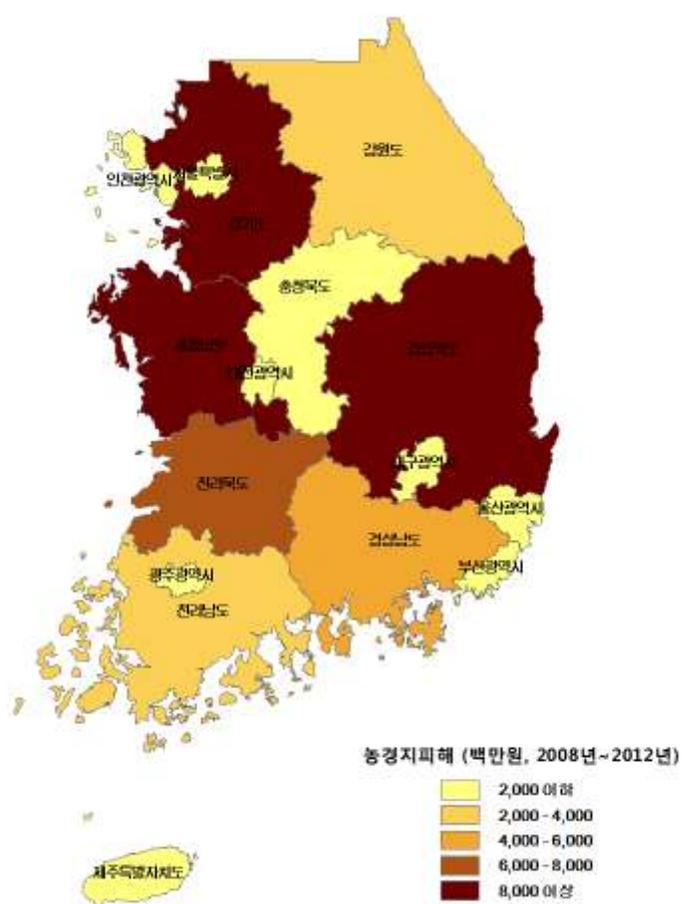


Loss of School Facilities('08~'12)

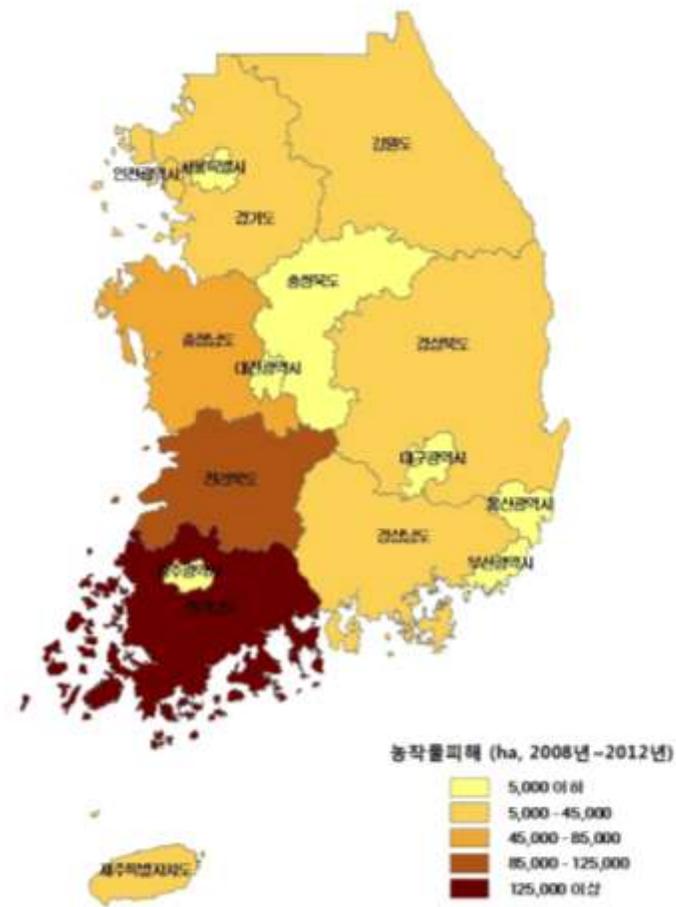


Loss of Railway Facilities('08~'12)

## 6. Regional distribution of agriculture impacts

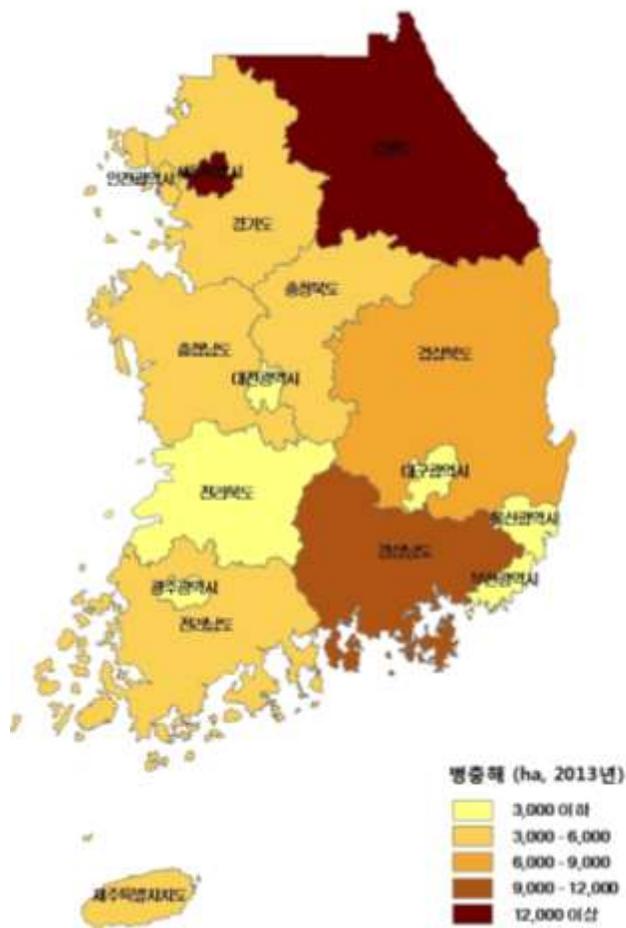


Loss of Agricultural area('08~'12)

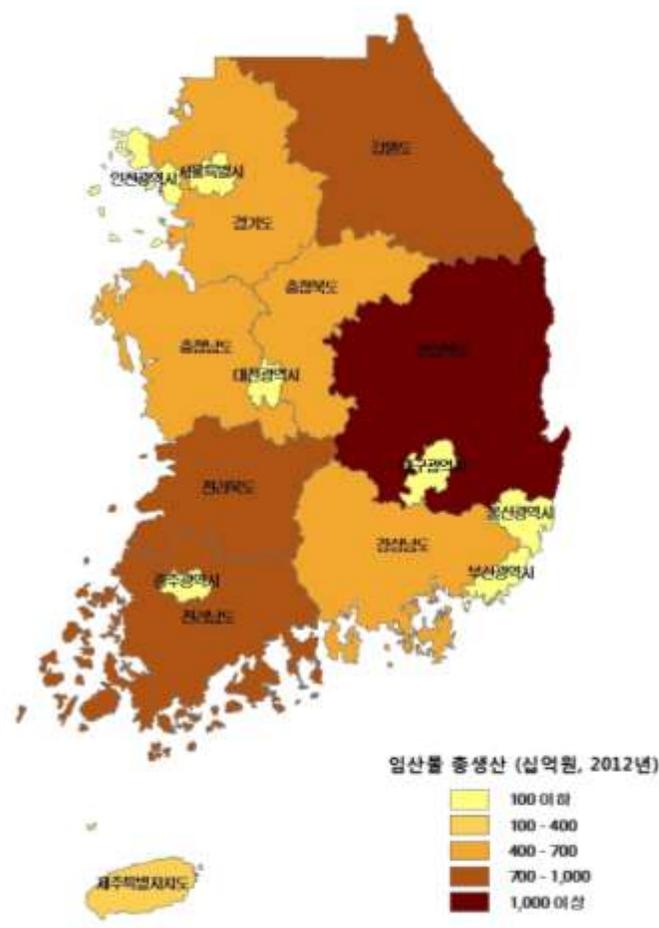


Crop Losses('08~'12)

## 6. Regional distribution of forestry impacts



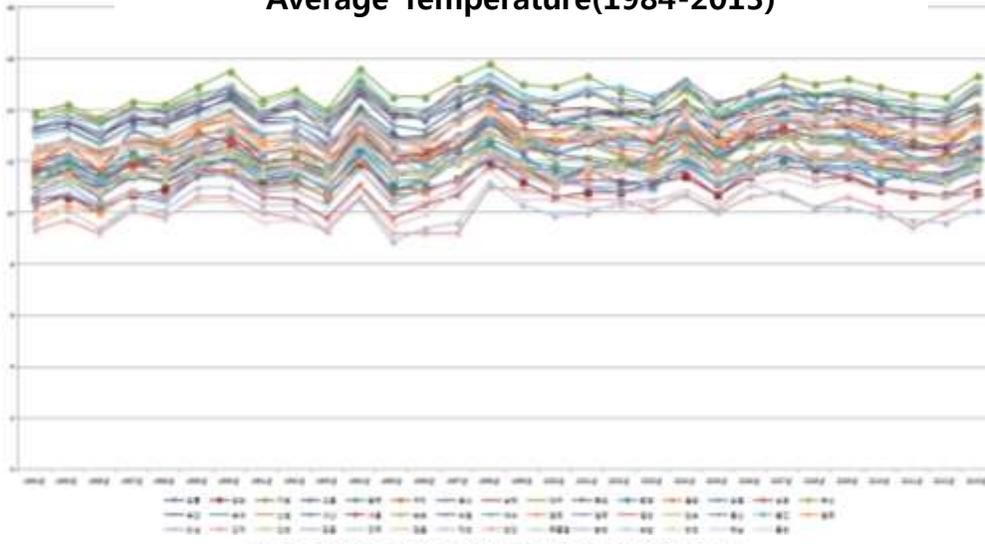
Crop Losses by paddy diseases(2013)



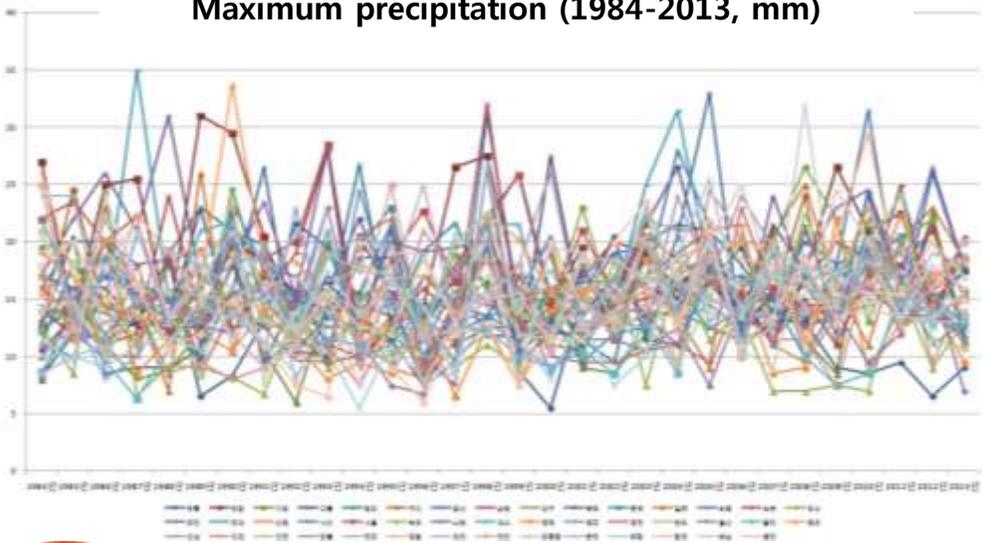
Gross Product of forest products(2012)

# 7. Climate indicator

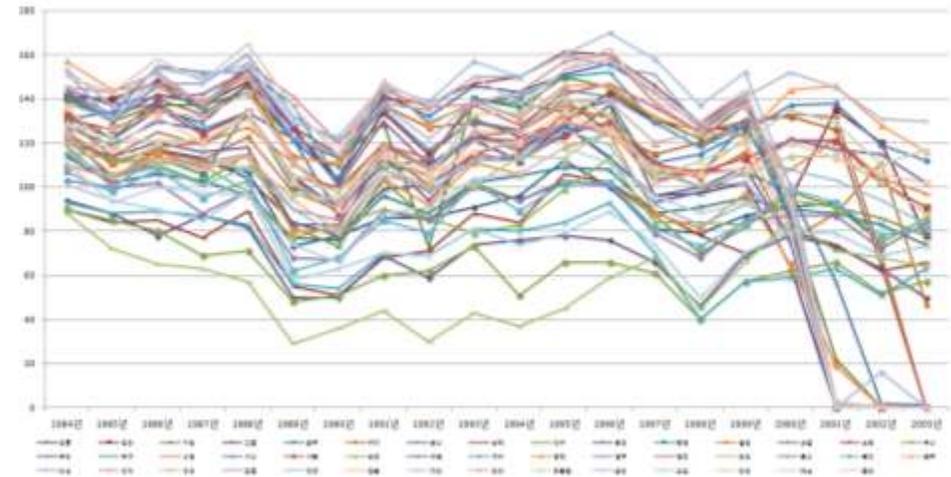
Average Temperature(1984-2013)



Maximum precipitation (1984-2013, mm)

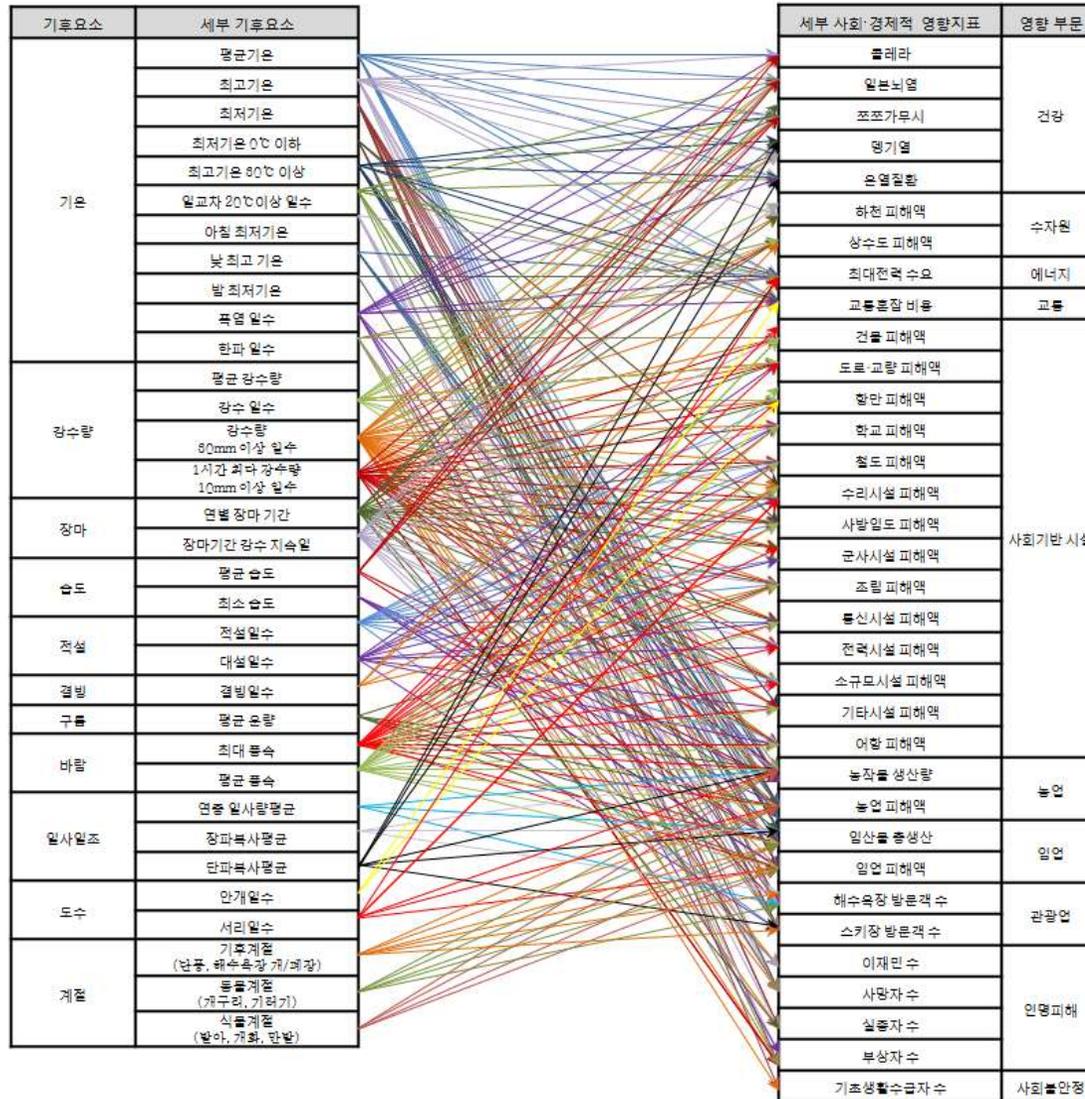


Number of freezing days (1984-2003)

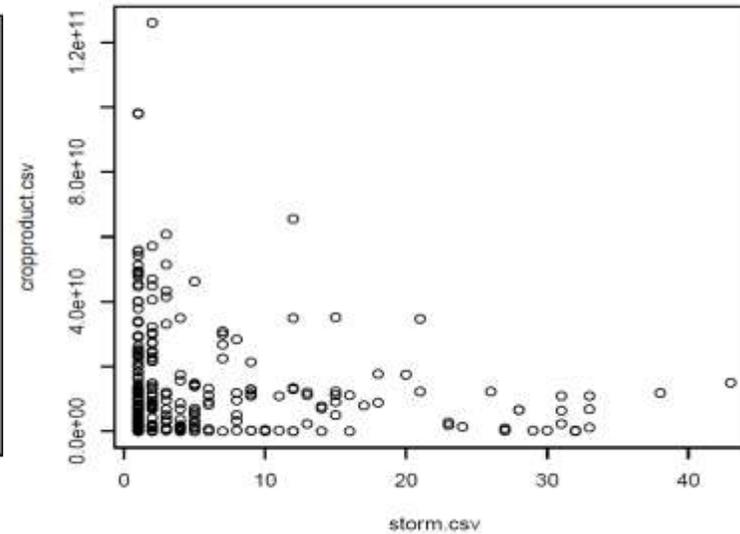
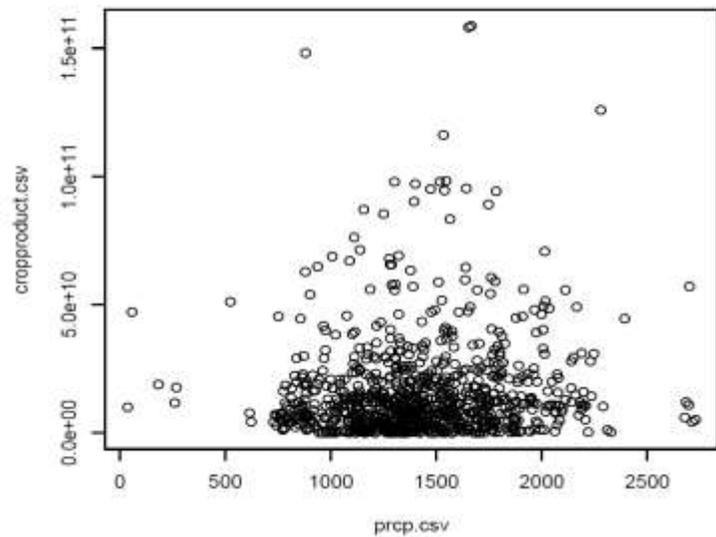
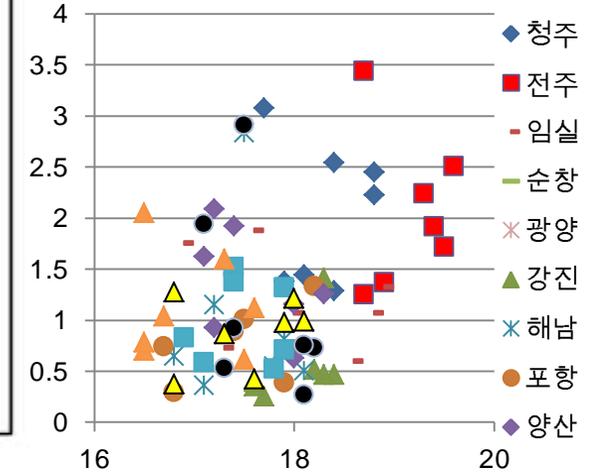
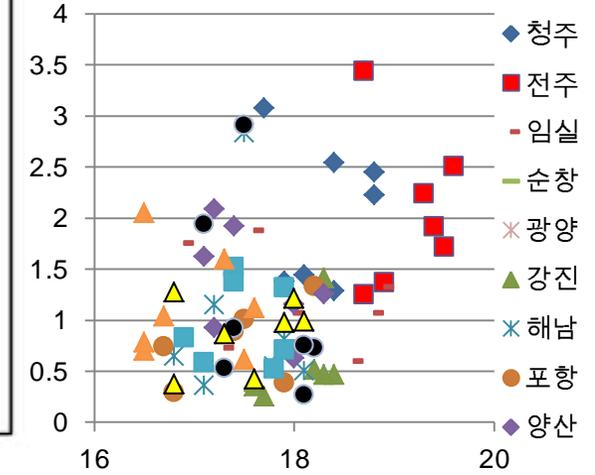
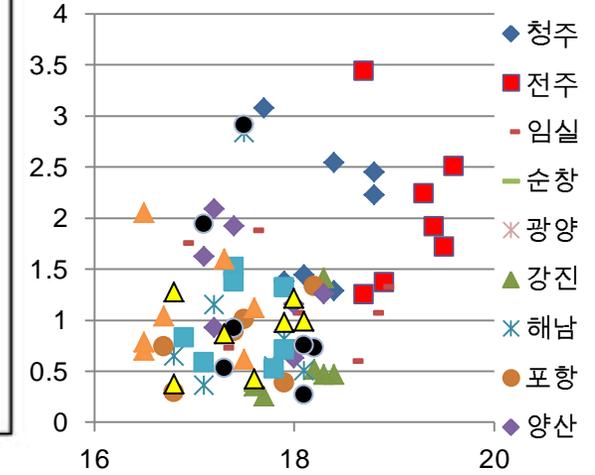
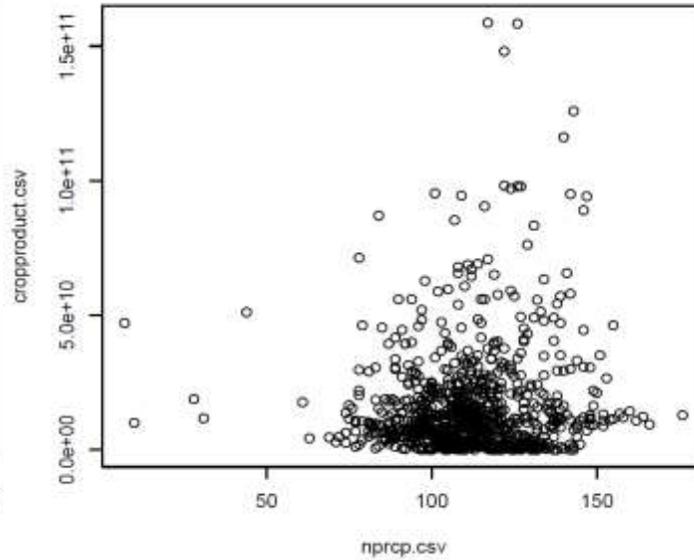
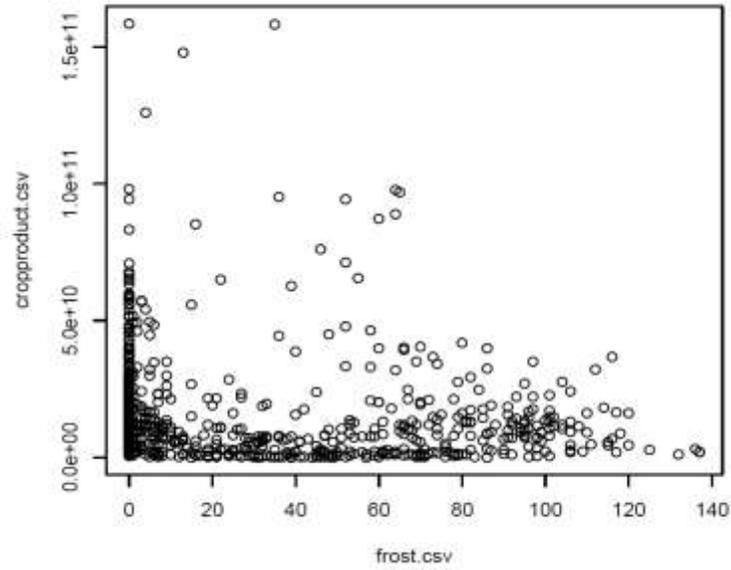


# 8. Relationship between socio-economic impacts and climate indicators

기후요소별 기후변화의 주요 사회 경제적 영향



# 9. Statistical analysis of socio-economic impacts and climate indicators



## 10. Discussion

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- **Data are required in many fields: Systematic management for climate change impacts and disaster data is required.**
- **Analysis on 2ndary impacts and their attribution is required**
- **Consistent monitoring of gradual impacts of climate change is required.**

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Thank you!