DROUGHT VULNERABILITY AND POLICY IN KOREA

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ORDER OF PRESENTATION

I. Status of Water Resources and Problems with Drought Policies in Korea

II. Assessment of Drought Vulnerability of Korea Due to Climate Change

III. Effective Drought Policy Measures against Climate Change

I. Status of Water Resources and Problems with Drought Policies in Korea

1. Background

- Korea is expected to suffer global climate change caused by global warming and water management vulnerability increased due to climate change (IPCC, 2007)
  - ※ 1.7 ℃ rose over the past 100 years (1912~2008) in Korea (6 major cities), compared to 0.74℃ in global average temperature
- Korea will probably undergo further changes in patterns of future precipitation and runoff, uncertainty increasing, and water shortages in some areas.
  - ※ It is viewed to lack 1 bil. ㎥ of water nationwide in 2016 (Long-term Water Comprehensive Plan , 2006)
- For Korea, water utilization is very low due to the influence of weather, terrain; the efficient utilization of a high proportion of agricultural water is insufficient.
- An impact of climate change and an ability to respond to drought are different by region, so discriminatory drought policies need to be established considering the drought vulnerability.
  - Korea's land is small, but its exposure to climate, such as temperature, precipitation, etc, is high in terms of deviation, and its ability to respond to drought is relatively weak in regions without water resources in the four major rivers.

2. Status and Characteristics of Korea Water Resources

- The annual precipitation is greater than the global average, but the annual precipitation per capita is very low due to the high population density and the seasonal variations are high.
  - Korea's average annual precipitation is 1,245 ㎜ (approximately 1.4 times of the world average). The total amount of annual precipitation per capita world is about 1/8 of the world average.
  - Two – third(2/3) of Korea's annual precipitation are concentrated during the flooding period (July to September) and the rainy and typhoon season.

- Sixty five percentage(65%) of the country consists of mountainous terrains. So, flood spills at once and thus Korea suffers the lack of runoff in the dry season

- Out of 1,240 billion ㎥ / year in a total amount of water, the quantity used reaches 33.7 billion ㎥ / year, which accounts for 27% of the total.
  - The rest is washed away to the sea through evapotranspiration, infiltration, and rivers.
  - In water use, dams account for 14%, surface water 10%, and ground water 3%.

- In water resources by utilization, agriculture occupies 47% of the total use.
  - Household water 7.6 billion ㎥ (23%), industrial water 2.6 billion ㎥ (8%), agricultural water 16.billion ㎥ (47%), reserved water 7.5 billion ㎥ (22%)

3. Problems with Policies against Drought in Korea

- Korea lacks in policies considering the regional drought vulnerability

  - It lacks in policies considering the characteristics of its regional vulnerability to drought, and in the differentiation in policies between local government.

- Korea also lacks in connection with drought polices and land use.

  - Measures in terms of structures, such as rivers, reservoirs, etc. are a large part of Korea's policies in water resources.

  - The lack of of policy in terms of land use, including water source conservation, maintenance of cities and enhancement of water running, sound water circulation systems, etc.

- Korea's policy in water resources is insufficient in terms of measures for the agricultural water in spite of a high proportion of resources utilization.

  - Agricultural water accounts for 47% out of a total of 33.7 billion tons in water resources used, but Korea's policy in water use is not satisfactory in efficiency

- Being unsatisfactory in basin-wide comprehensive water resources planning

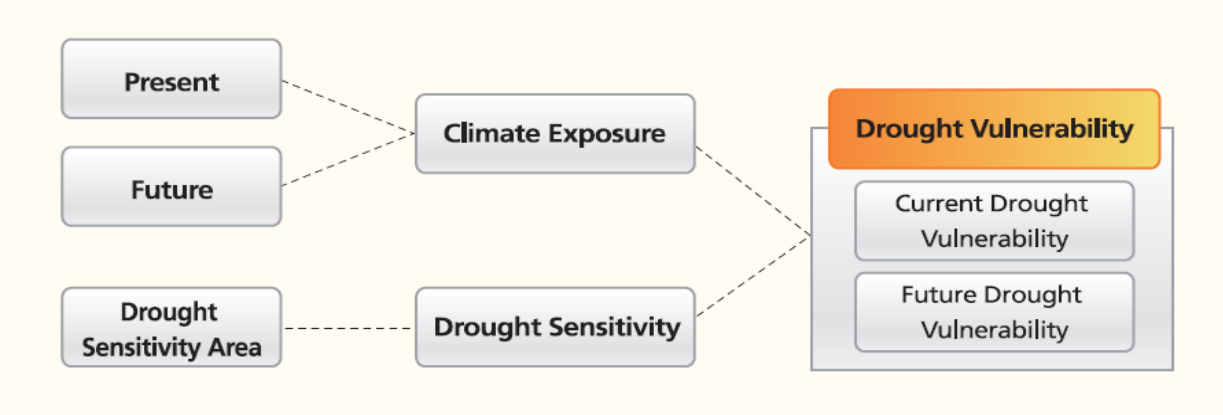
  - There is no water resources planning for river basins regarded as an intermediate concept of between the national and local governmental units, so Korea has limits in establishing drought policies or comprehensive measures for upstream and downstream, through regional cooperation.

II. Assessment of Drought Vulnerability of Korea due to Climate Change

1. Drought Vulnerability Assessment due to Climate Change

- In this study, first, drought vulnerability is defined by the vulnerability according to 「climate exposure」 and 「drought sensitivity」 following the vulnerability concept of IPCC.
- Present and future drought vulnerabilities are relatively assessed by dealing with present and future climate exposures and current drought vulnerabilities by local government and overlapping these data.
  - Current climate exposure: Manned stations' data during 1981~2010, obtained from KMA(Korea Meteorological Agency), are used.
  - Future climate exposure: National standard climate change scenario "A1B" is used.
  - Drought sensitive region: Assessment is carried out by a variety of sensitivity indices to reflect characteristics of regional vulnerability to drought

<Assessment Method of Drought Vulnerability Due to Climate Change>



※ It is very difficult to quantify an ability to adapt and to derive indicators to offset the potential vulnerability according to exposure and sensibility, so it is considered to be careful to take advantage of uncertain indicators. (Ministry of Land, Transport, and Maritime Affairs, 2011)

2. Drawing Evaluation Indicators

Process to deduce drought vulnerability assessment

1) Drawing impact indicators: Drought and meteorological factors and causal relationship with physical characteristics of the land are examined considering damage characteristics of drought.

2) Drawing 1st assessment indicators: For each impact indicator, previous research and others are reviewed.

3) Drawing 2nd indicators (final): The adequacy and objectivity of the 1st assessment indicators are complemented through expert consultation, and the utilization statistical data are considered.

Final indicators to assess drought vulnerability due to climate change

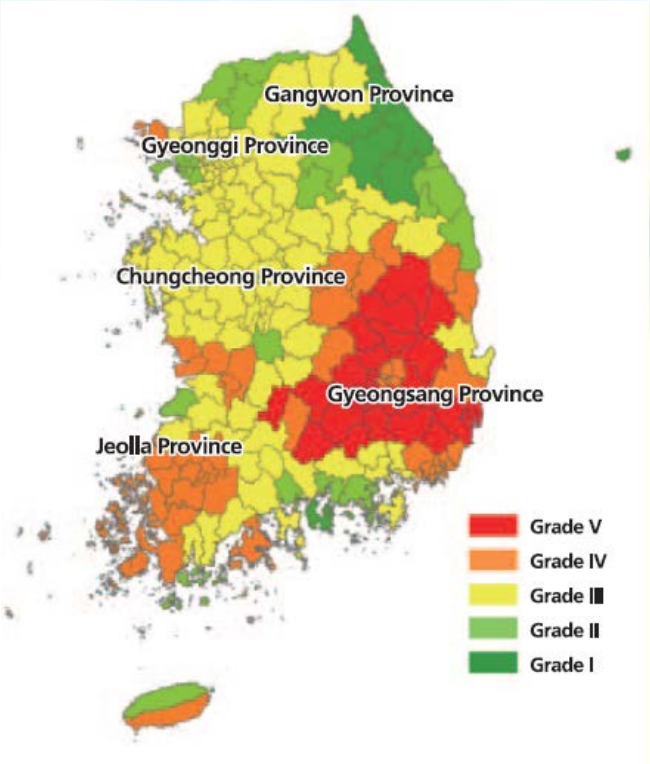
Segment		Assessment Index	Source
Climate Exposure (Present, Future)	Precipitation	·Number of annual longest precipitation - free days	**Korea Metrological Agency, National Institute of Environmental Research**
		· Average annual precipitation of fall, winter, spring(October ~ April) precipitation	**Korea Metrological Agency, National Institute of Environmental Research**
	Temperature	·Annual average daily maximum temperature	**Korea Metrological Agency, National Institute of Environmental Research**
Drought Sensitivity	Drought – sensitive area	·Non- water supply - wide regions	**Korea Statistical Information Service**
		· Number of soil moisture dry days	**Satellite rainfall data TRMM(NASA)**
		· Non- water areas of the four major rivers	**WAMIS**

※ Weights according to expert survey: Exposure to climate 0.3, Drought sensibility 0.7

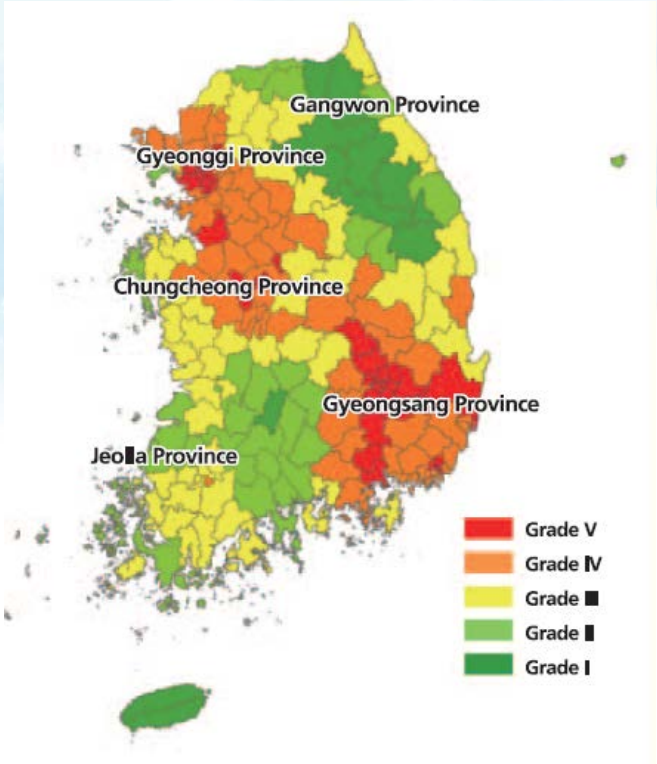
3. Climate Change Driven Drought Vulnerability Assessment Results

- Climate Exposure
  - Current : Southeastern region and Southwestern coastal area highly exposed
  - Future : expanding around Geyonggi, Chungcheong, Gyeongsang Provinces highly exposed

<Current(1981~2010)>



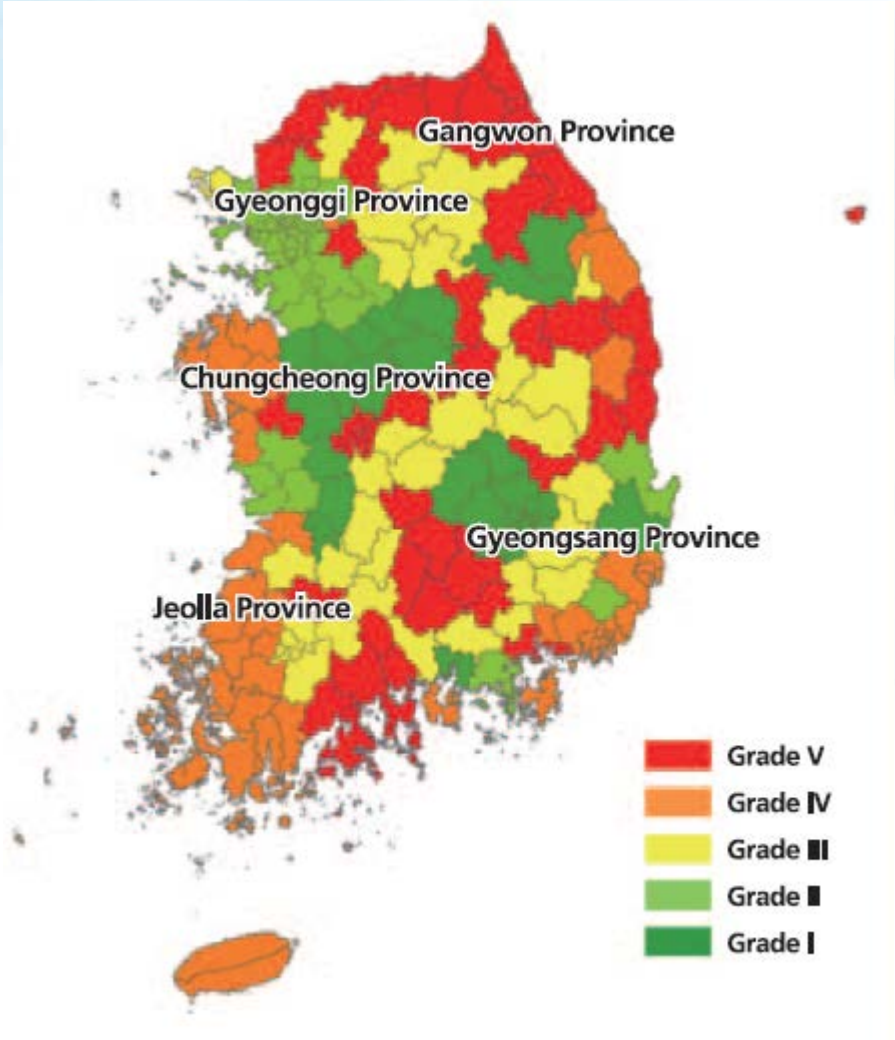
<Future(2100)>



※ Grade V being the highest level

Drought Sensitivity

- Northern Gyeonggi, Gangwon coastal area, Jeolla coastal area, Mt. Jiri area sentive

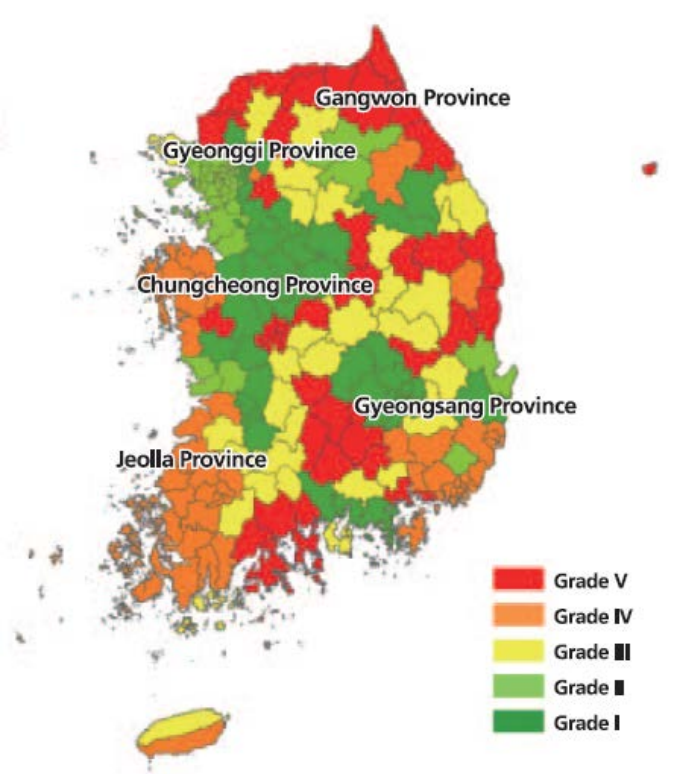


※ Grade V being the highest level

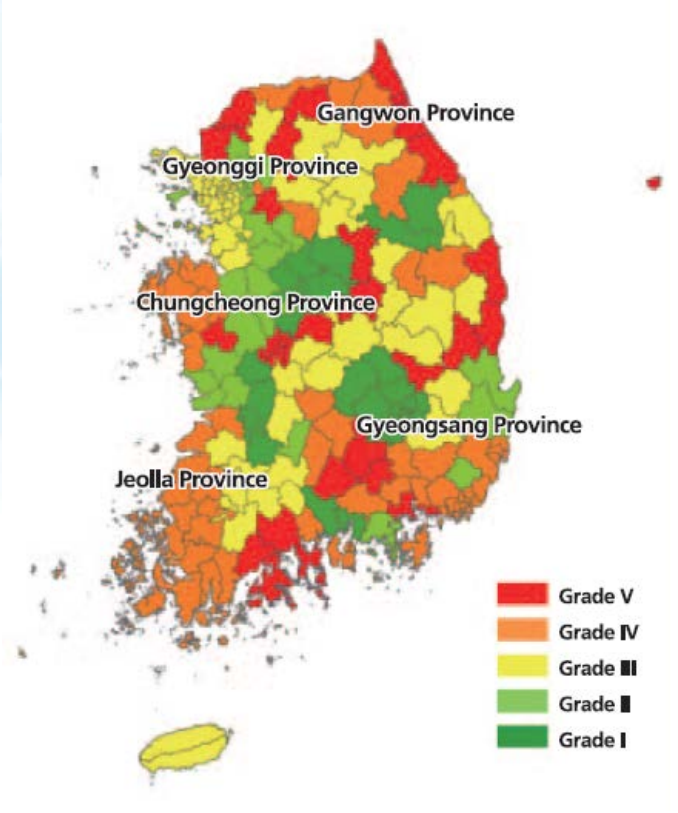
Drought Vulnerability

- Current : Northern Gyeonggi, Northern Gangwon, Gangwon coastal area, Gyeongsang coastal area, Jeolla coastal area, Chungcheong, Mt. Jiri area vulnerable
- Future: Similar to current vulnerability(Gangwon , Mt. Jiri area alleviated)

<current vulnerability>



<future vulnerability>

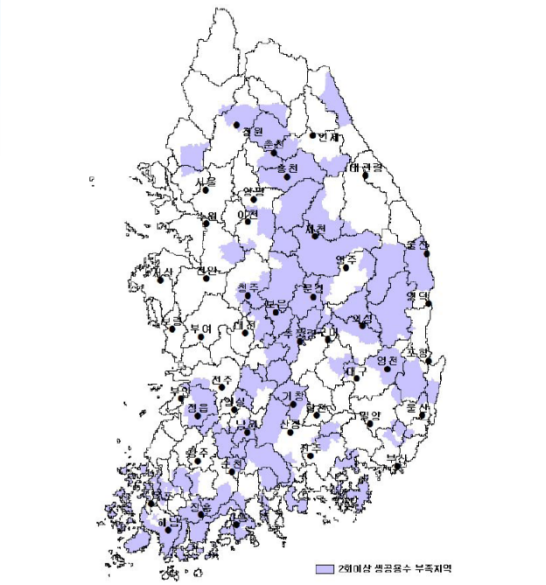


※ Grade V being the highest level

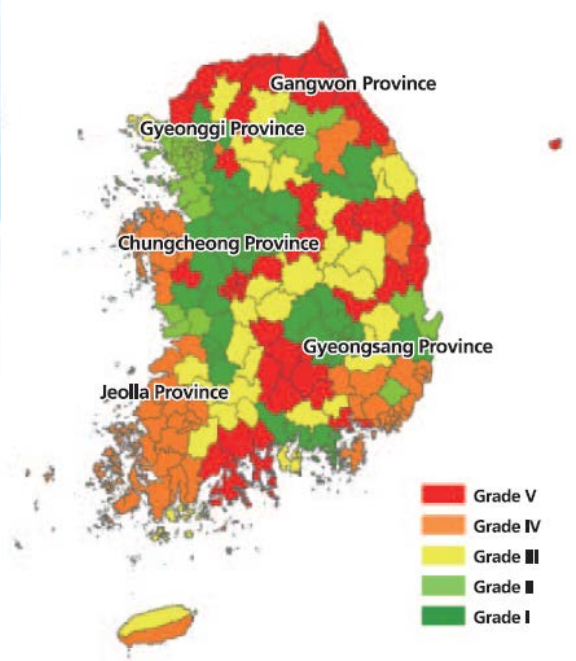
- Comparison of drought vulnerability assessed results in this study and humidity and drought affected areas in the past

  - The two results all show that northern parts of Gyeonggi – do, northern parts of Gangwon-do, the whole place of Mt. Jiri, and costal and island areas of Jeollanam-do are classified as a vulnerable area. Thus, it is believed that the results of this study are appropriate.
  - This study demonstrates that drought vulnerability has been improved in the local governments having water resources in the fours major rivers in consideration of the 4 Rivers Project.

<Habitual drought-affected areas in the past>



<Results of the study: Current vulnerability >



* Limited water supply area 2 or more times in 1994, 1995, and 2001

III. Effective Drought Policy Measures against Climate Change

Goal: Enhancement of National Territorial Adaptation Ability to Secure Water Resources Stably to Prepare for Climate Change

Four Strategies

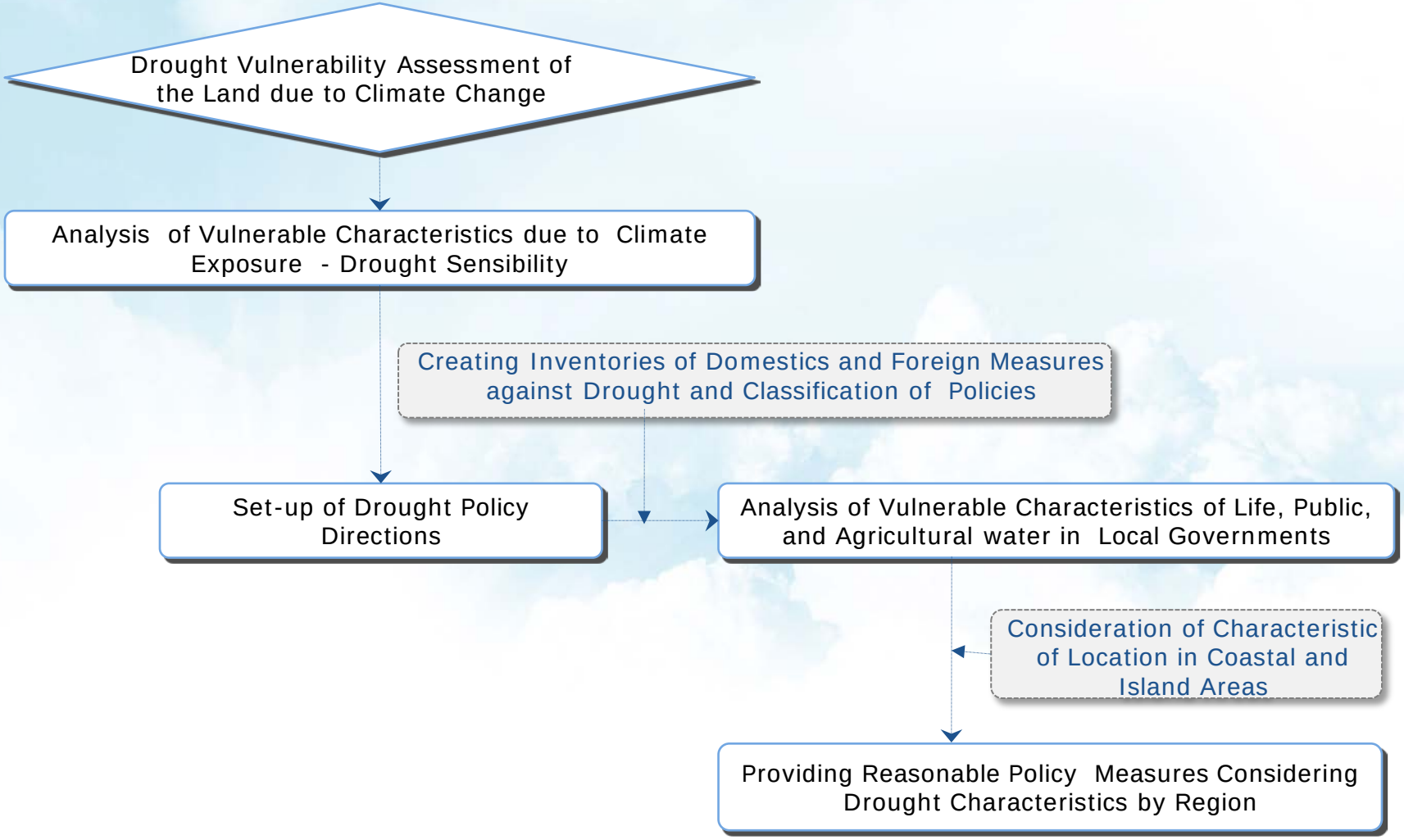
Problems of current drought policies

1. Insufficient consideration of regional drought vulnerability according to climate change
2. Insufficient linkage between drought policies and land use
3. Insufficient measures for agricultural water whose water resources use ratio is high
4. Lack of comprehensive water resources scheme at the river basin level

Improvement directions

1. Dealing rationally with the issue considering the regional drought vulnerability features
2. Adopting integrated actions in linkage with spatial schemes
3. Coping Efficiently through the re-establishment of agricultural water
4. Coping through comprehensive river basin water resources scheme

1. Reasonable Policy Measures Considering Characteristics of Regional Drought Vulnerability



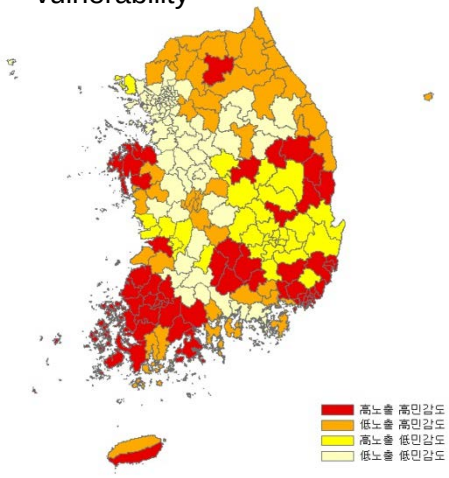
Review of vulnerable characteristics by region based on the results of an analysis of drought vulnerability of the land

- Vulnerable characteristics are classified into a “high exposure-high sensitivity” type, a“ low exposure-high sensitivity” type, a “ high exposure-low exposure” type, and a “low exposure-low sensitivity” by considering “drought climate exposure” and “drought sensitivity” on the current vulnerability.
- Areas highly sensitive to drought are found to be relatively vulnerable to drought.

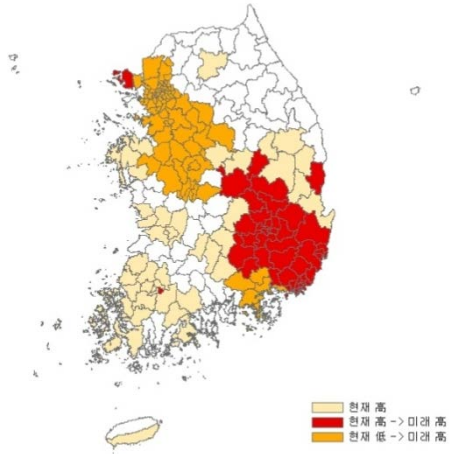
Segment	Sum	I	II	III	IV	V	Vulnerability
Sum	232(100%)	52	47	32	58	43	Vulnerable
「high exposure – high sensitivity」 type	64(28%)			2	48	14	
「high exposure - low sensitivity」 type	51(22%)		1	12	9	29	
「low exposure – high sensitivity 」 type	32(14%)	17	5	9	1		
「low exposure – low sensitivity」 type	85(36%)	35	41	9			Safe

- Data of vulnerability in the future are used as the material to forecast changes in circumstances in the future
  - The number of local governments under high - exposure at present increased to 96 areas ; that in the future to 131 areas .
    - ⇒ It suggests that the area of drought to climate in the land will be wide.
  - The number of local government under both high – exposure at present and that in the future is found to be 51 areas.
  - The number of local governments not under high - exposure at present but under that in the future is shown to be 80 areas.

➢ Regional distribution according to the climate exposure – drought sensitivity of the current vulnerability



➢ Status of local governments in high exposure at present and high exposure in the future in terms of climate



Policy direction considering drought vulnerability according to climate change by region

- 「high exposure – high sensitivity」type,「low exposure - high sensitivity」type

⇒ Structure – related drought response systems to be preferentially established due to the high drought sensitivity.

- Establishment of wide-area water supply system, improving a water supply rate, new development of new environment-friendly small dams and reservoirs, etc.

- 「high exposure - low sentivity」 type

⇒ Focused on lowering the urban temperature or establishing sound water circulations systems by improving the efficiency of the existing systems and being linked to spatial planning

- Improvement of multipurpose dam operating systems, integrated management of groundwater and surface water, water demand management, construction of green networks such as parks, green spaces, etc.

- 「low exposure – low sensitivity」type

⇒ Focused on the practice of water demand management

※ Areas under high exposure to climate in the future

⇒ It is required to establish continuous monitoring systems, as the impact on drought will increase.

※ Areas turning into high exposure in the future from low exposure at present.

⇒ It is needed to reduce the impact of climate change through monitoring and spatial planning.

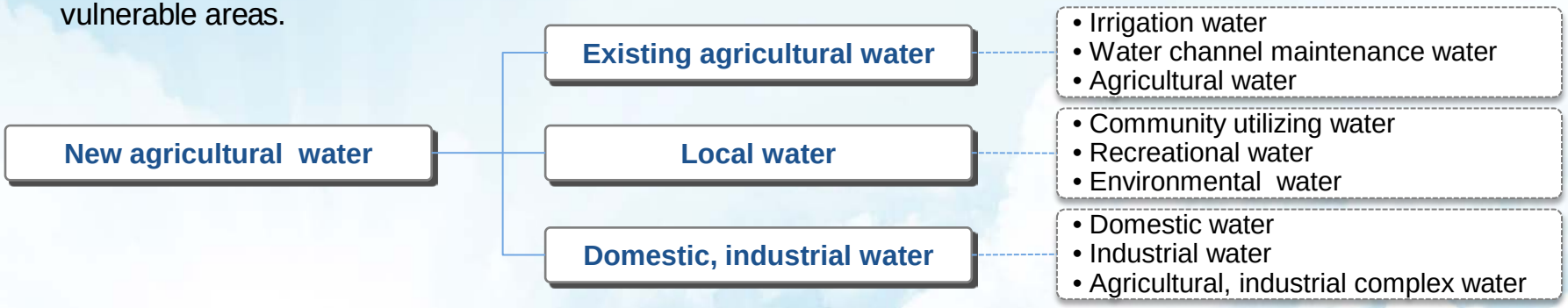
2. Integrated drought policy measures using spatial planning through urban planning and developing

- Establishment of sound water circulations system using spatial planning
  - Lowering the urban temperature in the sections of spatial planning, that is, a variety of sections such as spatial structure, land use, infrastructures, complex development, buildings; urban maintenance; and enhancement of water running.
  - The results of the drought vulnerability analysis show that the population is concentrated in urban areas. Thus, it is considered to be useful to apply the above planning to areas where high urbanization progress, such as impervious packaging, etc. is made

3. Effective Policy Measures through Re-establishing Agricultural Water

- Multipurpose use through new establishment of an agricultural water concept
  - (Existing) agricultural and livestock water for exclusive use ⇒ (improved) local water (river maintenance, environmental improvements), including manufacturing, industrial water, etc.
  - It is useful for drought areas of high sensitivity.

※ It is also useful for domestic and industrial water vulnerable areas, including domestic water, industrial water vulnerable areas.



- Efficient use of agricultural water for drought vulnerable areas linked to virtual water
  - It is required to review a concept of "virtual water" for the areas having many irrigation-impossible fields such as rain fed paddy fields, etc, for areas where drought response systems are insufficient, and areas insufficient in water resources and impossible to develop agricultural water.
    - Cultivation of the crops needing less required water quantity, instead of rice, and other methods .

※ Guadiana Basin of Spain : They cultivate grapes and grape vines instead of crops requiring a relatively large amount of water. They also cultivate crops in the vicinity where water resources are rich, and thus they make a contribution to efficient production of goods as well as efficient water use.

* Virtual Water: A quantity of water required to produce and process products.

4. Comprehensive Countermeasures through Establishing Basin Comprehensive Water Resources

- It is necessary to make cooperation between upper and lower streams and to establish polices and measures from the comprehensive perspective in a basin level.

  - There exists limits (water moving, upstream water source conservation, etc.) in response to climate change only through water resources long - term comprehensive plans in a national unit and through water supply maintenance master plans in a local unit.

    ※ China: National Water Resources Master Plan - Basin Water Resources Master Plan - Area Water Resources Master Plan

    ※ Japan : The Basin Comprehensive Water Resources Management Plan (draft) has been proposed to be established to respond to drought risks due to the recent climate change.

Targets for the counter measures

- Rivers for which the River Basin Comprehensive Plan has been made under the current 「River Act」(13 rivers)
- Small, medium rivers flowing through 2 or more municipalities considering drought vulnerability

5. Future Study

- A drought vulnerability analysis due to climate change in this study is useful to understand the characteristics of drought vulnerable areas and to set up the policy direction.

- However, future demand forecasting and empirical analysis of water resources models must be carried out at the same time, so that measures against drought should be established by figuring out the quantitative water deficit.

- An analysis of vulnerability to future climate change is required by establishing a methodology to forecast changes in conditions and in physical properties of the future.


Thank you