Disaster-related Statistical Geospatial Indicators

Jan 2019

Information and Communications
Technology and Disaster Risk
Reduction Division

Outline

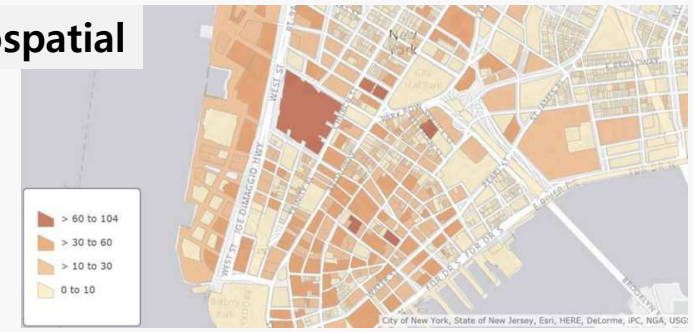
1. What is Statistical Geospatial Indicators?
2. Framework of Statistical Geospatial Indicators
3. Applications of Draft Framework and Indicators and Results
4. Future Plan

1. What is Statistical Geospatial Indicators?

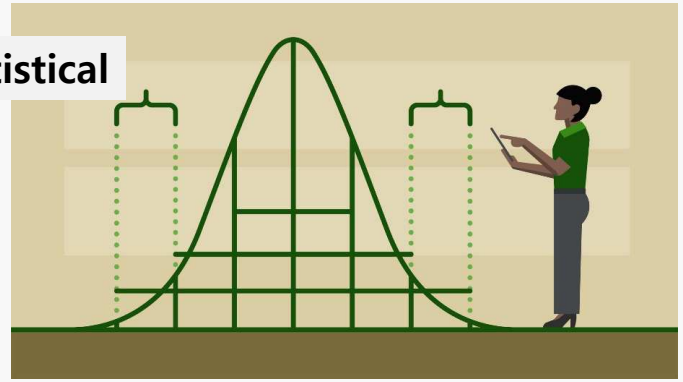
- Statistical data + Geospatial data,
- For policy makers,
- Disaster risks before disasters,
  rather than impact and loss after disaster breakout
- Geospatial data is critical to identify risks before disasters

Statistical Geospatial Indicators

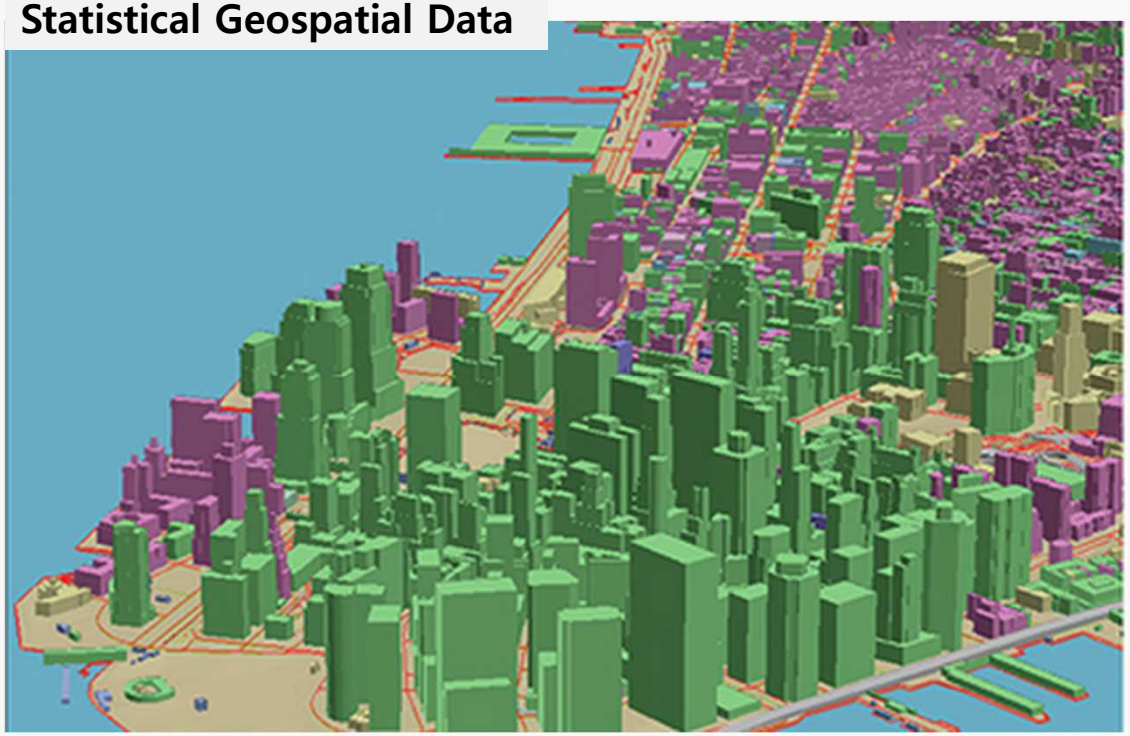
Geospatial



Statistical

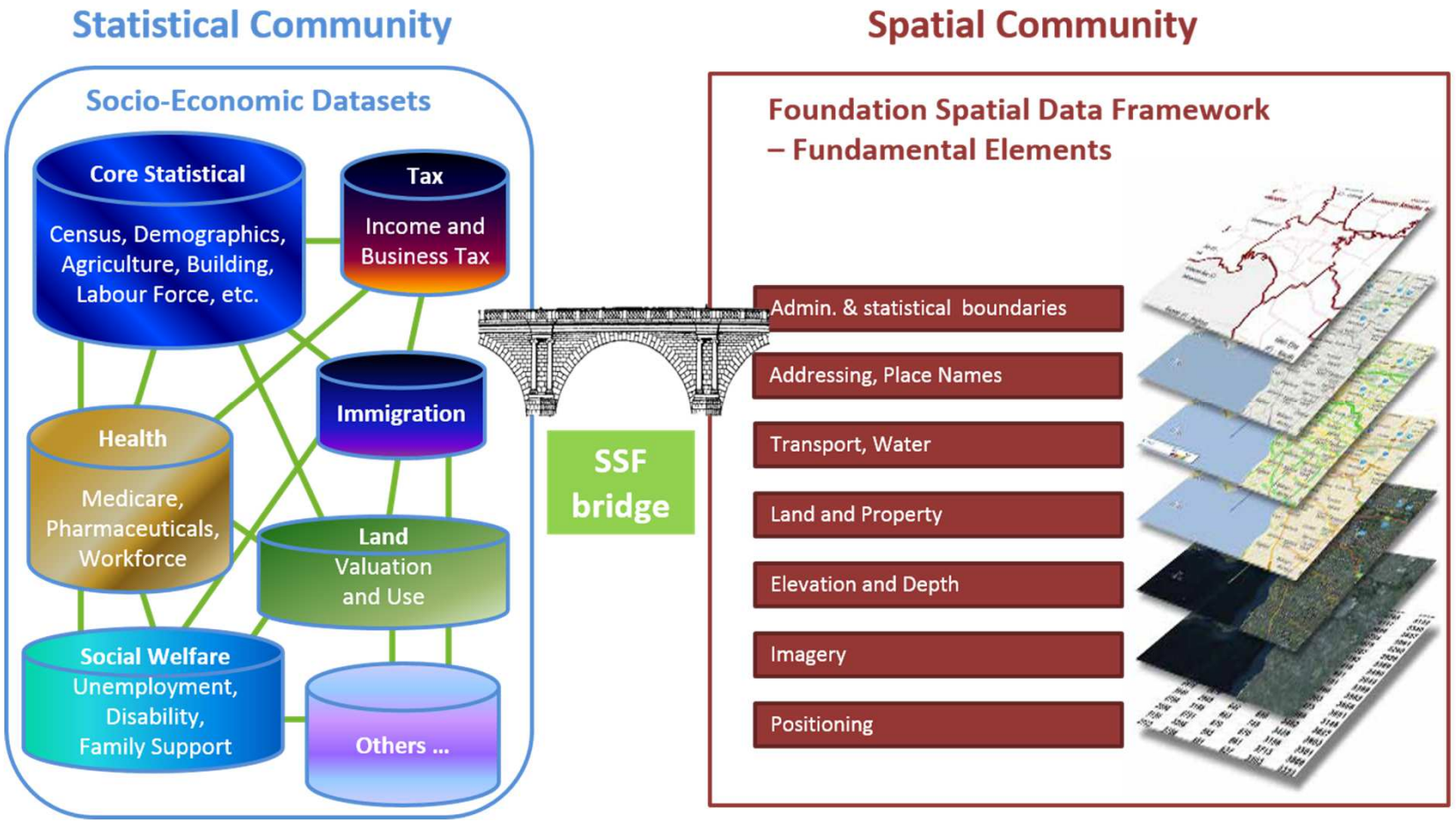


Statistical Geospatial Data



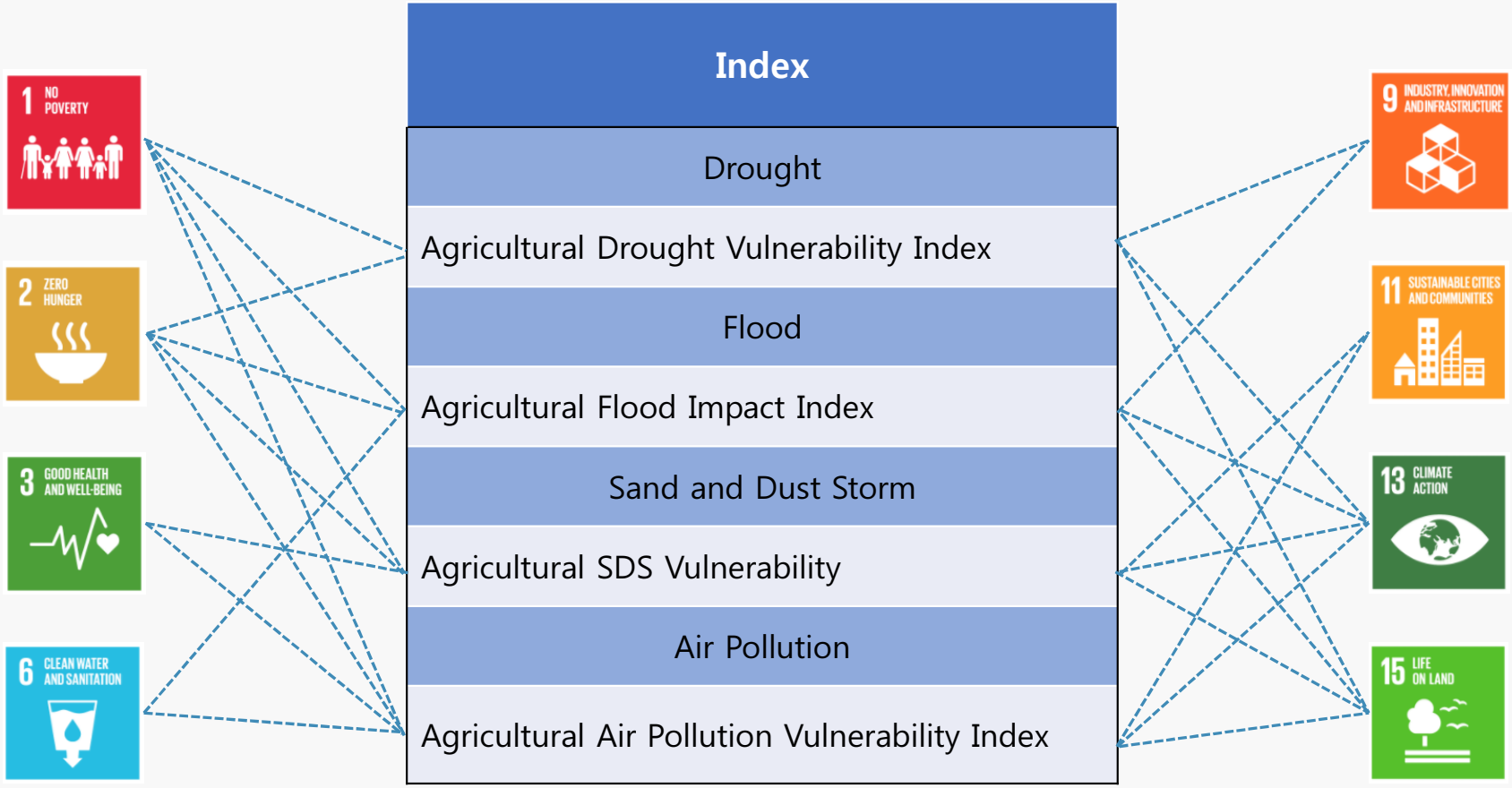
Source: Korea Univ

UNGGIM Statistical Geospatial Framework



Source: Martin Brady, "Towards a Global Statistical Geospatial Framework", Australian Bureau of Statistics , November 2015

Linkage with the SDGs



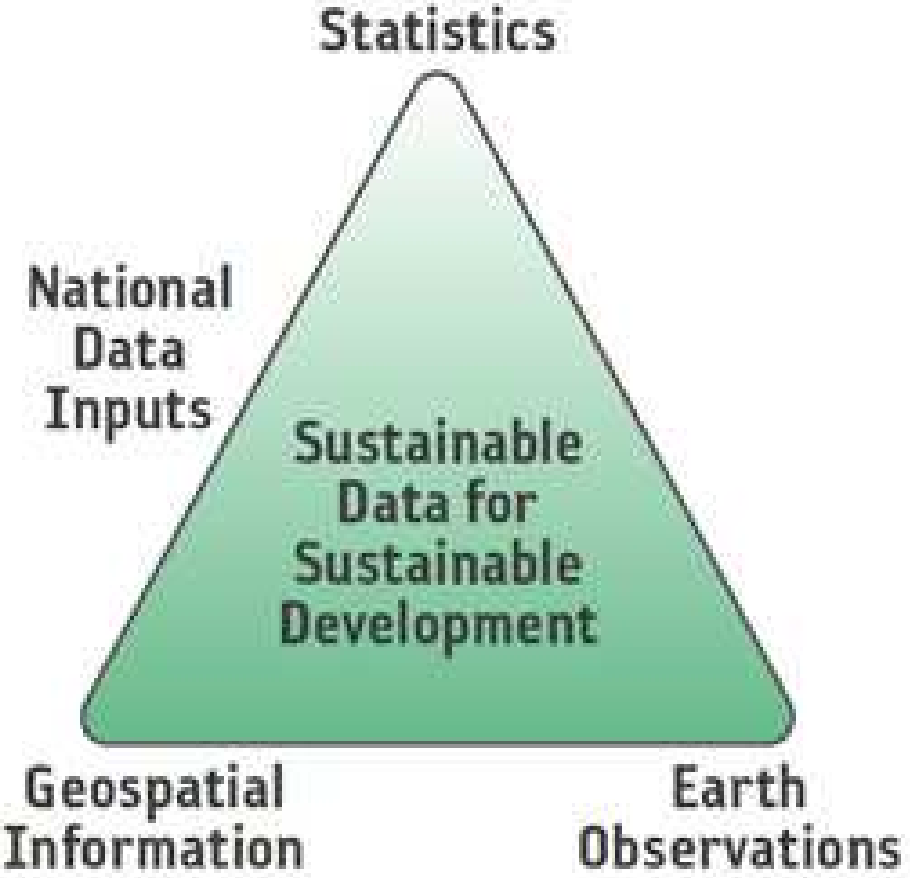
Source: Prof Woo Kyun Lee, Korea University, 2018

Key Questions

1. What are Disaster Risks? (not Disasters)
2. How can combine better statistical data and geospatial data?
    - What frameworks or platforms or models?

Literature Review

SDG Indicators



Disaster - SDG 232 Indicators

Target	Indicator
Target 1.5: By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters	Indicator 1.5.1: Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population Indicator 1.5.2: Direct economic loss attributed to disasters in relation to global gross domestic product (GDP Indicator 1.5.3: Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030 Indicator 1.5.4: Proportion of local governments that adopt and implement local sadister risk reduction strategies in line with national disaster risk reduction strategies
Target 11.b: By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels	Indicator 11.b.1: Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030 Indicator 11.b.2: Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies

Disaster - SDG 232 indicators

Target	Indicator
Target 11.5: By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations	Indicator 11.5.1: Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population Indicator 11.5.2: Direct economic loss in relation to global GDP, damage to critical infrastructure and number of disruptions to basic services, attributed to disasters
Target 13.1: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	Indicator 13.1.1: Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population Indicator 13.1.2: Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030 Indicator 13.1.3: Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies

Sendai Framework for DRR

Global target A: Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality between 2020-2030 compared with 2005-2015.	
A-1 (compound)	Number of deaths and missing persons attributed to disasters, per 100,000 population.
A-2	Number of deaths attributed to disasters, per 100,000 population.
A-3	Number of missing persons attributed to disasters, per 100,000 population. The scope of disaster in this and subsequent targets is defined in paragraph 15 of the Sendai Framework for Disaster Risk Reduction 2015-2030 and applies to small-scale and large-scale, frequent and infrequent, sudden and slow-onset disasters caused by natural or man-made hazards, as well as related environmental, technological and biological hazards and risk.

Global target B: Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 between 2020-2030 compared with 2005-2015.	
B-1 (compound)	Number of directly affected people attributed to disasters, per 100,000 population.
B-2	Number of injured or ill people attributed to disasters, per 100,000 population.
B-3	Number of people whose damaged dwellings were attributed to disasters.
B-4	Number of people whose destroyed dwellings were attributed to disasters.
B-5	Number of people whose livelihoods were disrupted or destroyed, attributed to disasters.

Sendai Framework for DRR

Global target C: Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030.	
C-1 (compound)	Direct economic loss attributed to disasters in relation to global gross domestic product.
C-2	Direct agricultural loss attributed to disasters. *Agriculture is understood to include the crops, livestock, fisheries, apiculture, aquaculture and forest sectors as well as associated facilities and infrastructure.*
C-3	Direct economic loss to all other damaged or destroyed productive assets attributed to disasters. *Productive assets would be disaggregated by economic sector, including services, according to standard international classifications. Countries would report against those economic sectors relevant to their economies. This would be described in the associated metadata.*
C-4	Direct economic loss in the housing sector attributed to disasters. *Data would be disaggregated according to damaged and destroyed dwellings.*
C-5	Direct economic loss resulting from damaged or destroyed critical infrastructure attributed to disasters. *The decision regarding those elements of critical infrastructure to be included in the calculation will be left to the Member States and described in the accompanying metadata. Protective infrastructure and green infrastructure should be included where relevant.*
C-6	Direct economic loss to cultural heritage damaged or destroyed attributed to disasters.

Global target D: Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030	
D-1 (compound)	Damage to critical infrastructure attributed to disasters.
D-2	Number of destroyed or damaged health facilities attributed to disasters.
D-3	Number of destroyed or damaged educational facilities attributed to disasters.
D-4	Number of other destroyed or damaged critical infrastructure units and facilities attributed to disasters. *The decision regarding those elements of critical infrastructure to be included in the calculation will be left to the Member States and described in the accompanying metadata. Protective infrastructure and green infrastructure should be included where relevant.*
D-5 (compound)	Number of disruptions to basic services attributed to disasters.
D-6	Number of disruptions to educational services attributed to disasters.
D-7	Number of disruptions to health services attributed to disasters.
D-8	Number of disruptions to other basic services attributed to disasters. *The decision regarding those elements of basic services to be included in the calculation will be left to the Member States and described in the accompanying metadata.*

Sendai Framework for DRR

Global target E: Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020.	
E-1	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030.
E-2	Percentage of local governments that adopt and implement local disaster risk reduction strategies in line with national strategies. *Information should be provided on the appropriate levels of government below the national level with responsibility for disaster risk reduction.*

Global target F: Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030.	
F-1	Total official international support, (official development assistance (ODA) plus other official flows), for national disaster risk reduction actions. *Reporting of the provision or receipt of international cooperation for disaster risk reduction shall be done in accordance with the modalities applied in respective countries. Recipient countries are encouraged to provide information on the estimated amount of national disaster risk reduction expenditure.*
F-2	Total official international support (ODA plus other official flows) for national disaster risk reduction actions provided by multilateral agencies.
F-3	Total official international support (ODA plus other official flows) for national disaster risk reduction actions provided bilaterally.
F-4	Total official international support (ODA plus other official flows) for the transfer and exchange of disaster risk reduction-related technology.
F-5	Number of international, regional and bilateral programmes and initiatives for the transfer and exchange of science, technology and innovation in disaster risk reduction for developing countries.
F-6	Total official international support (ODA plus other official flows) for disaster risk reduction capacity-building.
F-7	Number of international, regional and bilateral programmes and initiatives for disaster risk reduction-related capacity-building in developing countries.
F-8	Number of developing countries supported by international, regional and bilateral initiatives to strengthen their disaster risk reduction-related statistical capacity.

Sendai Framework for DRR

Global target G: Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk informati on and assessments to the people by 2030.	
G-1 (compound G2-G5)	Number of countries that have multi-hazard early warning systems.
G-2	Number of countries that have multi-hazard monitoring and forecasting systems.
G-3	Number of people per 100,000 that are covered by early warning information through local governments or t hrough national dissemination mechanisms.
G-4	Percentage of local governments having a plan to act on early warnings.
G-5	Number of countries that have accessible, understandable, usable and relevant disaster risk information and assessment available to the people at the national and local levels.
G-6	Percentage of population exposed to or at risk from disasters protected through pre-emptive evacuation follo wing early warning. *Member States in a position to do so are encouraged to provide information on the number of evacuated peo ple.*

<Resource: Climate policy observer, http://climateobserver.org/depth-monitoring-progress-sendai-framework-disaster-risk-reduction/>

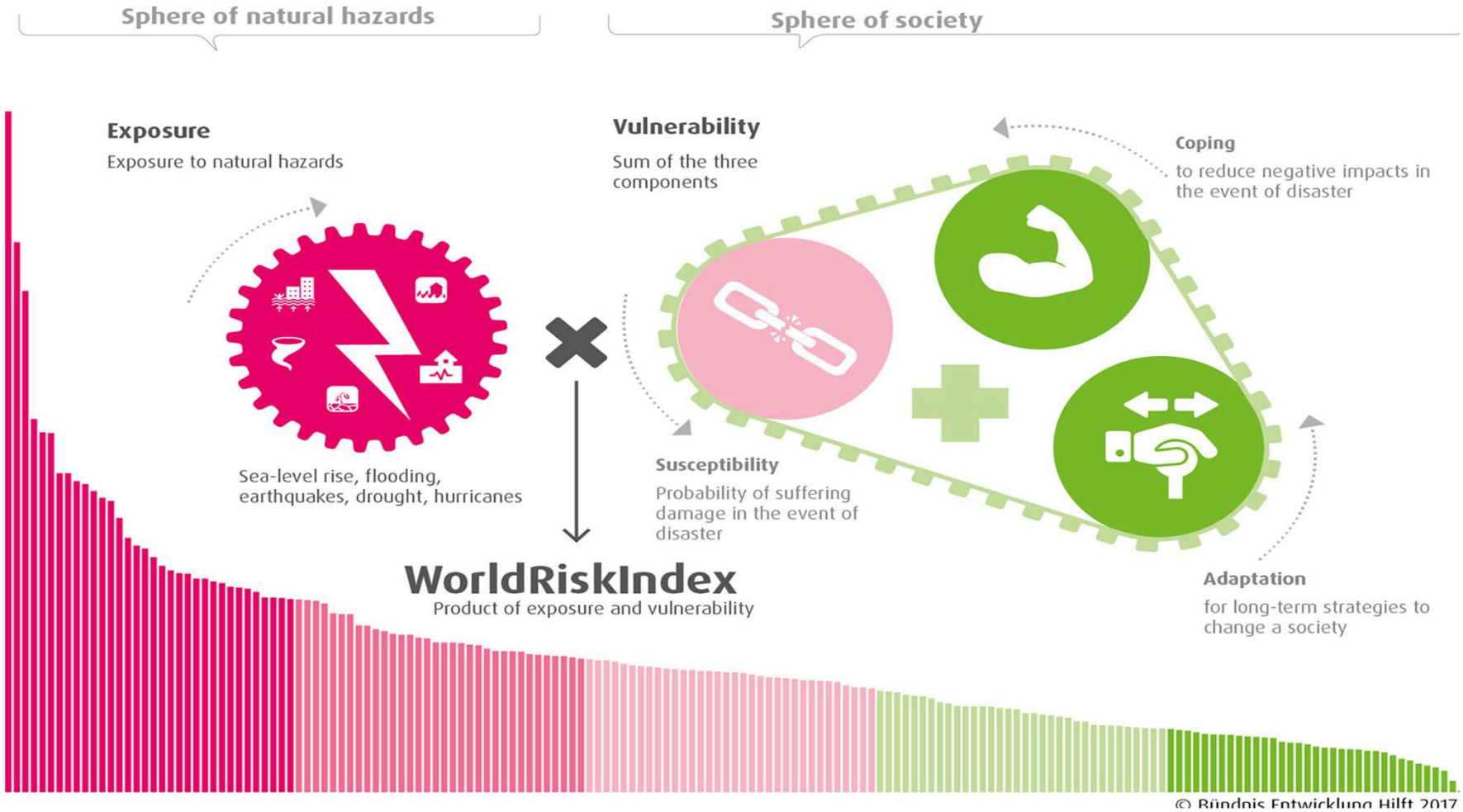
Literature Review on Indicators and Index

Index	Indicator	Description and Additional Information	Usage	Reference
Palmer Drought Severity Index (PDSI)	temperature, precipitation	An indicator to estimate relative dryness and that has been widely adopted in the USA for long-term drought monitoring	FAO USDM (USA) Canada Republic of Korea	Palmer (1965)
Keetch-Byram Drought Index (KBDI)	precipitation, temperature	An indicator of soil moisture deficit because it is directly related to drought stress on crops	USDA (USA)	Keetch and Byram (1968)
Precipitation	precipitation	A simple indicator used all over the world	FAO Canada Syria	
Percent of Normal Precipitation	precipitation	An indicator that uses simple calculation to identifying various impacts of droughts		
Standardized Precipitation Index (SPI-n)	precipitation	A statistical indicator that is used to identify a precipitation shortage by comparing the total precipitation received at a particular location during a period of n months with the long-term rainfall distribution for the same period of time at that location	FAO WMO JRC (Europe) Republic of Korea Palestine	McKee et al (1993)
Standardised Precipitation-Evapotranspiration Index (SPEI)	precipitation, potential evapotranspiration	An indicator for determining the onset, duration and magnitude of drought conditions based on climatic data to identify the impact of increased temperatures on water demand and is an extension of SPI		Vincente-Serrano et al. (2010)
Surface Water Supply Index (SWSI)	reservoir storage, streamflow, snowpack, precipitation	An indicator calculated at the basin level used for water supply forecasting and is an extension of PDSI since it adds additional information including water supply data	FAO NRCS, USDM (USA) Republic of Korea	Shafer and Dezman (1982)

Literature Review on Indicators and Index

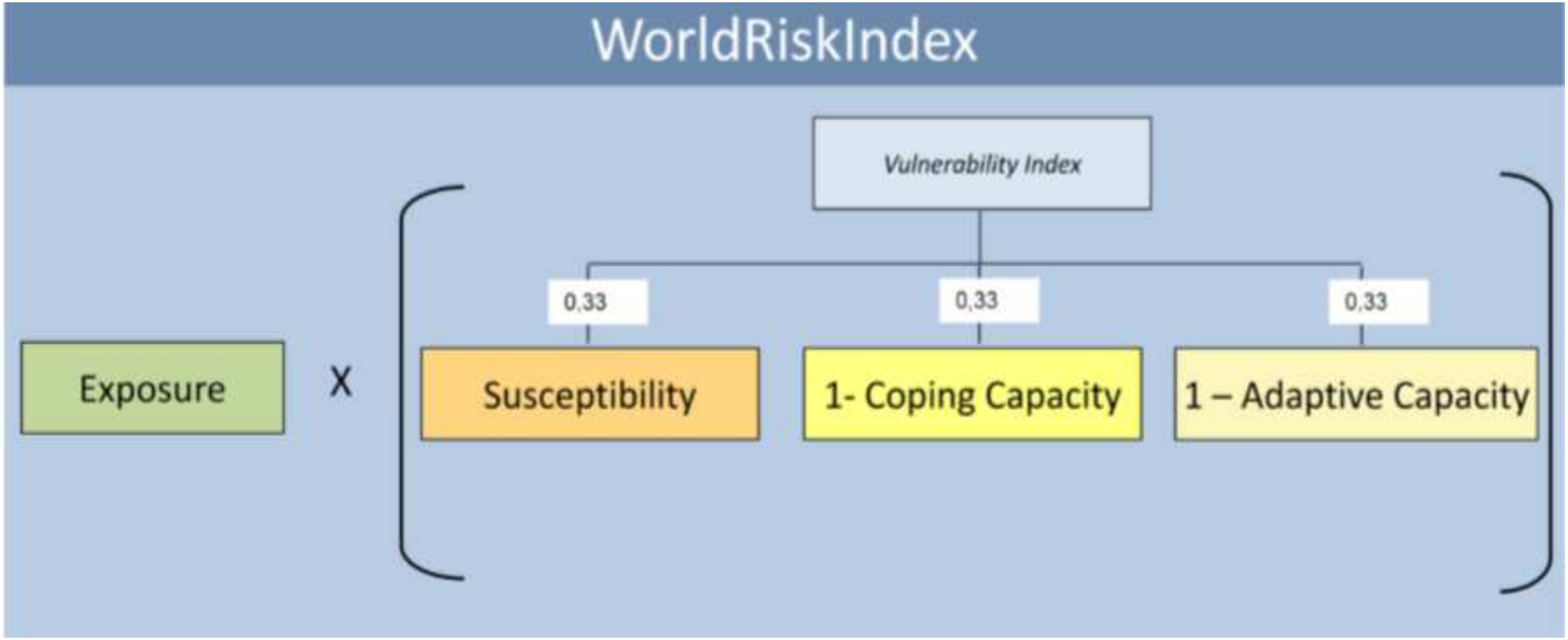
MEASUREMENT	Developer/ Affiliation	Focus	Components	Smallest unit of analysis	Methodology	Participatory	Data sources	Stage of development
NATIONAL LEVEL								
Hyogo Framework for Action (HFA) Monitor	**UNISDR** (globally)	progress towards HFA using 31 indicators on three levels (outcomes, goals, priorities)	indicators for the outcome, three strategic goals and five priority areas	local government or country	self-assessment by governments on scale from 1 to 5; mostly input-related	yes (self-assessment)	primary (self-assessment)	**IMPLEMENTATION; 2009, 2011 and 2013**
WorldRiskIndex	**UNU-EHS**	disaster risk value for 173 countries	exposure, susceptibility, coping capacities, adaptation	country	quantitative; weighted composite index with 28 indicators	no	secondary data only	**IMPLEMENTATION;** annually since 2011
Global Focus Model (GFM)	**UN OCHA & Maplecroft**	hazards, vulnerabilities and response capacity at country-level	hazard, vulnerability, capacities, humanitarian need	country & region	quantitative; weighted composite index	no	secondary data only; some data from proprietary indices of Maplecroft	**IMPLEMENTATION; annually since 2007**
Socio-Economic Resilience Index	**Maplecroft**	socio-economic resilience as part of a set of natural hazards risk atlas	*not known*	country	*not known*	no	*not known*	**IMPLEMENTATION; at least since 2011; only paid access**
Risk Reduction Index (RRI)	**DARA**	measurement of underlying risks; so far Latin America and Western Africa	environment and natural resources, socio-economic conditions, land use and the built environment, governance	country	mostly qualitative; local perceptions about underlying risk using key informants	yes (perception surveys)	primary data (questionnaire, workshops)	**IMPLEMENTATION; partially since 2010**
Prevalent Vulnerability Index (PVI)	**Inter-American Development Bank**	part of a set of four indicators that measure the potential impact of natural hazards	exposure, susceptibility, socioeconomic fragility and resilience	country (but also sub-national)	composite index consisting of 3 sets of 8 high-level indicators	No	secondary data only	**IMPLEMENTATION; partially in Latin America**
Country Resilience Rating	**World Economic Forum**	resilience of countries to global risks	robustness, redundancy, resourcefulness, response and recovery	country	mix of quantitative (mostly existing indices) and perception data	yes (perception surveys)	secondary data and perception surveys	**INDICATORS DEFINED**
AGIR Results Framework	AGIR	food and nutrition resilience in Sahel and West Africa	4 impact indicators and a set of outcome indicators for 4 objectives	country	quantitative and qualitative set of individual indicators for each objective	No	secondary data; indicators drawn from existing programmes and initiatives	**INDICATORS DEFINED**
Post-2015 indicators for Disaster Risk Reduction	**UNISDR**	disaster Risk Reduction including economic resilience	not defined, but might refer to economy, capital stock, investment and saving levels, trade flows, insurance penetration, fiscal resilience, social protection etc.	*not defined yet*	*not defined yet*	no	secondary data only	**PLANNING;** indicators only partially defined

World Risk Index



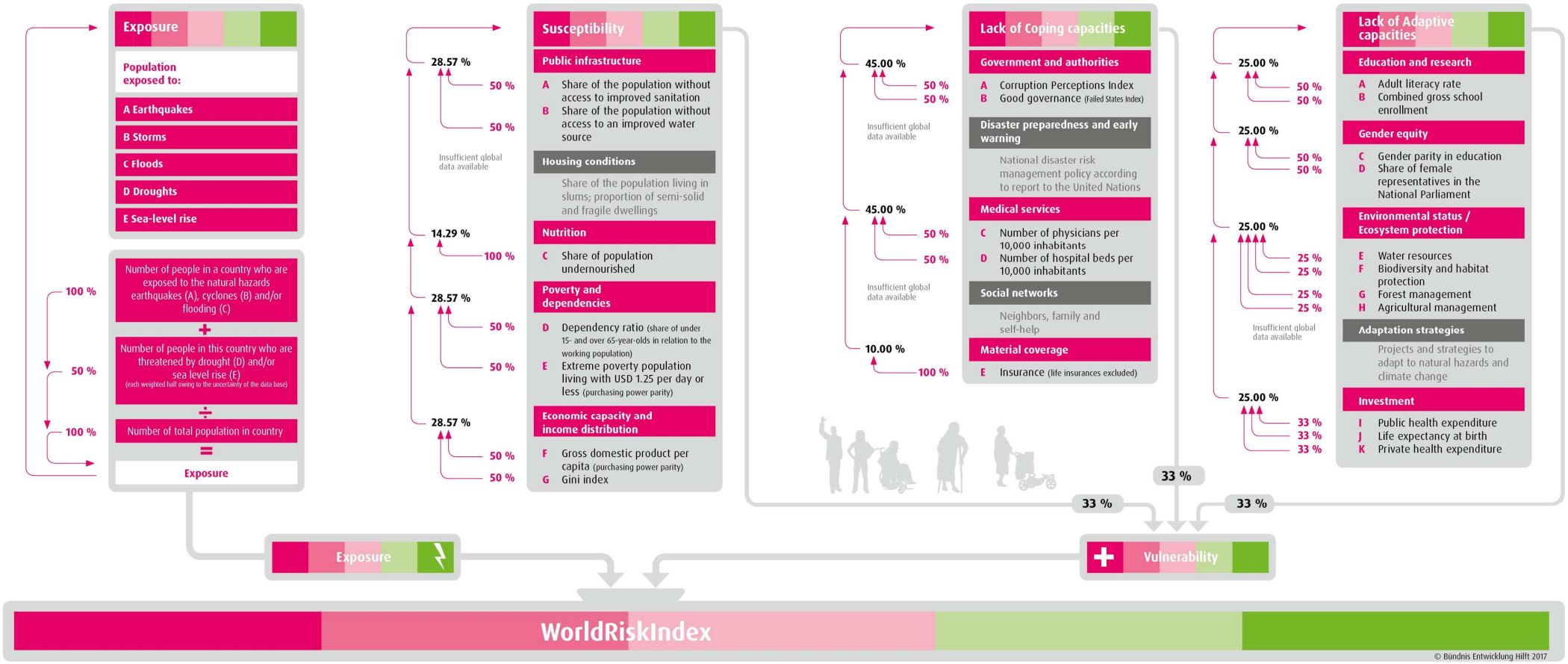
<Resource http://weltrisikobericht.de/english/>

World Risk Index



Aggregation of WorldRiskIndex <source: http://www.worldriskreport.org/>

World Risk Index



Key Findings from Literature Reviews

There are no or few indicators,

1. truly focusing on disaster risks before disaster breakout.
   - Most of index and indicators show impacts after disasters (not reducing disaster risks).
2. emphasizing adaptive and coping capacity.
3. highlighting Governments' efforts and roles in reducing risks.
4. combining statistical data and geospatial data.

2. Framework of Statistical Geospatial Indicators

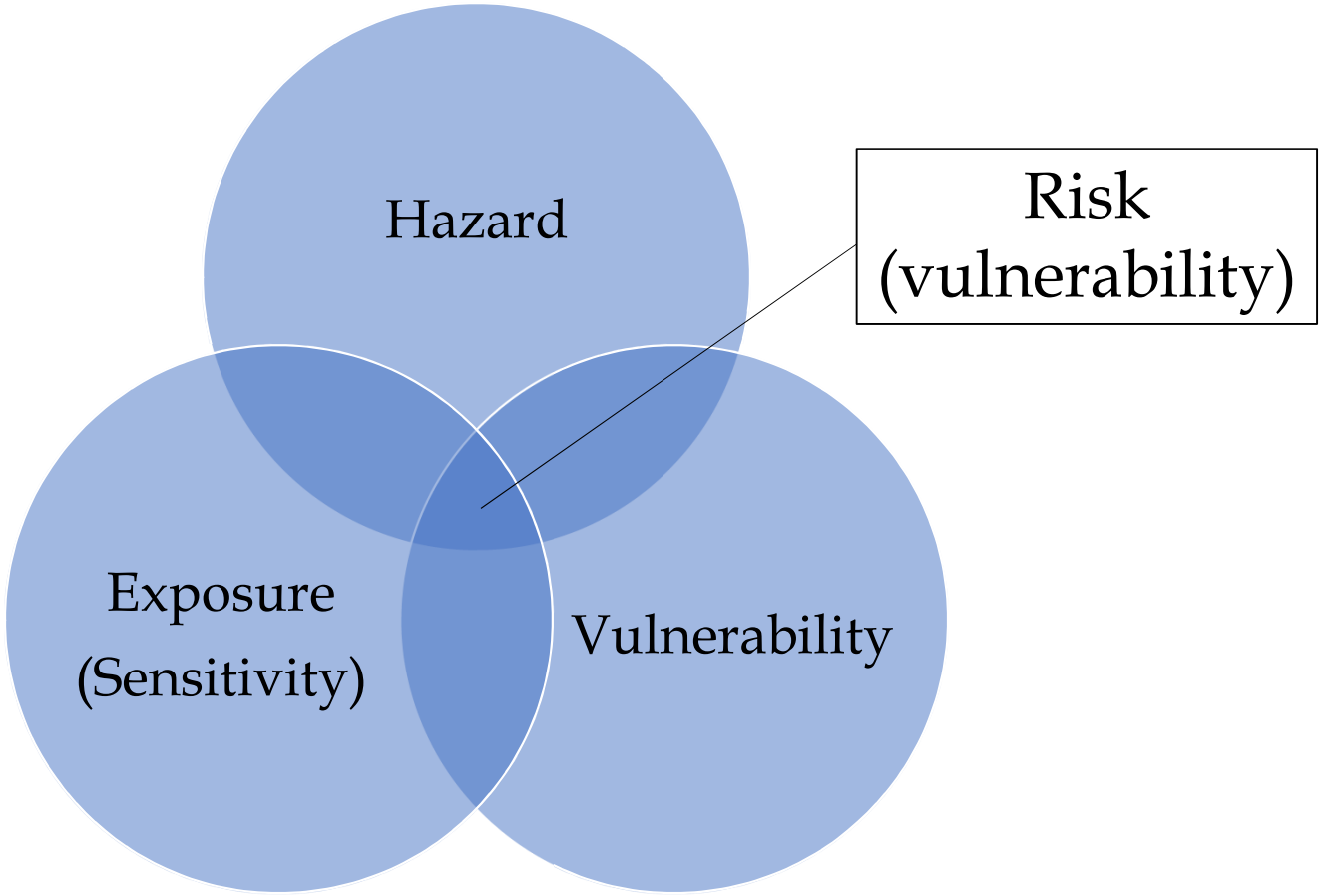
Key Questions

- How we define “risks” before disaster breakout?
- How better integrate statistical data and geospatial data?

2-1. What are risks?

- Risk is different from Disaster

Common Concept of Disaster Risk

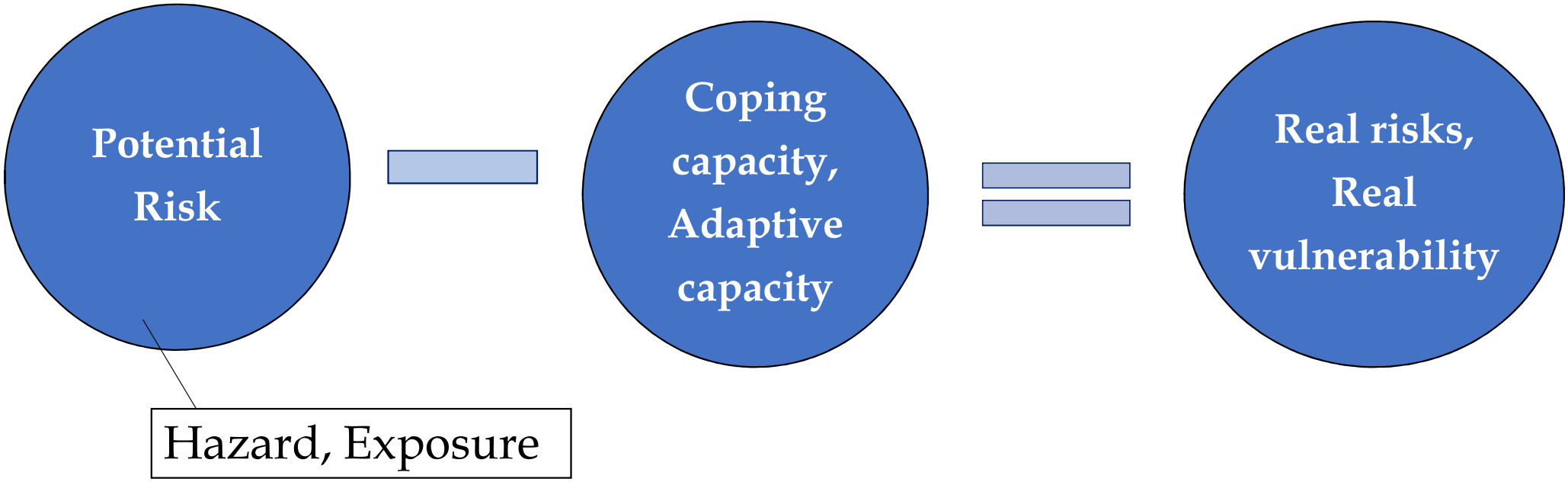


Common Concept of Disaster Risks (IPCC)

Term	Definition from IPCC
Vulnerability	"The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes"
Exposure	"The nature and degree to which a system is exposed to significant climatic variations"
Sensitivity	"The degree to which a system is affected, either adversely or beneficially, by climate-related stimuli"
Adaptive capacity	"The ability of a system to adjust to climate change to moderate potential damages, to take advantage of opportunities, or to cope with the consequences"

2-2. Our concept on Risk

Conceptual Framework



Differences from Existing Indicators

Existing Disaster Indicators	Statistical Geospatial Indicators
Measure after disasters	Measure risks before disasters
Measure death & economic loss	Measure required actions to reduce risks
Measure on specific date/time during or after disaster break-out	Measure progress for a period
Use statistical data	Combine statistical + geospatial data
Negative message (death and loss)	Positive message to governments Regardless of disaster loss, we remember governments' efforts to reduce disaster risks

2-3. Methodology for New Framework of Statistical Geospatial Indicators

Suggested Methodology (Approach)

1. **Modified Conventional (Vertical) Approach**
   - ❑ Combine statistical and geospatial data by putting up layers
2. **New SD-based (Horizontal) Approach**
   - ❑ Mix up statistical data and geospatial data randomly
   - ❑ Based on priority risks and capacity suitable to specific countries and regions

2-4. Modified Conventional (Vertical) Approach

Vertical Approach

Step 1

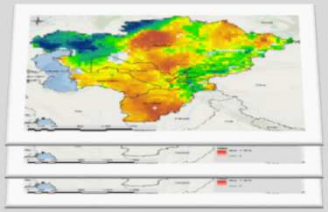
Exposure, Sensitivity (Geo-spatial) Indicators

Category	Indicator	Availability		Reference
		South Korea	Kazakhstan	
Exposure	Annual precipitation (mm)	0	0	Choi et al. (2009) Jung et al. (2010)
Sensitivity				

Adaptive Capacity (Statistical) Indicators

Category	Indicator	Availability		Reference
		South Korea	Kazakhstan	
Adaptive Capacity				

Step 2



Hazard, Exposure, Sensitivity Map

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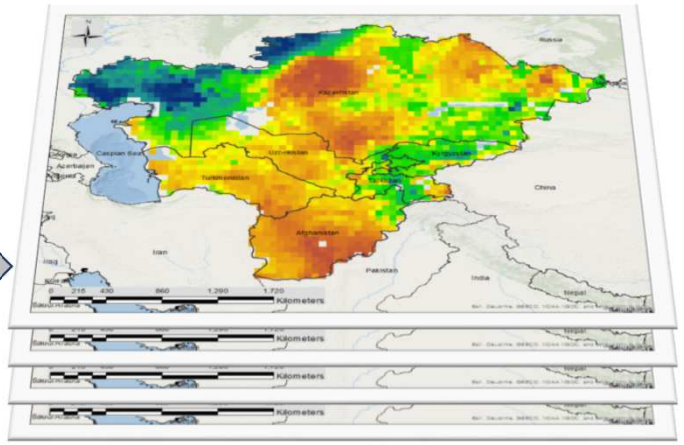
Adaptive Capacity Map



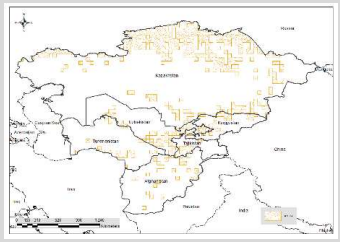
Real Risk Map

Vertical Approach

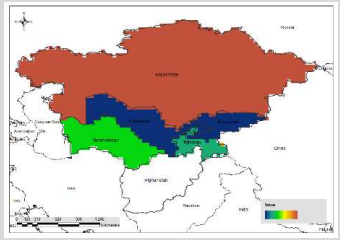
Drought

A-1. Exposure / Sensitivity Indicators

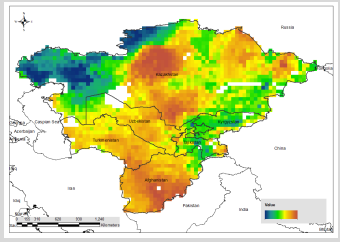
Agricultural land



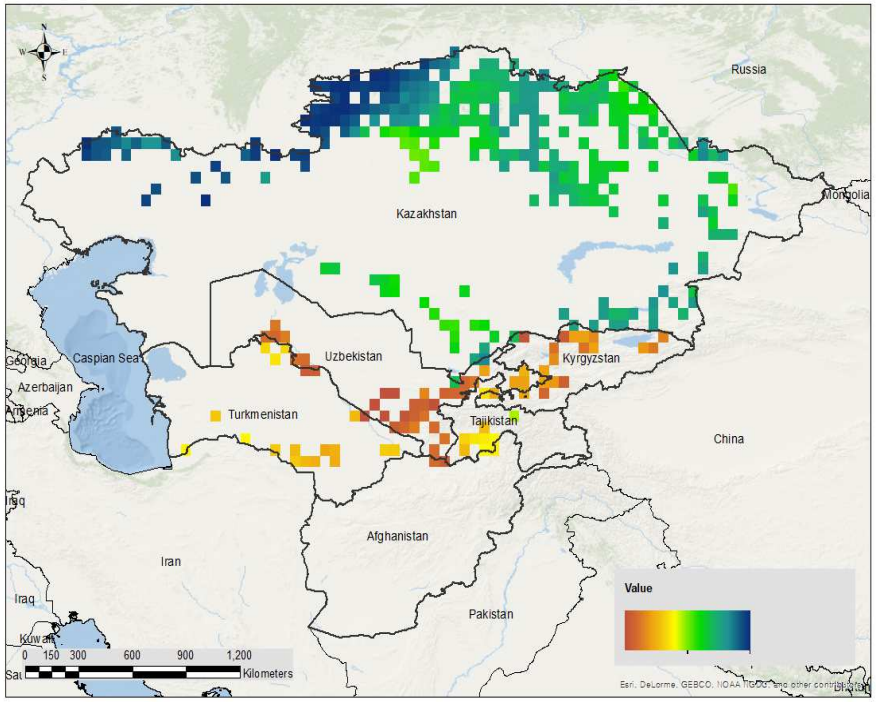
Agriculture value



PDSI



Exposure / Sensitivity Map
(geo-spatial / environmental)



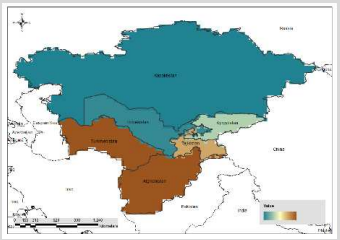
Source: Prof Woo Kyun Lee, Korea University, 2018

Vertical Approach

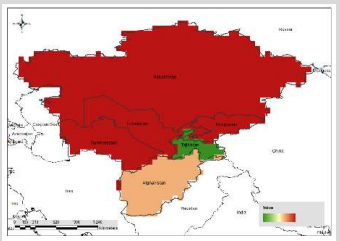
Drought

A-2. Adaptive Capacity Indicators

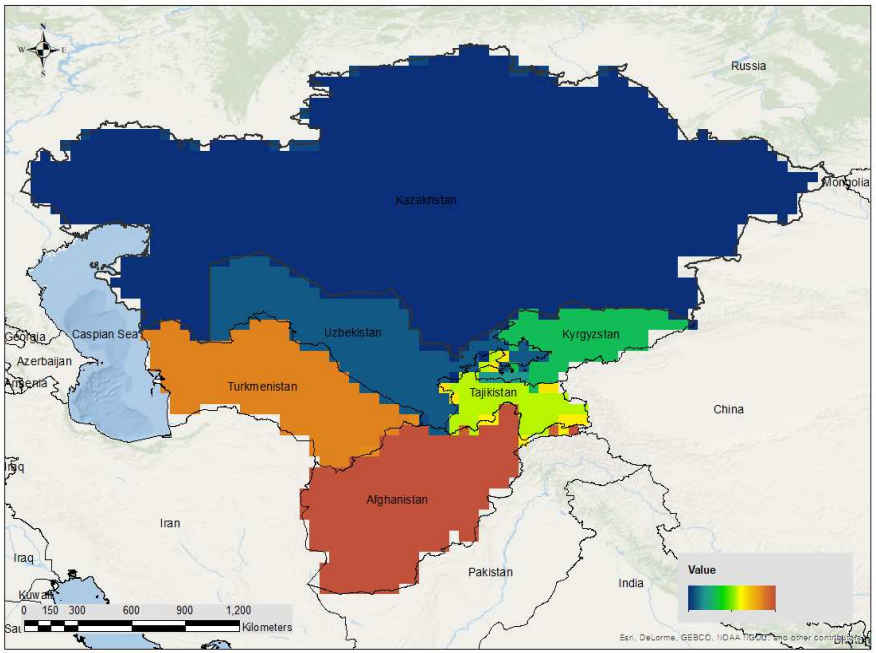
Improved water source



Disaster prevention and preparedness



Adaptive Capacity Map
(statistical / socio-economic)

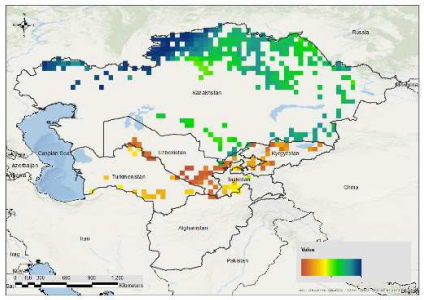


Source: Prof Woo Kyun Lee, Korea University, 2018

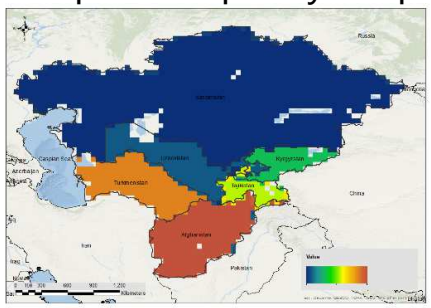
Vertical Approach

Drought

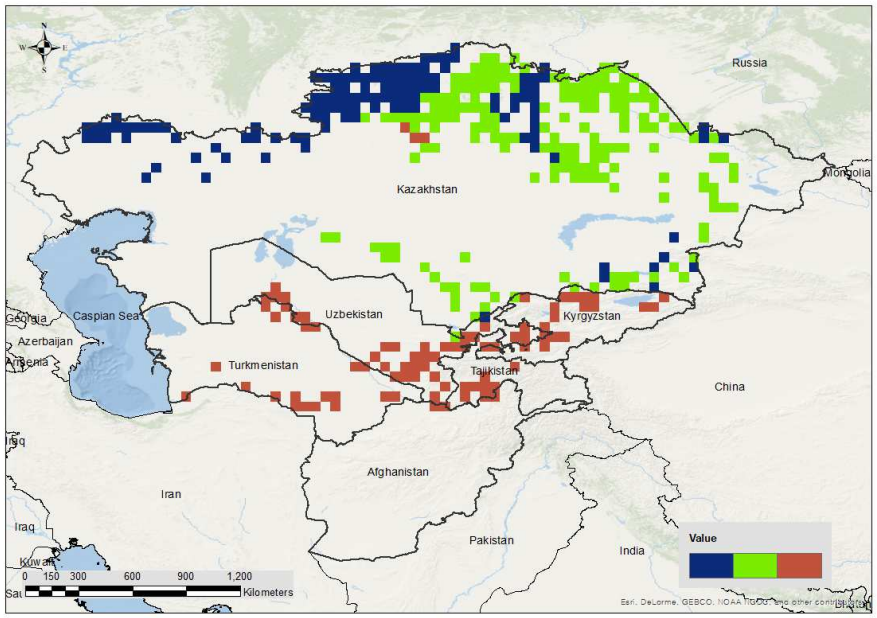
Sensitivity Map



Adaptive Capacity Map



Risk (Vulnerability) Map



Agricultural Drought Vulnerabilty Index
$= [(Agricultural\ land) \times (Agriculture\ value) \times (1 - PDSI)] \div [(Improved\ water\ source) \times (Disaster\ prevention\ and\ preparedness)]$

Description
This index is developed to see the potential impact of drought on agriculture by its value, water source, government's financial commitment to disaster prevention and preparedness, including the meaning of meteorological drought.

Source: Prof Woo Kyun Lee, Korea University, 2018

Vertical Approach

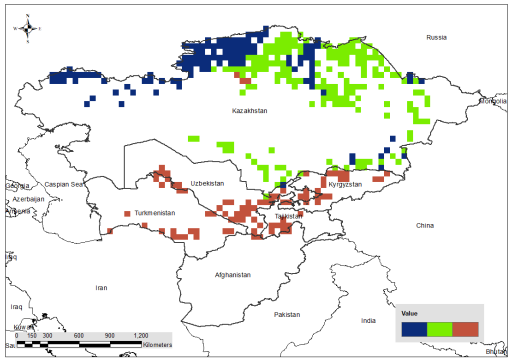
Drought

C. Developing Adaptive Pathways

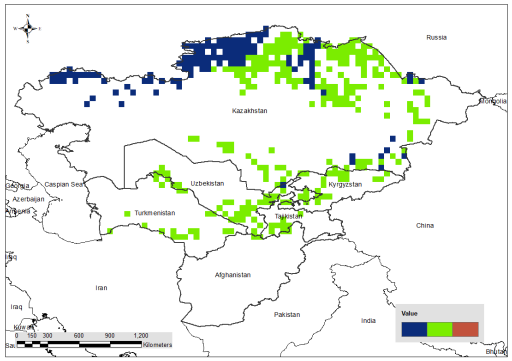
Source: Prof Woo Kyun Lee, Korea University, 2018

Agricultural Drought Impact Index

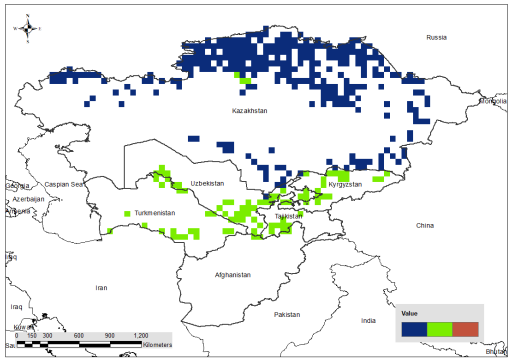
Risky Pathway (no action)



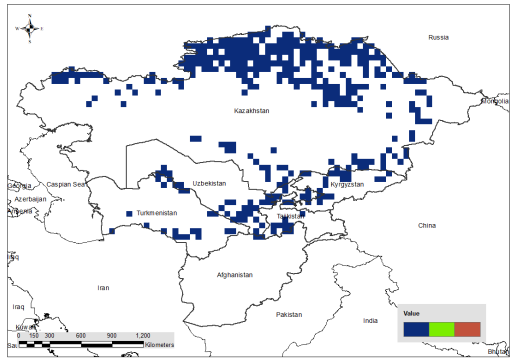
Passive Pathway (HV→MV)



Active Pathway (HV→MV, MV→LV)



Full Pathway (HV→LV, MV→LV)



Class	Risky Pathway		Passive Pathway		Active Pathway		Full Pathway	
	Area (km^2)	Area (%)	Area (km^2)	Area (%)	Area (km^2)	Area (%)	Area (km^2)	Area (%)
LV	302,500	31.5	302,500	31.5	745,000	77.6	960,000	100
MV	442,500	46.1	657,500	68.5	215,000	22.4	0	0
HV	215,000	22.4	0	0	0	0	0	0
Sum	**960,000**	**100**	**960,000**	**100**	**960,000**	**100**	**960,000**	**100**

Vertical Approach

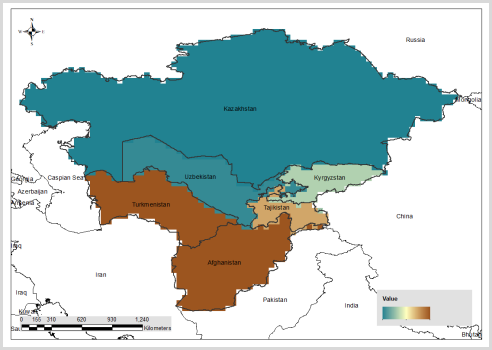
Drought

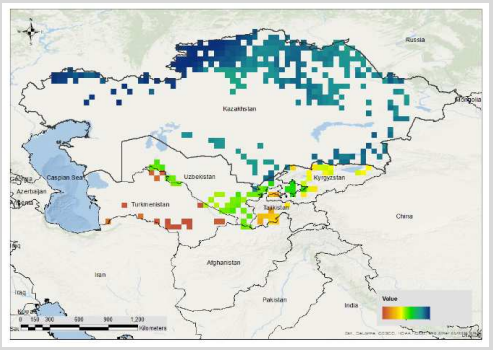
C. Developing Adaptive Pathways

Improved water source

Risk/Vulnerability

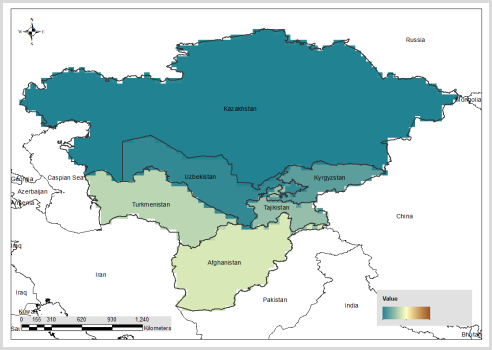
Present

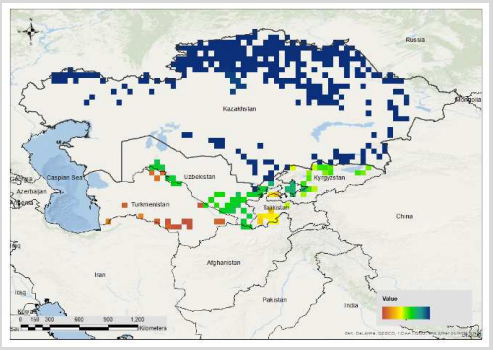




Increase in
Adaptive Capacity

Future





Source: Prof Woo Kyun Lee, Korea University, 2018

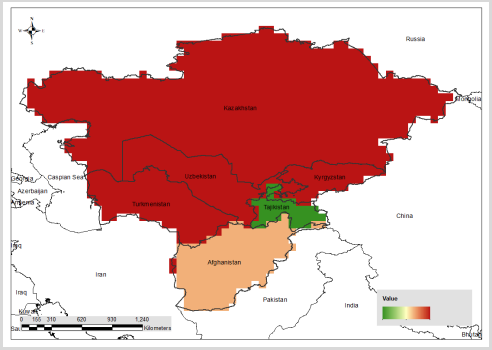
Vertical Approach

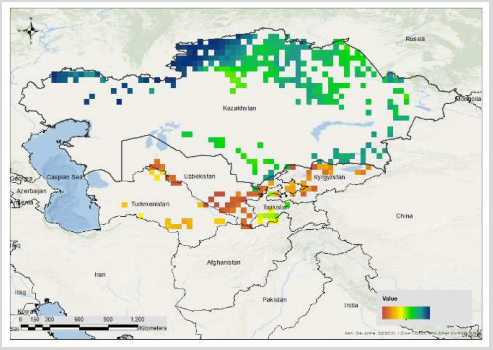
Drought

C. Developing Adaptive Pathways

Disaster Prevention and Preparedness | **Vulnerability**

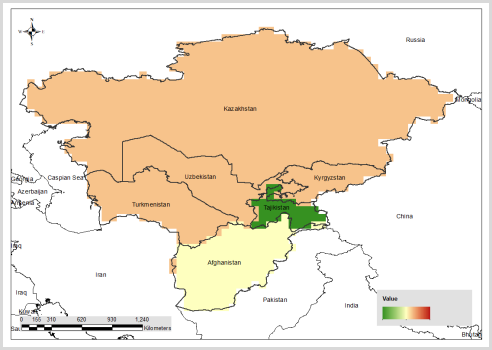
Present

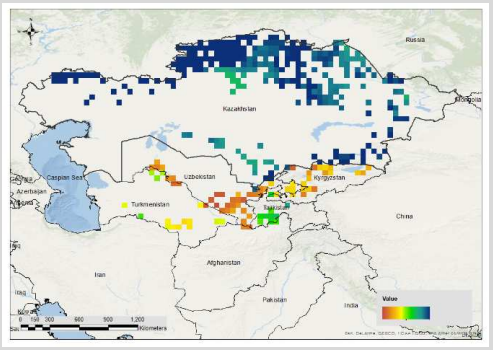




Increase in Adaptive Capacity

Future





Source: Prof Woo Kyun Lee, Korea University, 2018

Vertical Approach

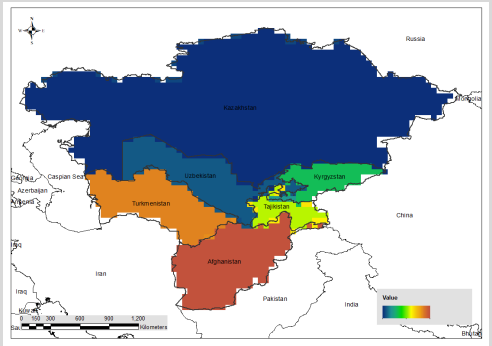
Drought

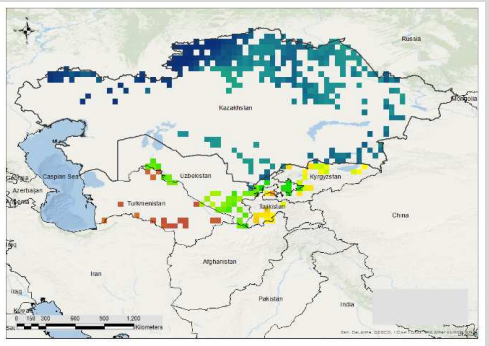
C. Developing Adaptive Pathways

Improved water source + Disaster prevention and preparedness

Risk/Vulnerability

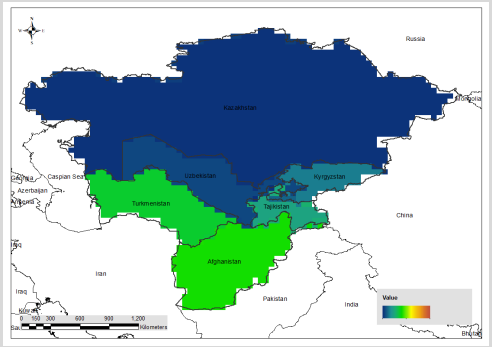
Present

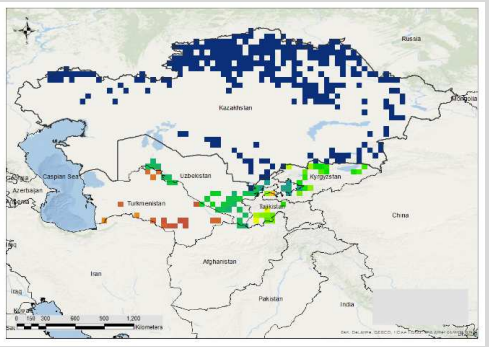




Increase in Adaptive Capacity

Future

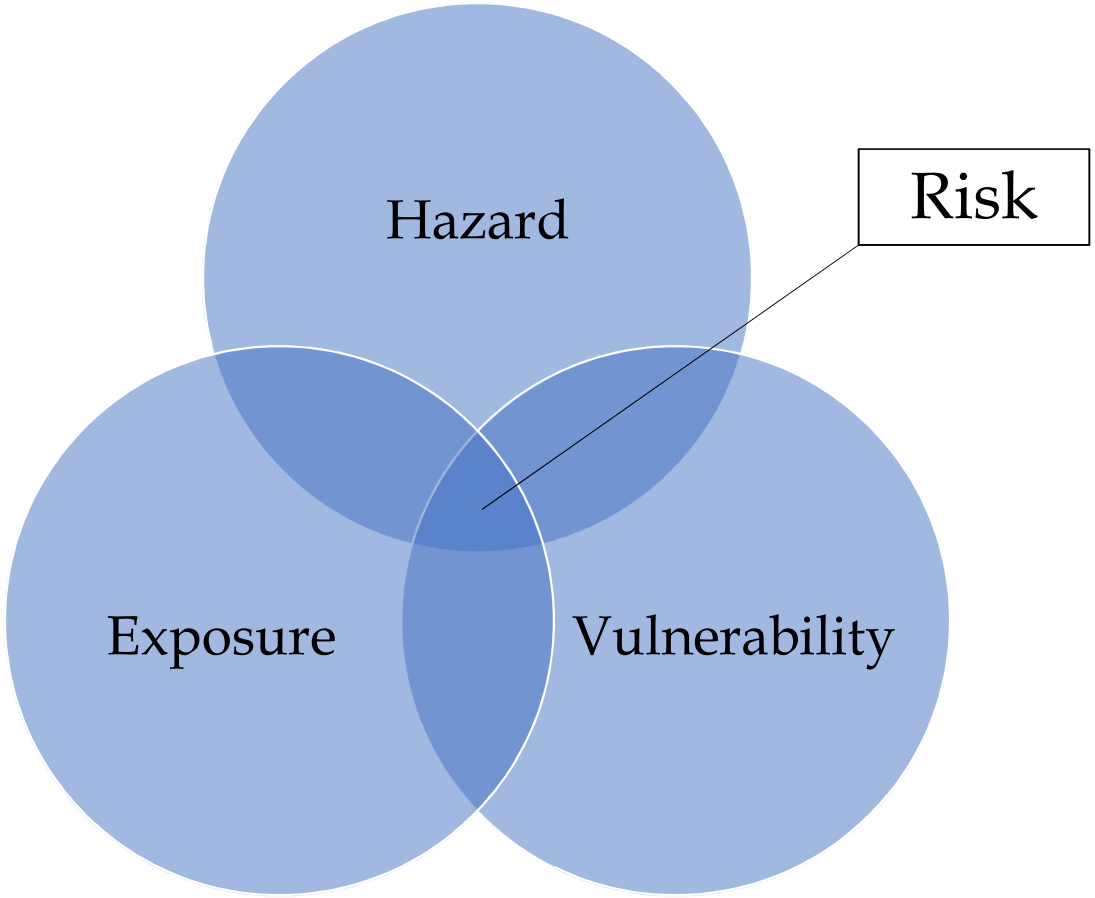




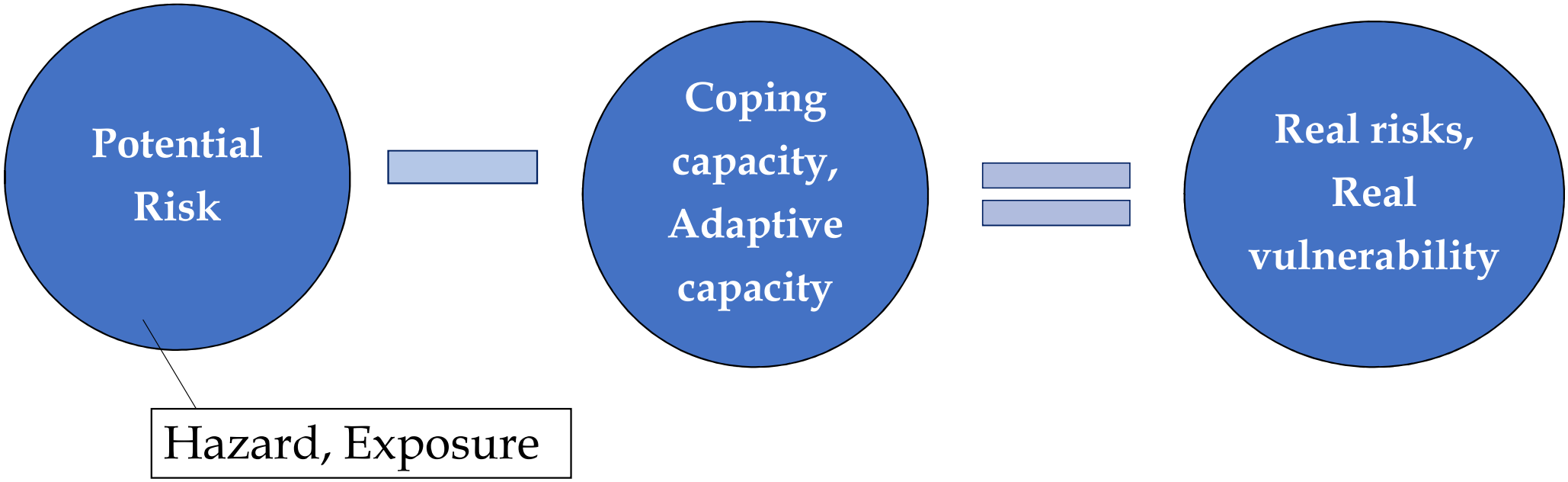
Source: Prof Woo Kyun Lee, Korea University, 2018

2-5 New Sustainability-based (Horizontal) Approach

Common Concept of Disaster Risk



Conceptual Framework



Key Principles

1. Adopt 3 pillars of sustainable development in row dimension
   - Economic, Social, Environmental Pillars
2. Two additional dimensions in row
   - Regulatory institutions, and Infrastructure
3. Adopt conventional concept in column dimension
   - Hazard, exposure, vulnerability and capacity
4. Select 25 indicators as first step.
   - Each country can adjust number of indicators

Horizontal Framework

	Hazard	Exposure	Vulnerability	Capacity	
Economic					
Social					
Environment					
Institutional					
Infrastructure					

Horizontal Framework

	Hazard	Exposure	Vulnerability	Capacity	
Economic					
Social					
Environment					
Institutional					
Infrastructure					

Three Pillars of Sustainable Development

Horizontal Framework

Risks / Dimensions	Hazard	Exposure	Vulnerability	Capacity	
Economic	5 indicators / per dimension x 5 dimensions = Total 25 indicators (can increase)				
Social					
Environment					
Institutional					
Infrastructure					

	Hazard	Exposure	Vulnerability	Capacity	
Economic	Government budget on disaster sector	Income inequality	Government tax related to DRR	Disaster-related fund	Annual economic disaster loss
Social	Number of disaster shelters	Number of hospitals	Disaster insurance	Regular exercise on disaster	Number of rescue team
Environment	Hazard data and mapping for disaster type	Land/city data mapping	Internet access to digital map	Urban population density	Urban population living in slums
Regulatory Institutions	Operating system on disaster risk reduction	Pre-disaster planning	Asset Management System under disaster breakout	Disaster response system	Disaster Information Management System
Infrastructure	Number of earthquake resilient building	Public facilities with resilient system	Ratio for Infrastructure with resilient system	Emergency call network	Emergency Item supply system

Yellow color: Geospatial data

3. Application of Proposed Framework and Indicators, and Results

3-1. Pilot in Korea and Kazakhstan (Conventional layer approach)

Indicator Equation for Drought

Drought

$$\boldsymbol{Agricultural\ Drought\ Vulnerabilty\ Index}$$
$$= [(1 - PDSI) \times (1 - TWI) \times (Agriculture\ value\ added)$$
$$\times (Drainage\ class\ (high))] \div [(Dam\ storage\ capacity)$$
$$\times (Improved\ water\ source) \times (Land\ designated\ for\ agricultural\ promotion)$$
$$\times (Agricultural\ water\ location) \times (Budget\ per\ capita)$$
$$\times (Disaster\ management\ fund)]$$

Description
This index is developed to see the potential impact of drought on agriculture by its value, water source, local governments' financial commitment to disaster management, including the meaning of meteorological drought.

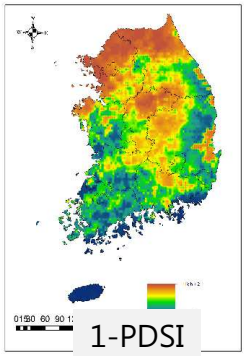
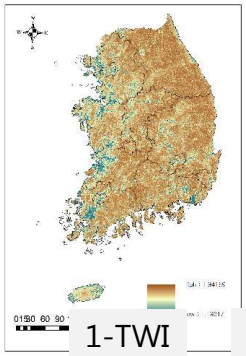
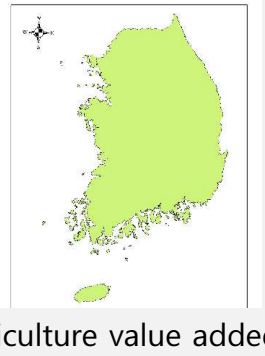
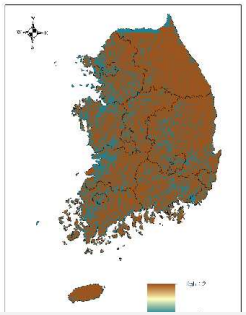
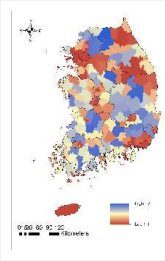
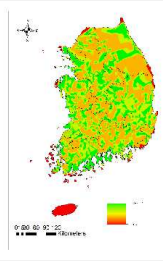
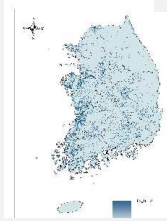
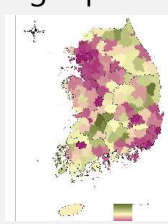
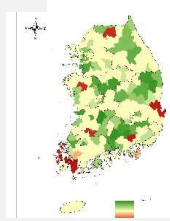
Source: Prof Woo Kyun Lee, Korea University, 2019

3-2. Result of Korea

Korea Pilot Result

Drought

2015 – Observation

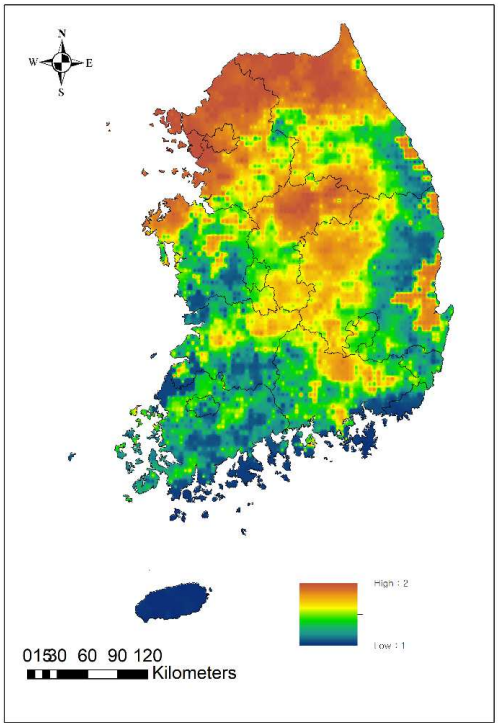
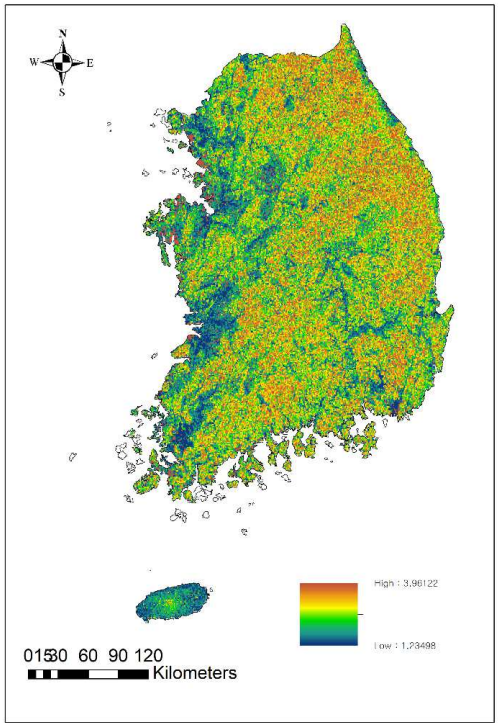
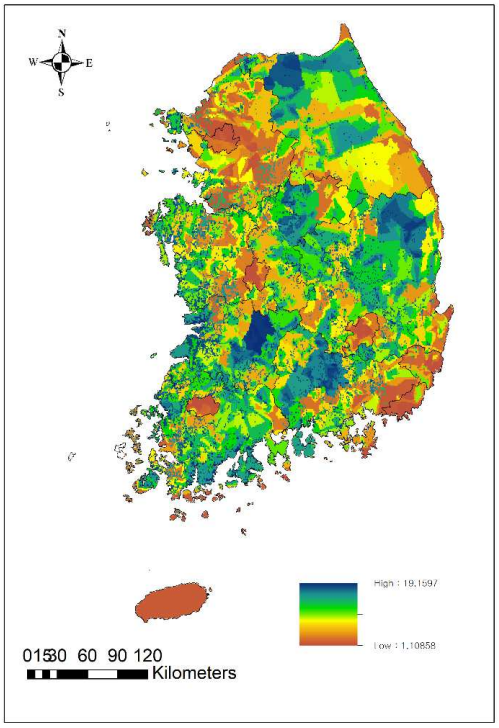
Exposure	Sensitivity	Adaptive Capacity
 1-PDSI	 1-TWI  Agriculture value added  Drainage class (high)	Improved water source   N/A  Dam storage capac Agricultural water location → Infra Budget per capita    Land designated for agricultural promotion Disaster management fund → Inst. & Policies

Source: Prof Woo Kyun Lee, Korea University, 2019

Korea Pilot Result

Drought

2015 – Observation

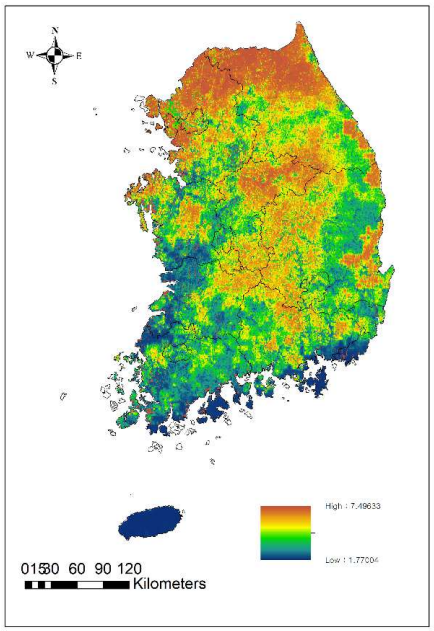
Exposure	Sensitivity	Adaptive Capacity
		

Source: Prof Woo Kyun Lee, Korea University, 2019

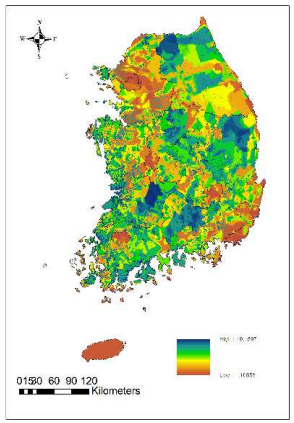
Korea Pilot Result

Drought

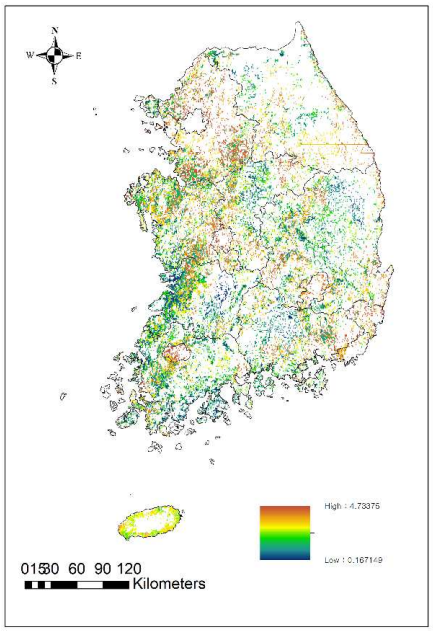
2015 – Observation
1km*1km



Exposure*Sensitivity



Adaptive Capacity



Risk (Vulnerability)

Source: Prof Woo Kyun Lee, Korea University, 2019

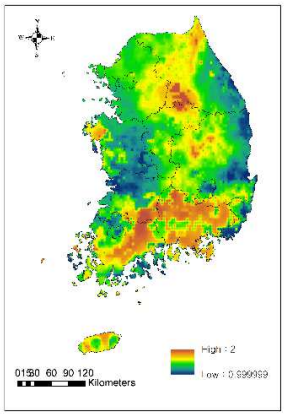
Korea Pilot Result

Drought

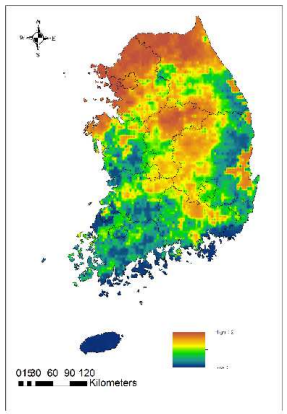
2014-2018 – Observation

1-PDSI

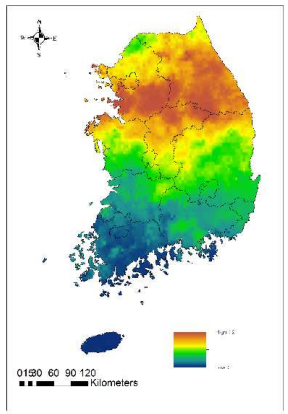
2014



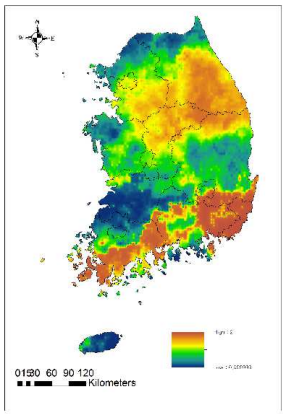
2015



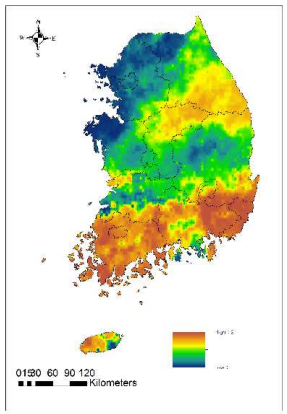
2016



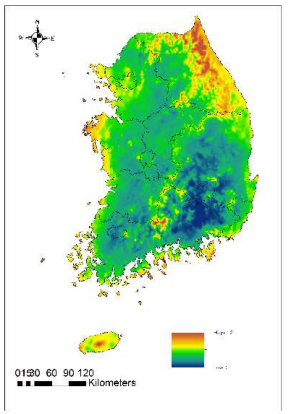
2017



2018



2019

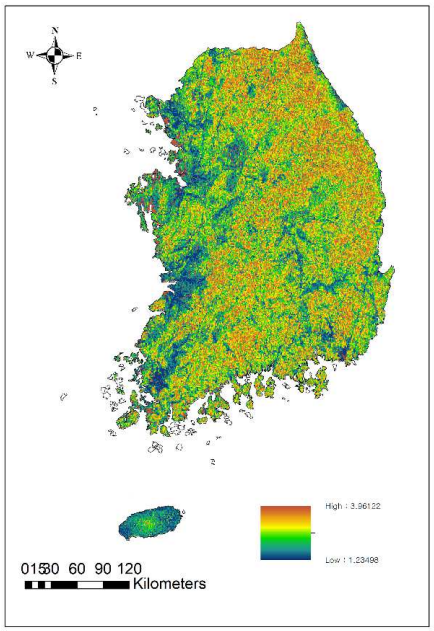


Source: Prof Woo Kyun Lee, Korea University, 2019

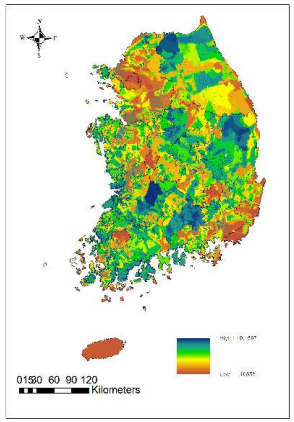
Korea Pilot Result

Drought

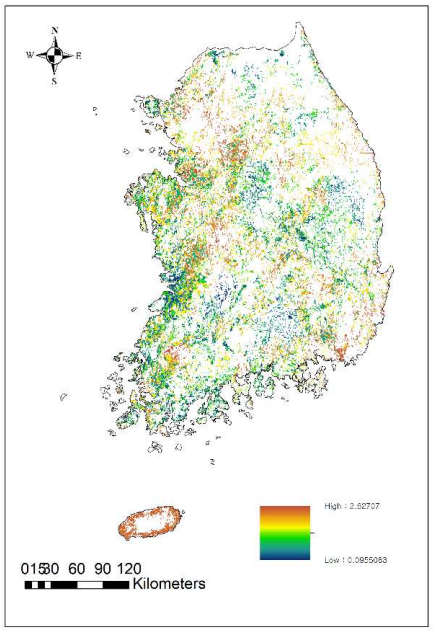
2015 – Observation
1km*1km



Sensitivity



Adaptive Capacity



Risk (Vulnerability)

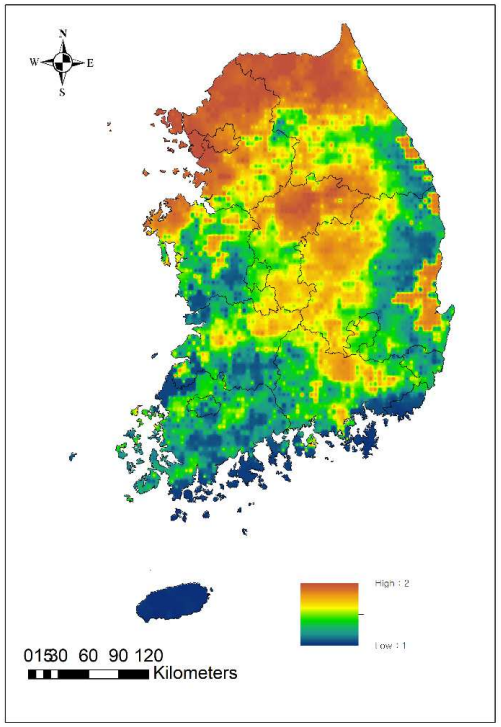
Source: Prof Woo Kyun Lee, Korea University, 2019

Result Verification

Drought

2015 – Observation

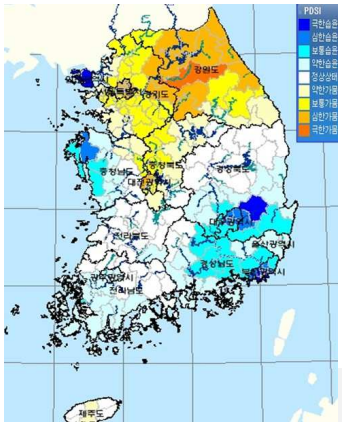
(1-PDSI) of 2015

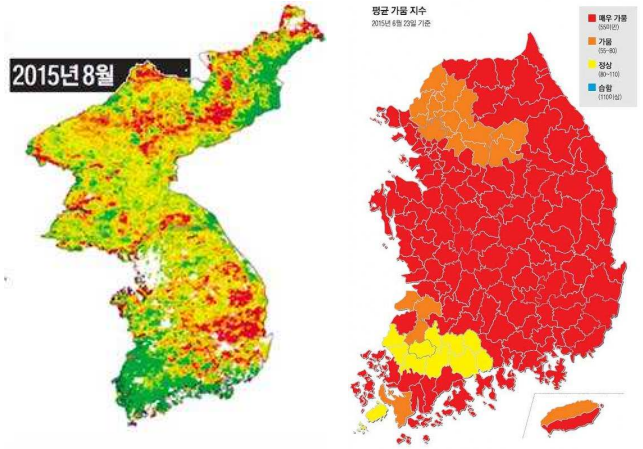


← 2014 accumulated precipitation

↓ Average drought index of June 23, 2015 from Ministry of Public Safety and Security

Drought of Aug, 2015 from RS (Choi et al.) →





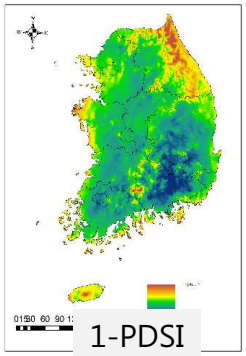
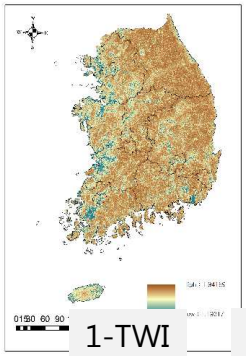
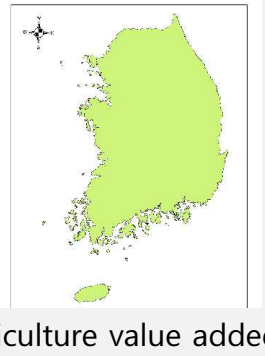
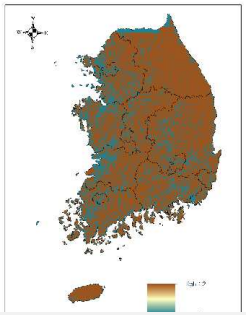
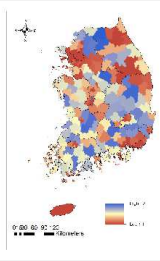
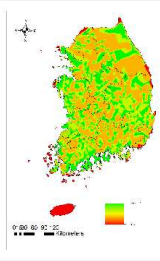
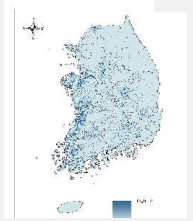
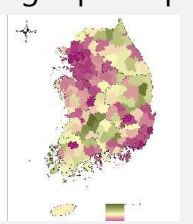
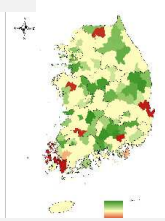
←PDSI of Feb 9, 2015 from K-water

Source: Prof Woo Kyun Lee, Korea University, 2019

Korea Pilot Prediction

Drought

2019 – Prediction

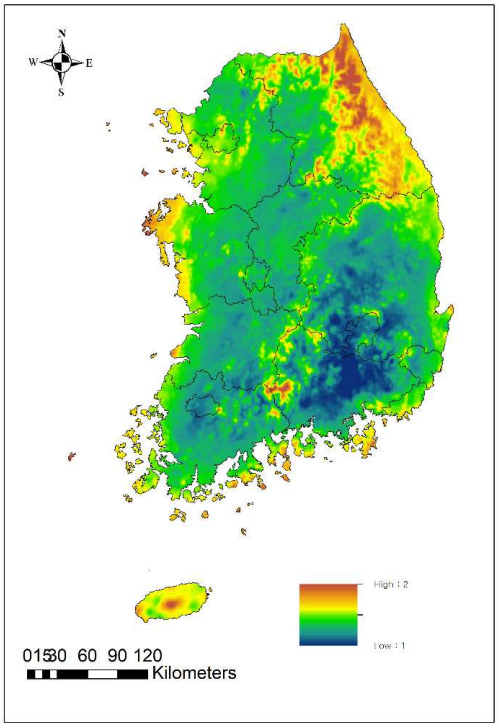
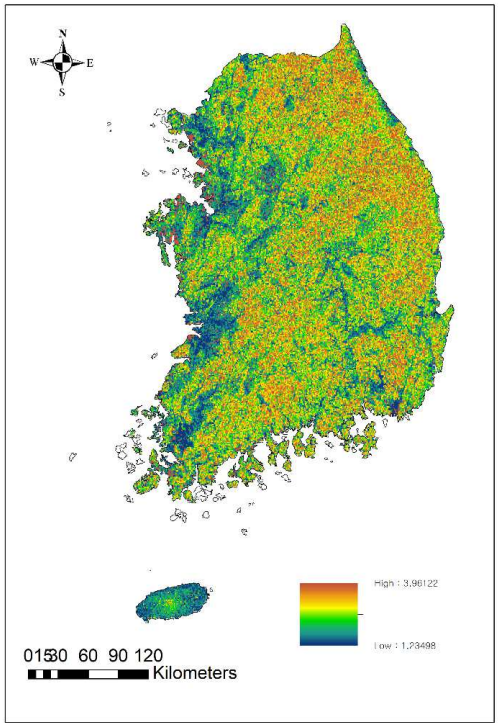
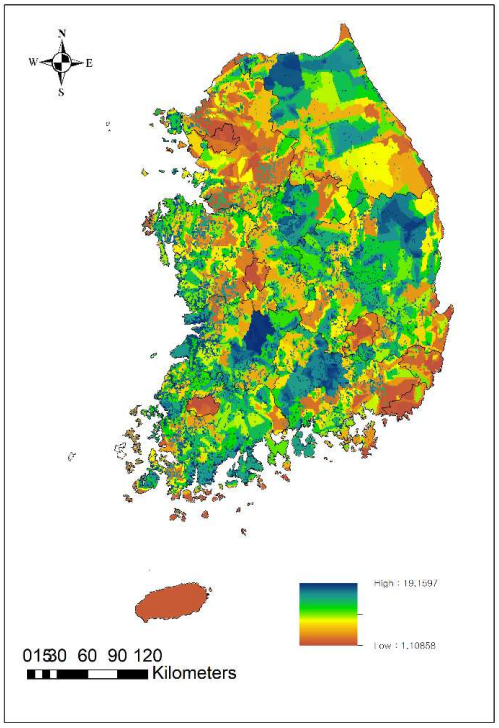
Exposure	Sensitivity	Adaptive Capacity
 1-PDSI	 1-TWI  Agriculture value added  Drainage class (high)	Improved water source   N/A  Dam storage capac Agricultural water location → Infra Budget per capita    Land designated for agricultural promotion Disaster management fund → Inst. & Policies

Source: Prof Woo Kyun Lee, Korea University, 2019

Korea Pilot Prediction

Drought

2019 – Prediction

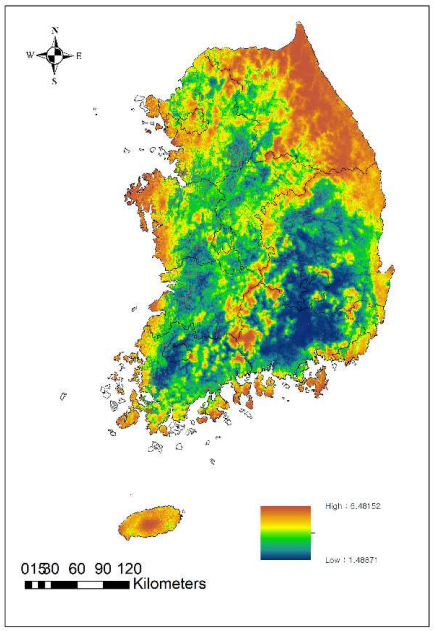
Exposure	Sensitivity	Adaptive Capacity
		

Source: Prof Woo Kyun Lee, Korea University, 2019

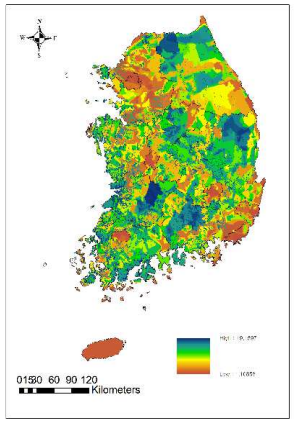
Korea Pilot Prediction

Drought

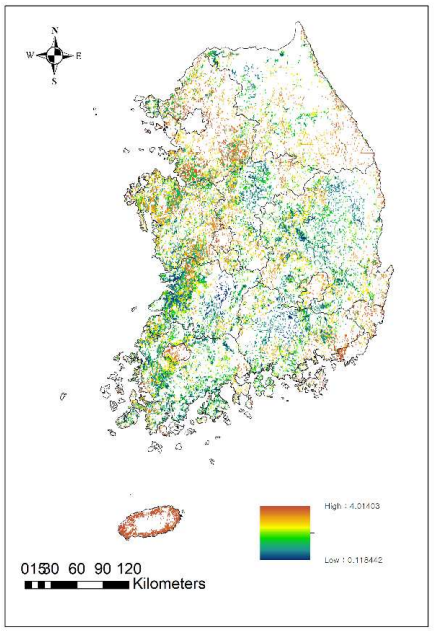
2019 – Prediction
1km*1km



Exposure*Sensitivity



Adaptive Capacity



Risk (Vulnerability)

Source: Prof Woo Kyun Lee, Korea University, 2019

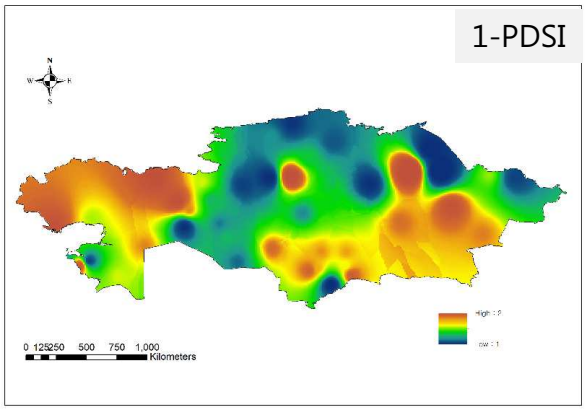
3-3. Result of Kazakhstan

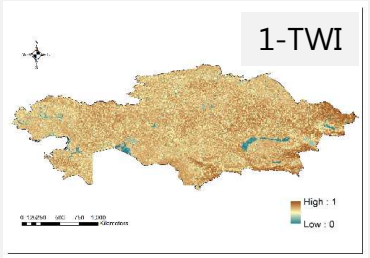
Kazakhstan Pilot Result

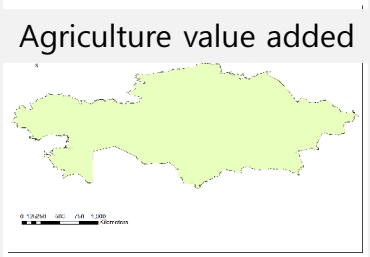
Drought

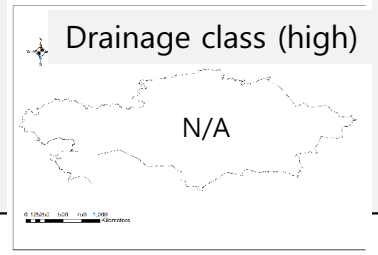
2015 – Observation

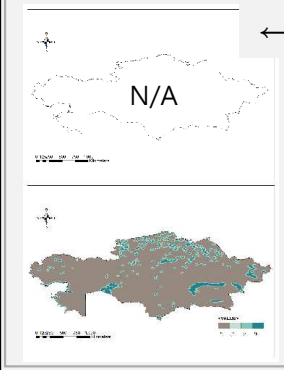
Exposure	Sensitivity	Adaptive Capacity
1-PDSI	1-TWI	← Dam storage capacity
		Improved water source
	Agriculture value added	← Agricultural water location
		(all lakes and reservoirs)
	Drainage class (high)	← Land designated for agricultural promotion
		Budget per capita
		← Disaster management fund

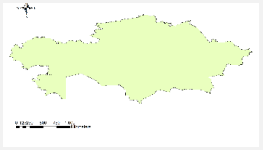


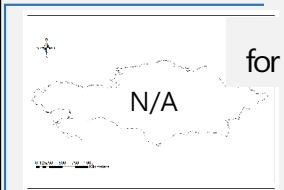


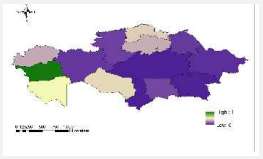












Infra

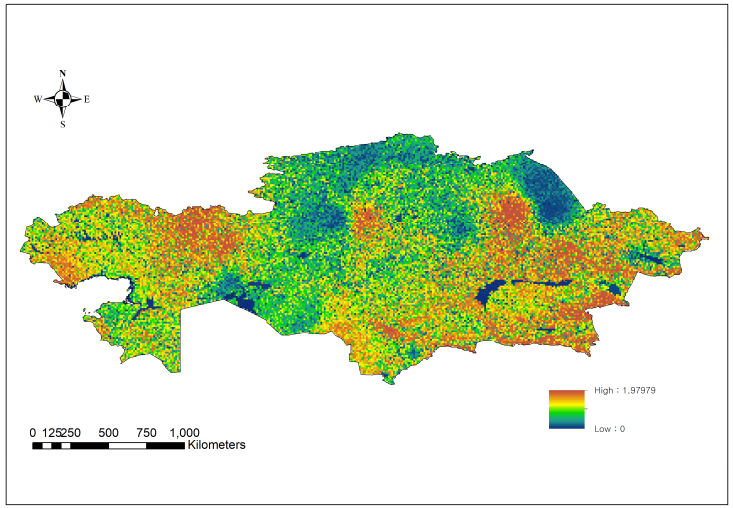
Inst. & Policies

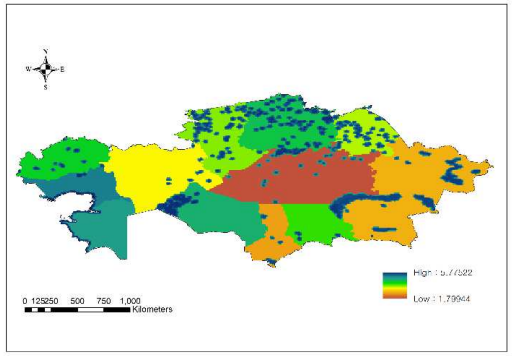
Source: Prof Woo Kyun Lee, Korea University, 2019

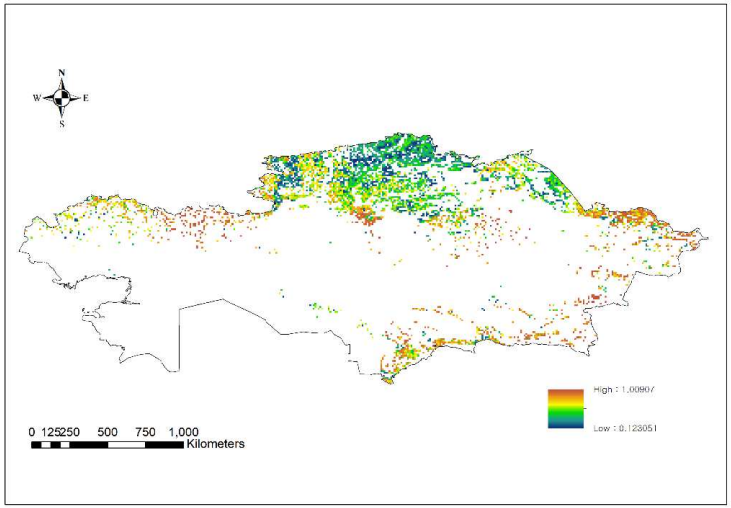
Kazakhstan Pilot Result

Drought

2015 – Observation
10km*10km







Exposure*Sensitivity

Adaptive Capacity

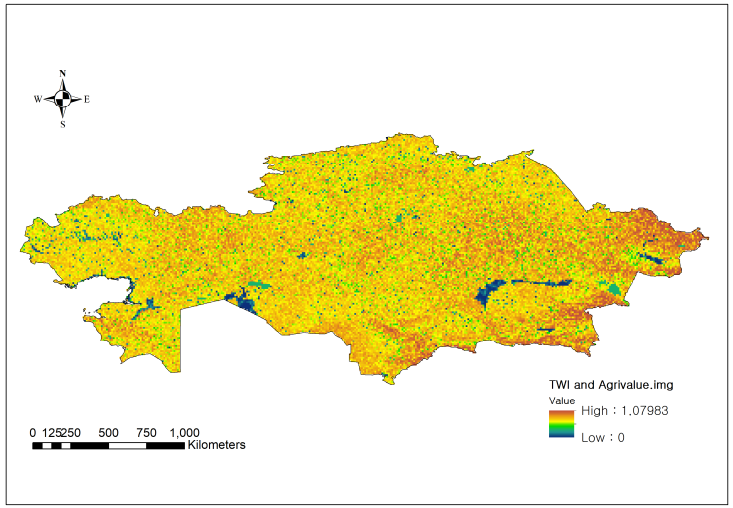
Risk (Vulnerability)

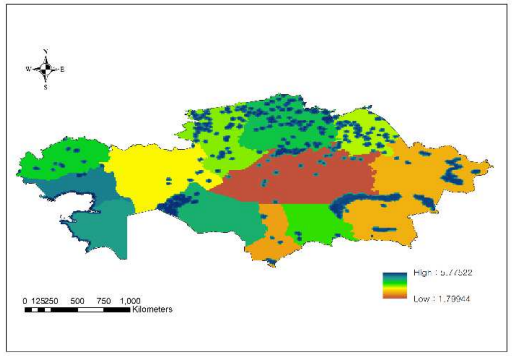
Source: Prof Woo Kyun Lee, Korea University, 2019

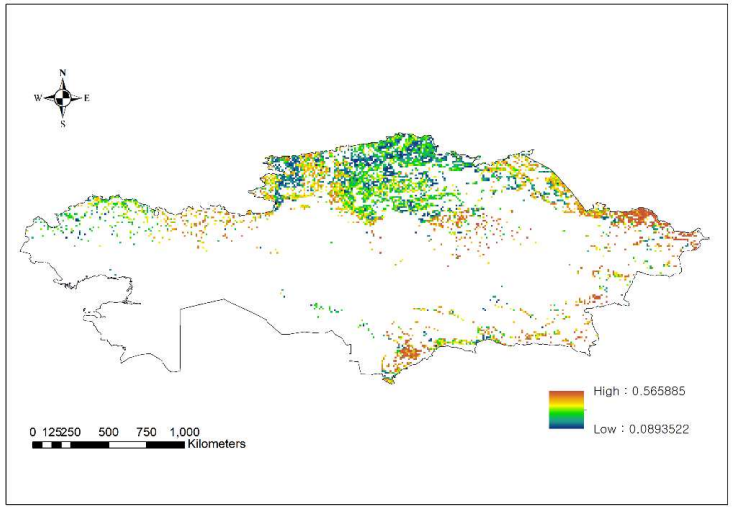
Kazakhstan Pilot Result

Drought

2015 – Observation
10km*10km







Sensitivity

Adaptive Capacity

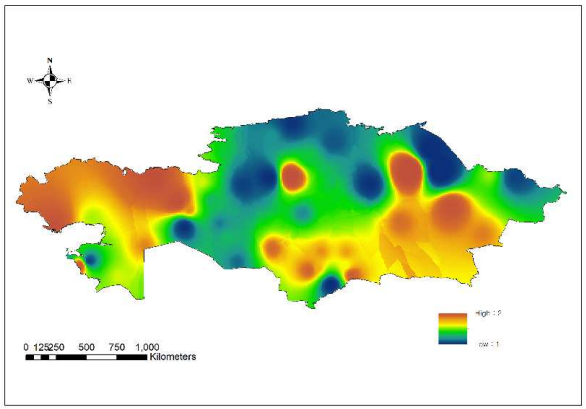
Risk (Vulnerability)

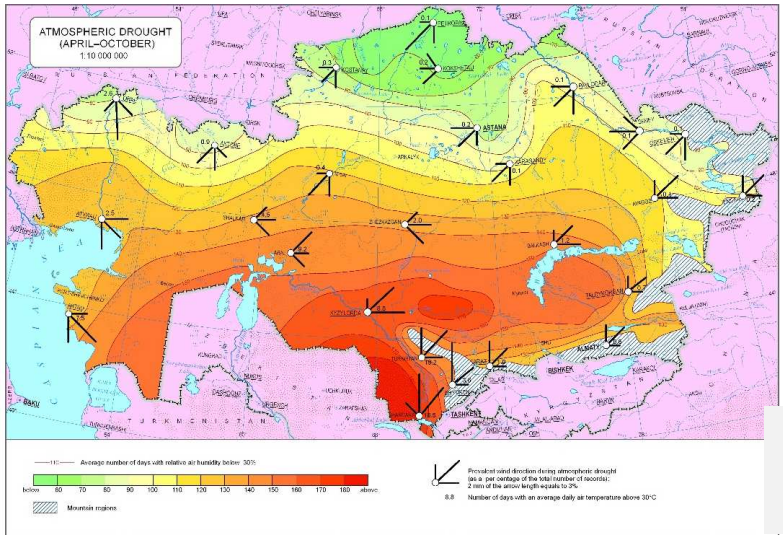
Source: Prof Woo Kyun Lee, Korea University, 2019

Kazakhstan Pilot Result

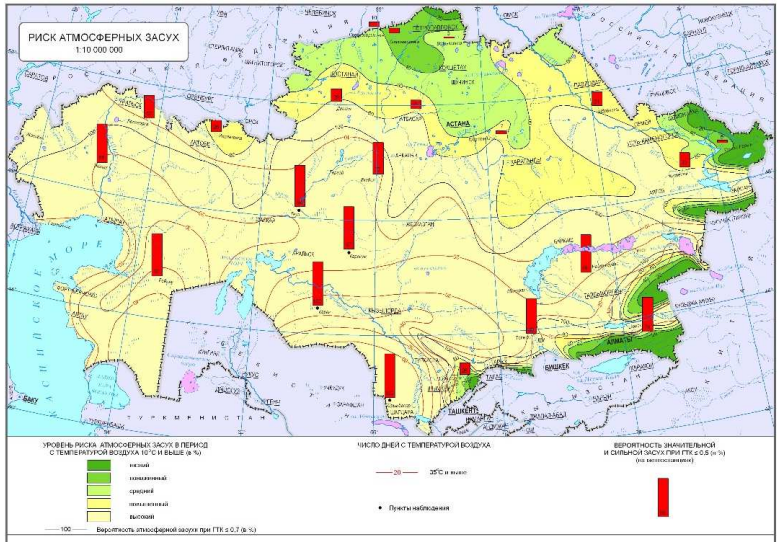
Drought

(1-PDSI) of 2015





Atmospheric drought
- Mainly from air humidity below 30%
- Average year



The risk of atmospheric drought from hydrothermal index
- (red bar) Probability of drought from hydrothermal index
- Average year

Source: Prof Woo Kyun Lee, Korea University, 2019

Availability of Data

Drought

Category	Indicator	Availability		Reference
		South Korea	Kazakhstan	
Exposure	Annual precipitation (mm)	O	O	Choi et al. (2009) Jung et al. (2010)
	Palmer Drought Severity Index (PDSI)	O	O	Sivakumar et al. (2010)
	Standardized Precipitation Index (SPI)	O	O	Łabędzki and Bąk (2014)
Sensitivity	Population density	O	O	Oh et al. (2012) Swain and Swain (2011)
	Cultivated area	O	O	Kim et al. (2013) Jang (2006)
	Topographic Wetness Index (TWI)	O	O	Muukkonen et al. (2015) Zhang et al. (2011)
	Drainage class	O	X	Quiring and Ganesh (2010)
	Agricultural value added/GDP (%)	O	O	Iglesias et al. (2009)

Source: Prof Woo Kyun Lee, Korea University, 2019

Availability of Data

Drought

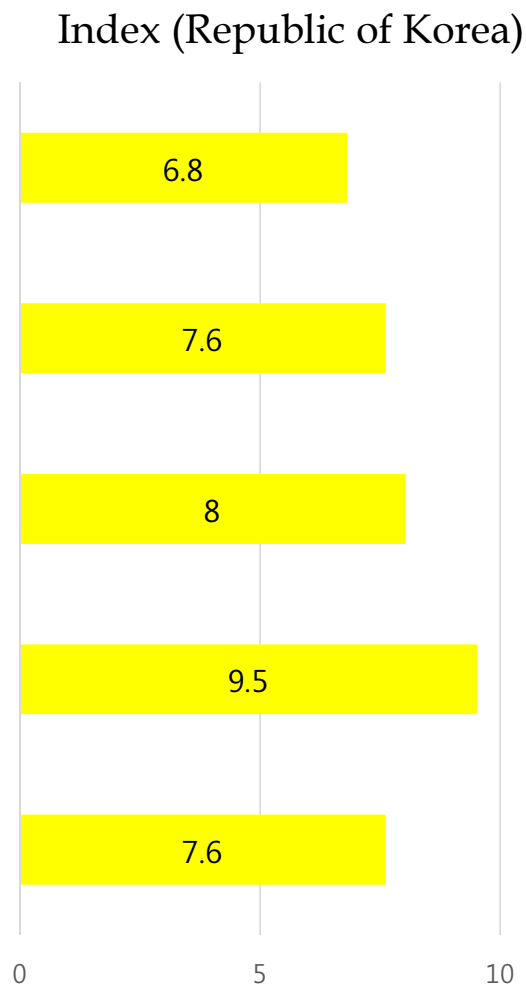
Category	Indicator	Availability		Reference
		South Korea	Kazakhstan	
Adaptive Capacity	GDP per capita	O	O	Cheng and Tao (2010) Wu et al. (2013)
	Population with access to improved water (% of total)	△	O	Iglesias et al. (2009)
	Available reservoir storage of farm dams	O	△	Oh et al. (2012)
	Number of reservoirs	O	O	Cancelliere et al. (1998).
	Agricultural water location	O	△	Yi et al. (2004)
	Disaster management fund	O	X	Kim (2010) Park (2008) Lee et al. (2017)
	Land designated for agricultural promotion	O	X	Park (2006)
	Annual budget per capita	O	O	This study

Source: Prof Woo Kyun Lee, Korea University, 2019

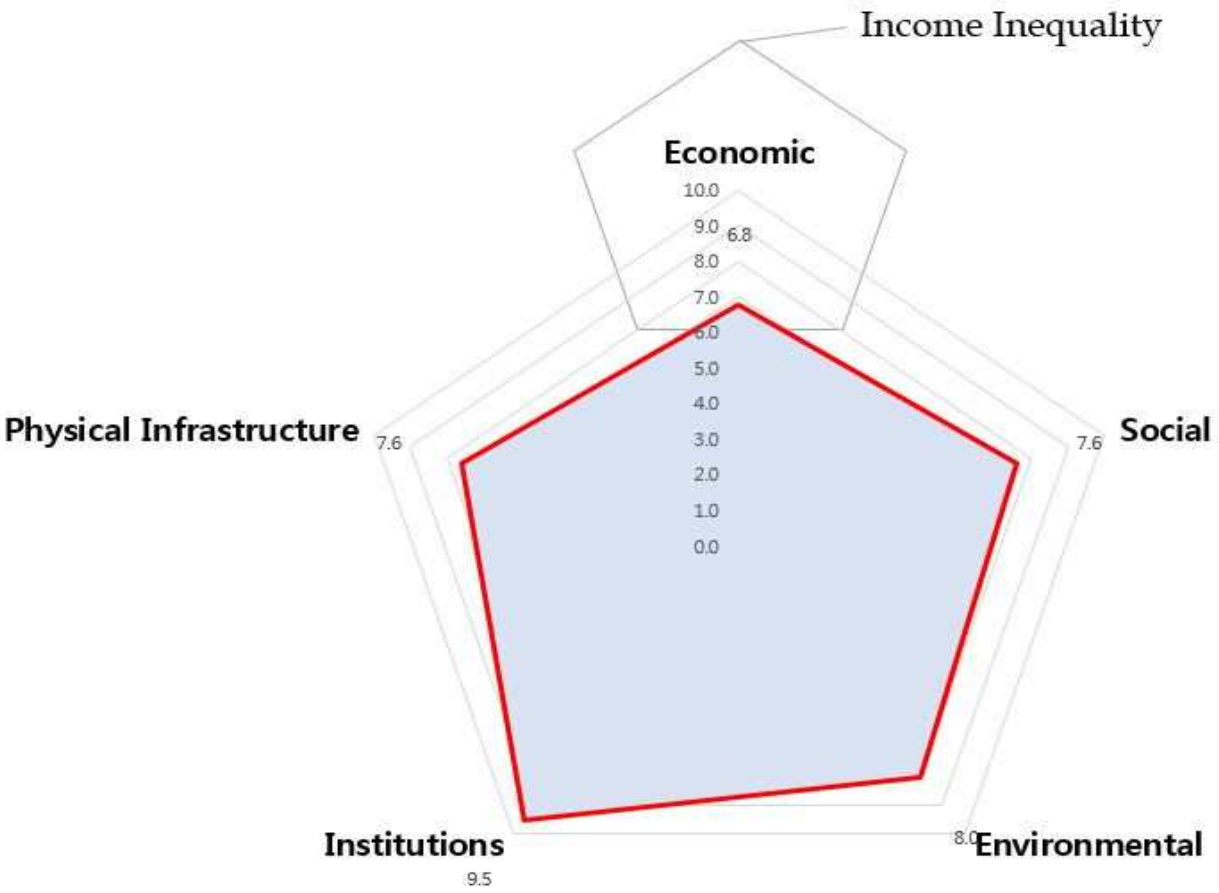
3-4. New SD-based (Horizontal) Approach

Applications of Indicators (Korea as Reference)

	Hazard	Exposure	Vulnerability	Capacity	
Economic	Government budget on disaster sector	Income inequality	Government tax related to DRR	Disaster-related fund	Annual economic disaster loss
Social	Number of disaster shelters	Number of hospitals	Disaster insurance	Regular exercise on disaster	Number of rescue team
Environment	Hazard data and mapping for disaster type	Land/city data mapping	Internet access to digital map	Urban population density	Urban population living in slums
Institutional	Operating system on disaster risk reduction	Pre-disaster planning	Asset Management System under disaster breakout	Disaster response system	Disaster Information Management System
Infrastructure	Number of earthquake resilient building	Public facilities with resilient system	Ratio for Infrastructure with resilient system	Emergency call network	Emergency Item supply system

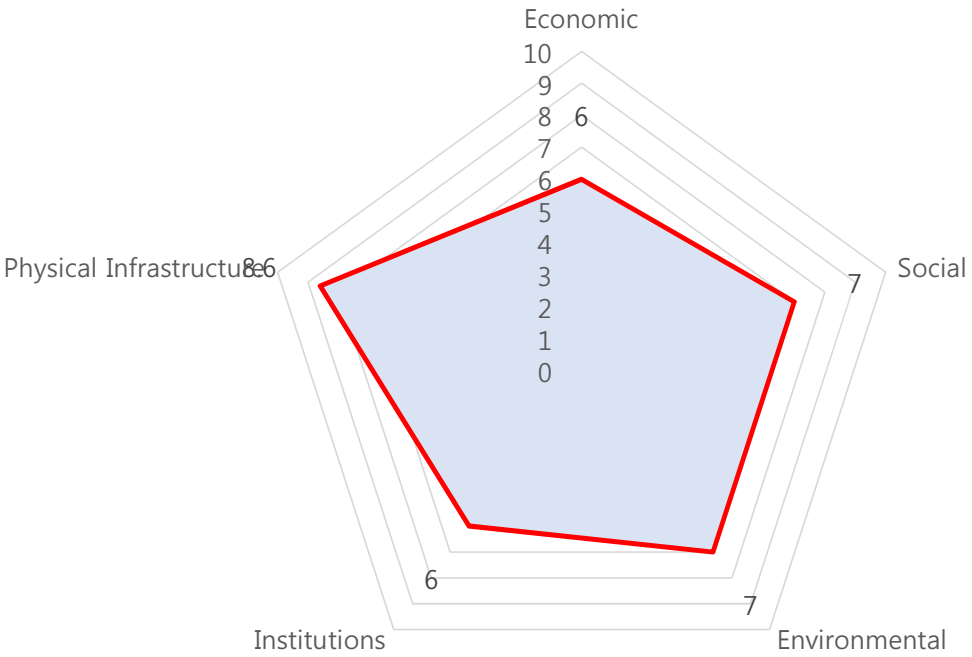


Result for Korea (2017)

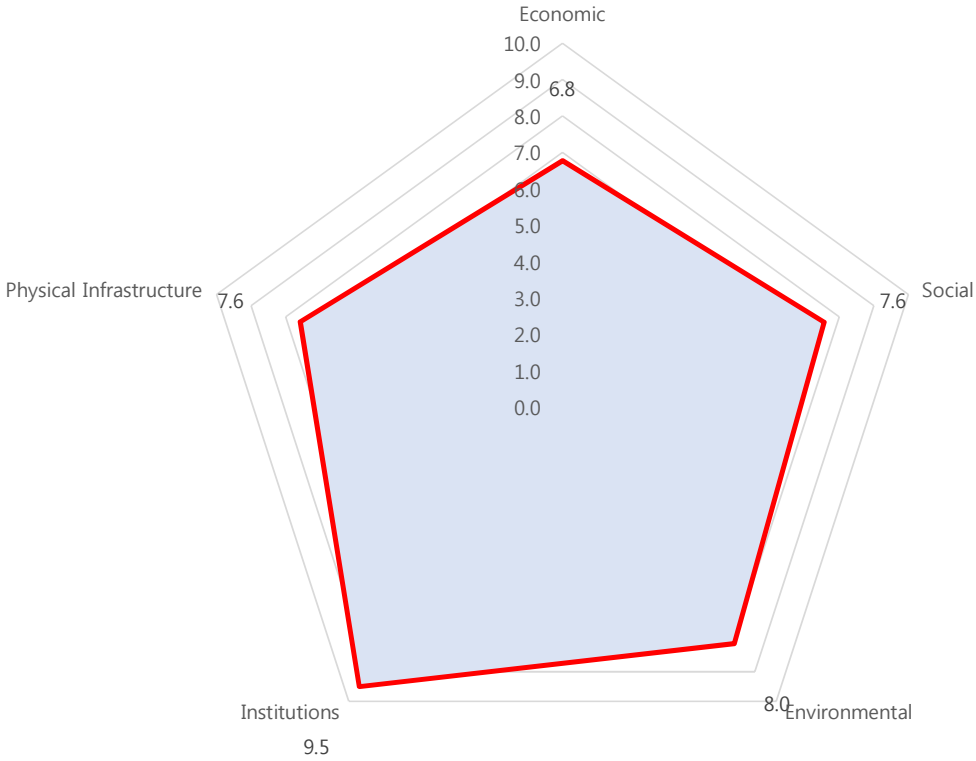


Economic	6.8
Social	7.6
Environmental	8.0
Institutions	9.5
Infrastructure	7.6

Time Period Comparison (2007 vs 2017)

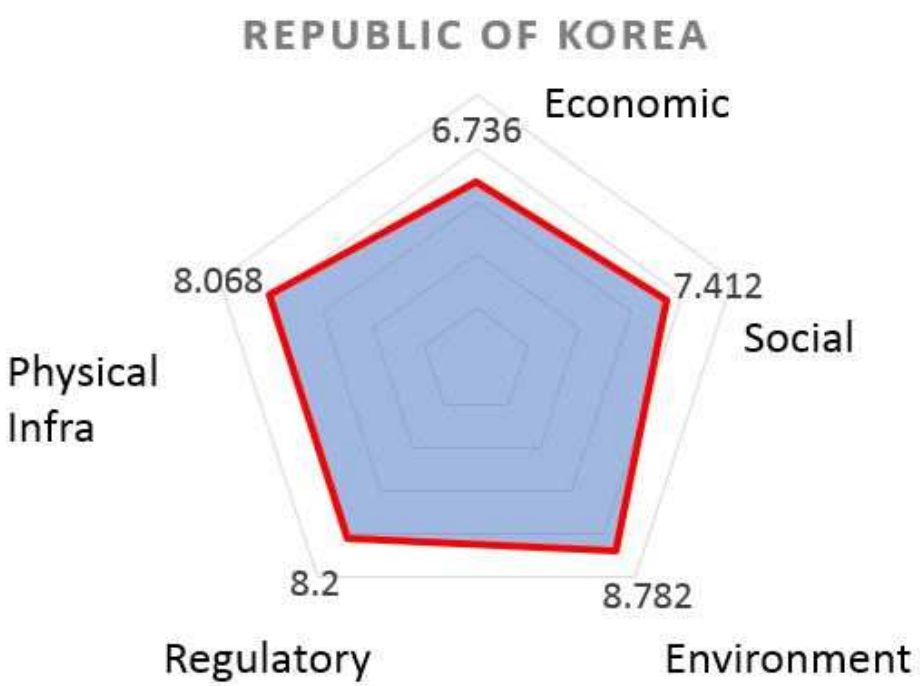


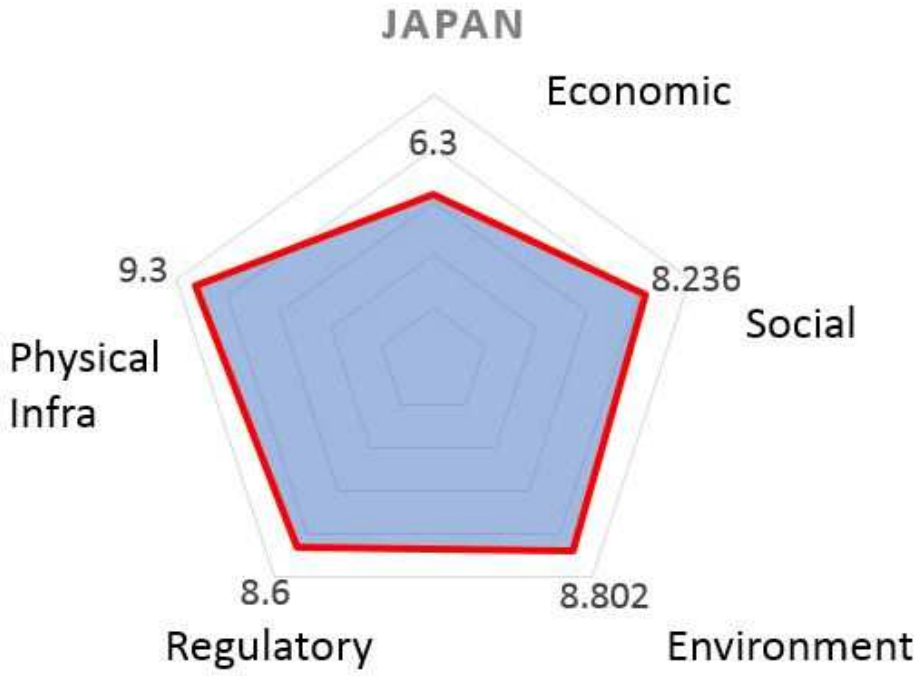
Republic of Korea (1997) (hypothetic)



Republic of Korea (2017)

Comparison Between Countries (ROK and Japan)





4. Future Plan

Next Step

1. Application of framework and indicators to other countries
   - Subject to funding
2. Late March 2019: Wrap up meeting in Bangkok

Thank You

Tae Hyung KIM

IDD / UNESCAP

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