CHULA ENGINEERING
Foundation toward Innovation

Water-Energy-Food NEXUS

Case of Thailand

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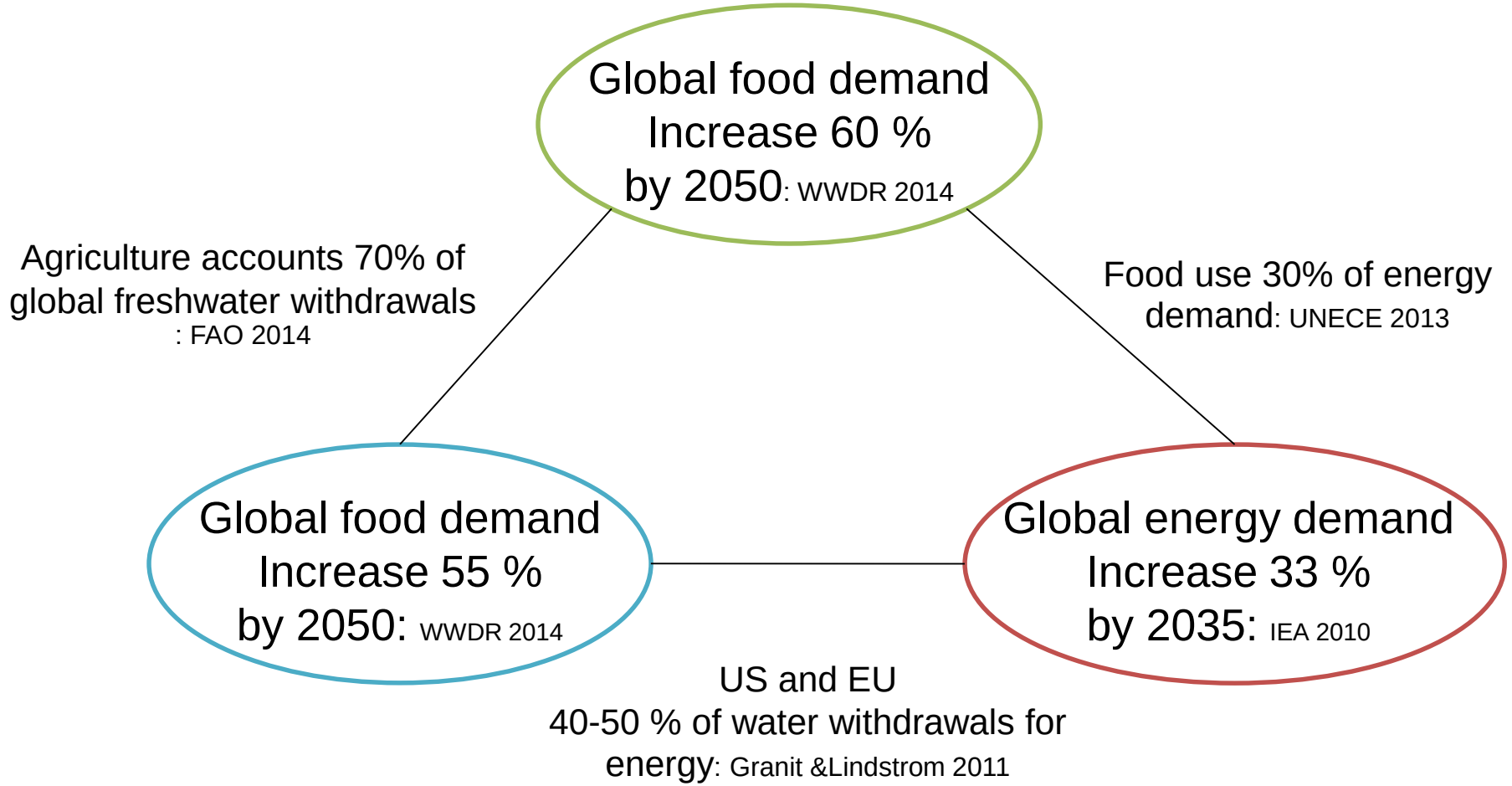
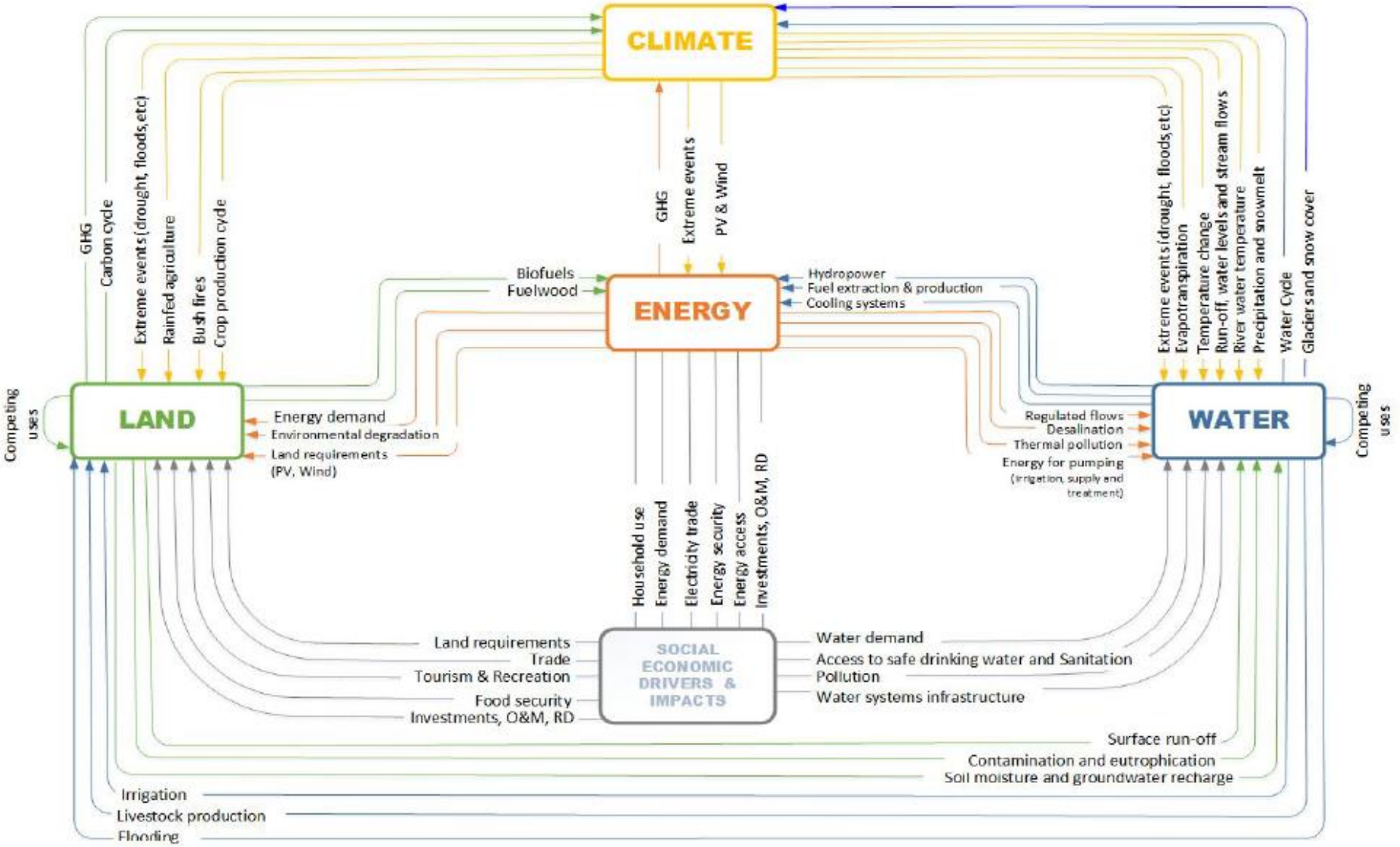
Foundation toward Innovation

Water-Energy-Food Nexus

Now and the future



The CLEWs framework and interlinkages ….



Source: Mark.Howells (2016), The Climate, Land, Energy, Water (CLEW) and Ecosystem Nexus

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2. Why we need W-E-F NEXUS?

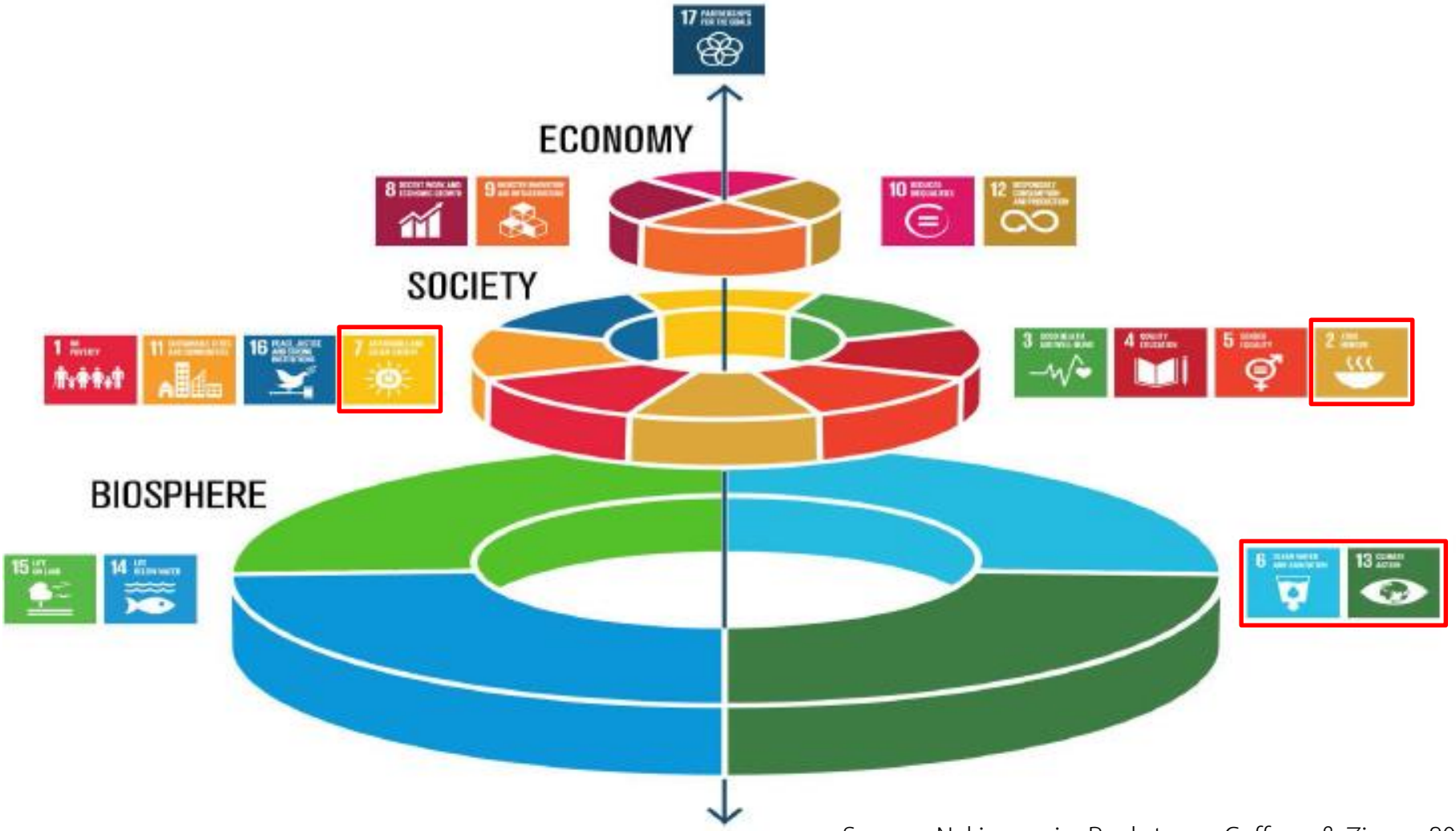
- External driving force
- Internal driving force

Global goals: SDGs

- Sustainable Development Goals (Sep 2015)
- UN Climate Change Conference 2015: COP21 (Nov-Dec 2015, France)

Source: UN

Interconnected SDGs



Source: Nakicenovic, Rockstrom, Gaffney & Zimm, 2016

WEF NEXUS: Mediterranean

Water for food
- Irrigation
- Livestock requirements
- Human consumption

Water for energy
- Cooling
- Hydropower
- Irrigation of bioenergy crops

SDG 6 Water

Security
Availability, accessibility, Adequacy, affordability

SDG 2 Food feed/fiber

SDG 7 Energy

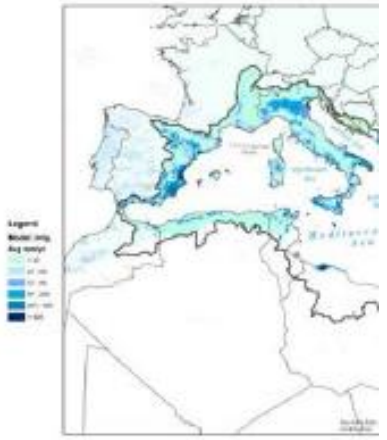
Food impact on water
- Virtual transport
- Water quality

Energy for water
- Extraction transportation
- Water treatment, distribution
- Irrigation of bioenergy crops
- Waste water , drainage, treatment, disposal

Food for energy
- Biofuels
- Manure, waste

Energy for food
- Energy for irrigated crops
- Energy for fertilizer

Joint Research Centre



Source: Cesar Carmona Moreno (2016), JRC AFRIMED WEF Nexus Approach

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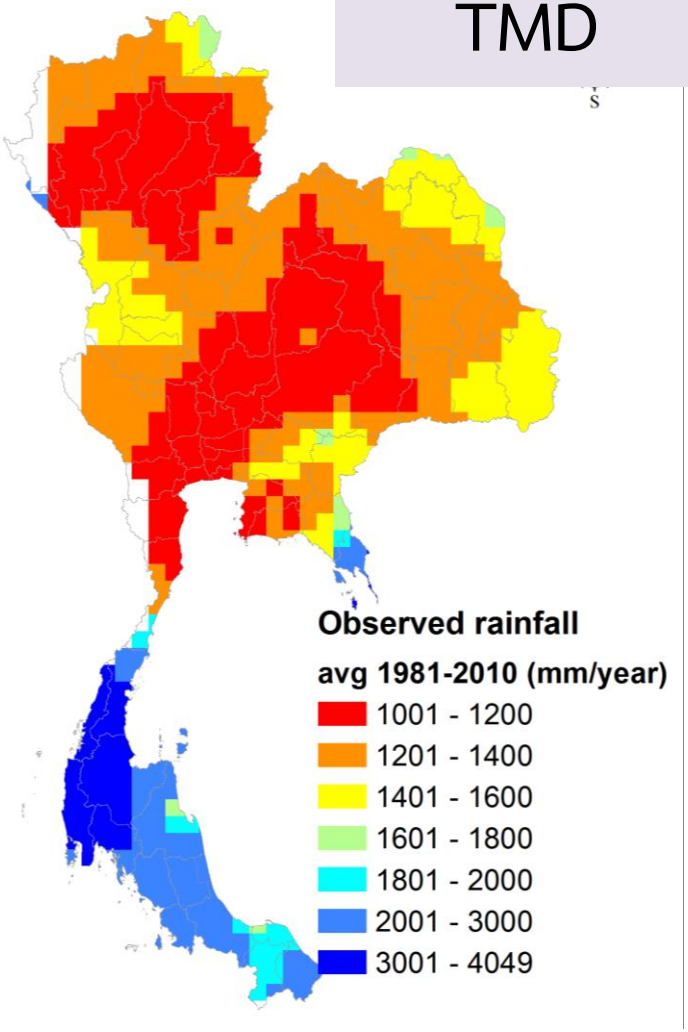
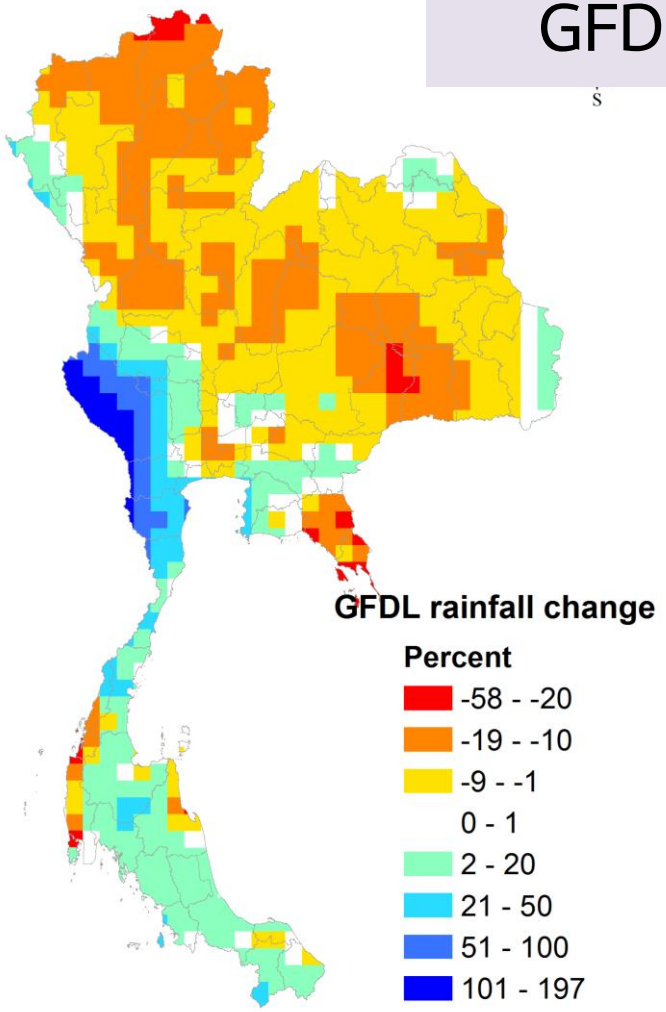
Change in annual rainfall

TMD



GFDL



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Thailand strategy

- The 12th National Socio-Economic Development Plan (2017-2021)
  - Water infrastructure investment and CC impacts and adaptation
- Strategic Plan for Water Resources Management 2015 - 2026 (National Committee of Water Resources Management)
- Thailand Energy Efficiency Development Plan (2011-2030)

กระทรวงพลังงาน
MINISTRY OF ENERGY

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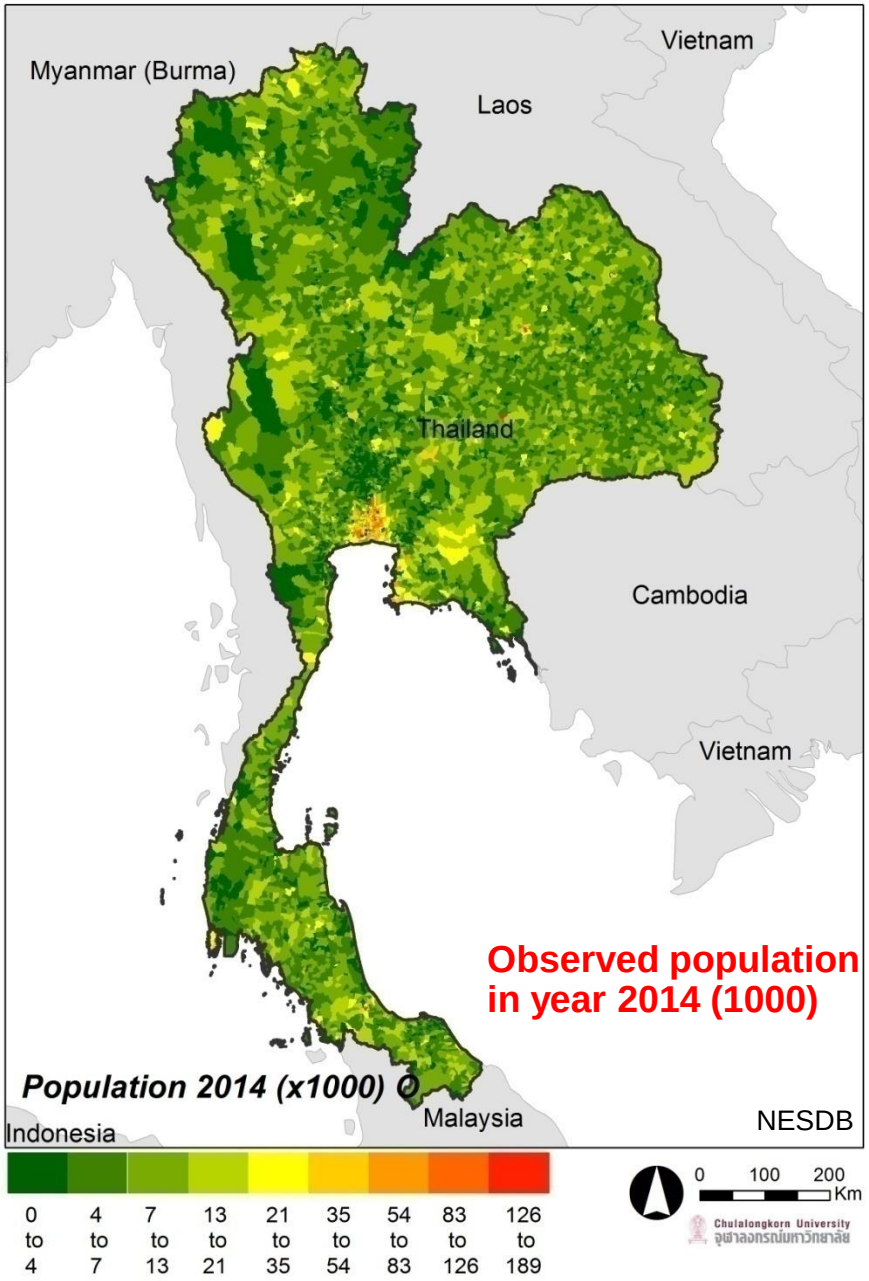
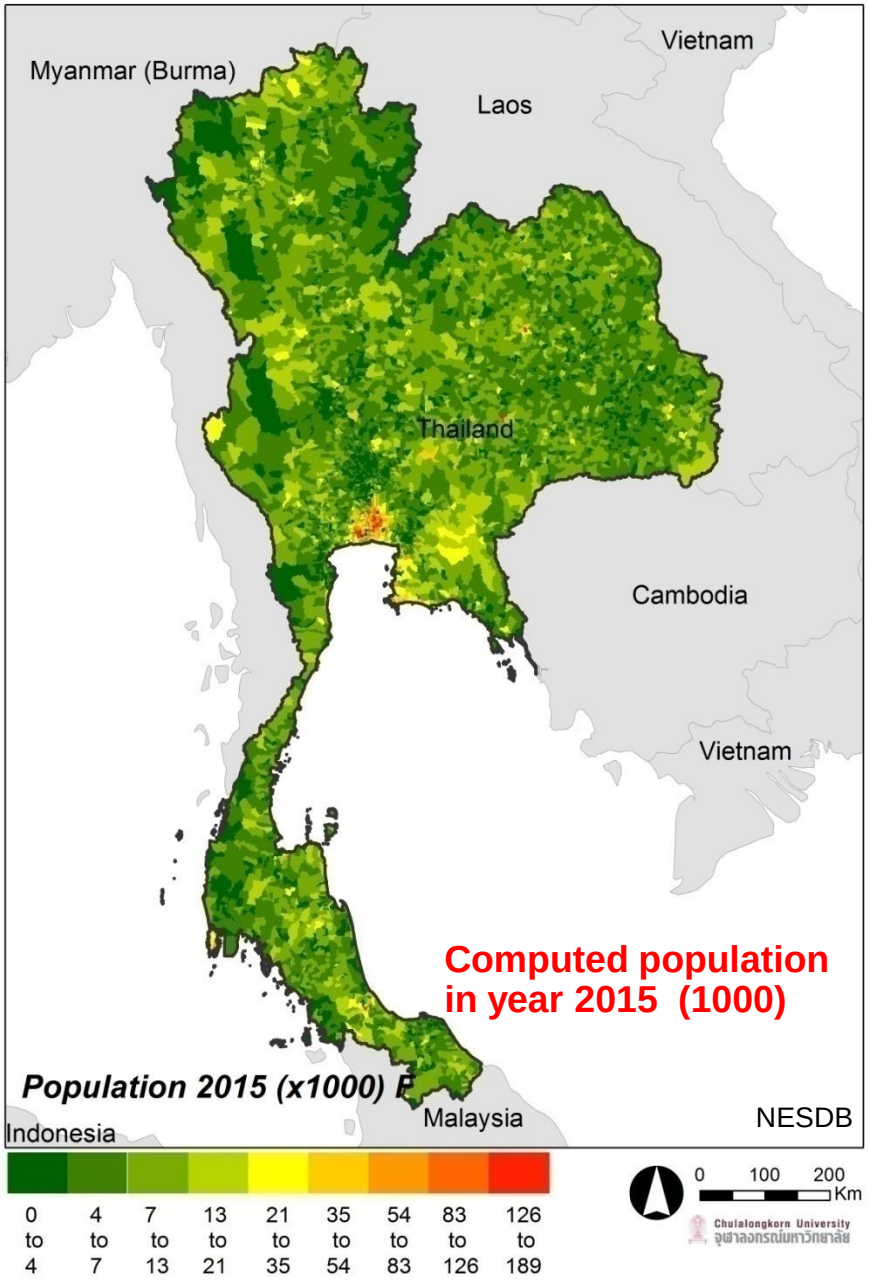
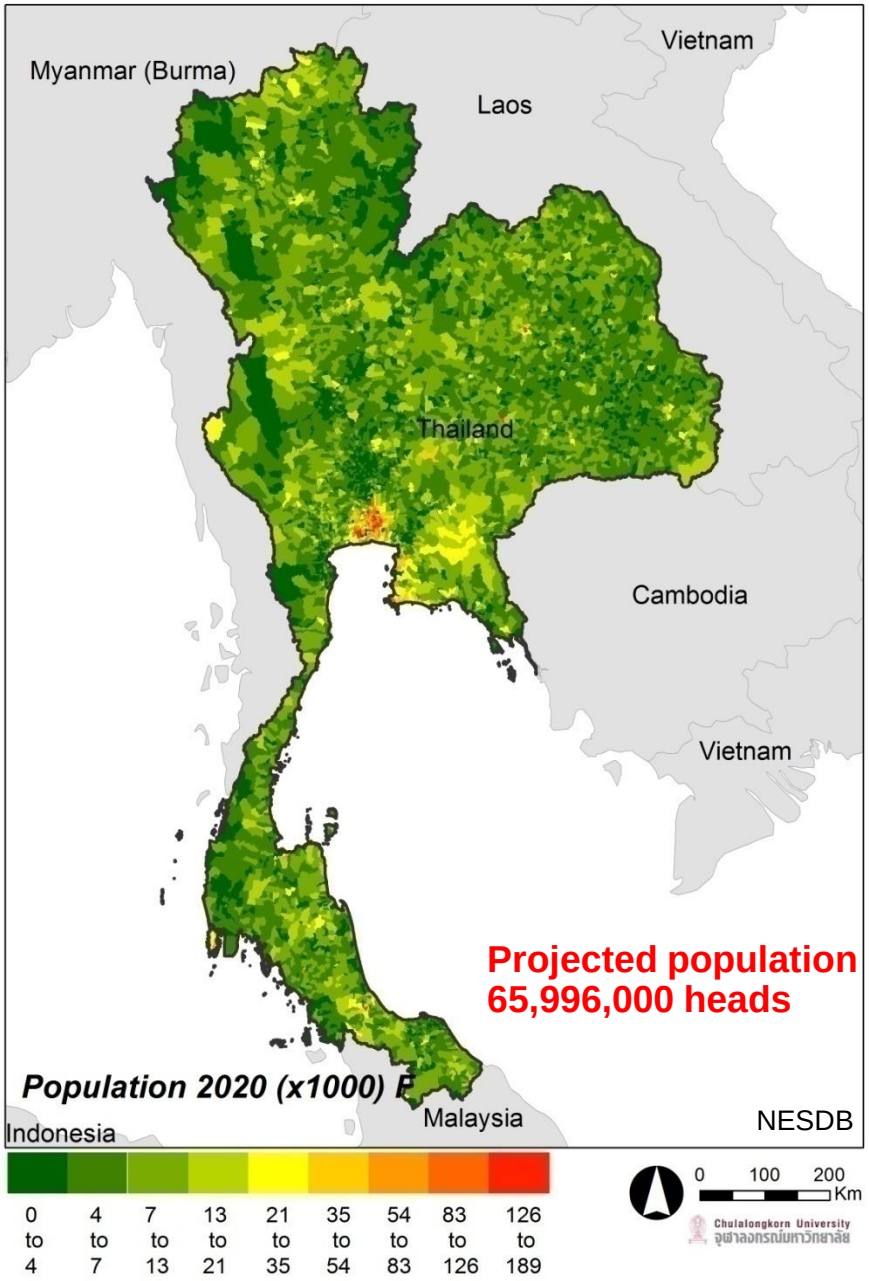
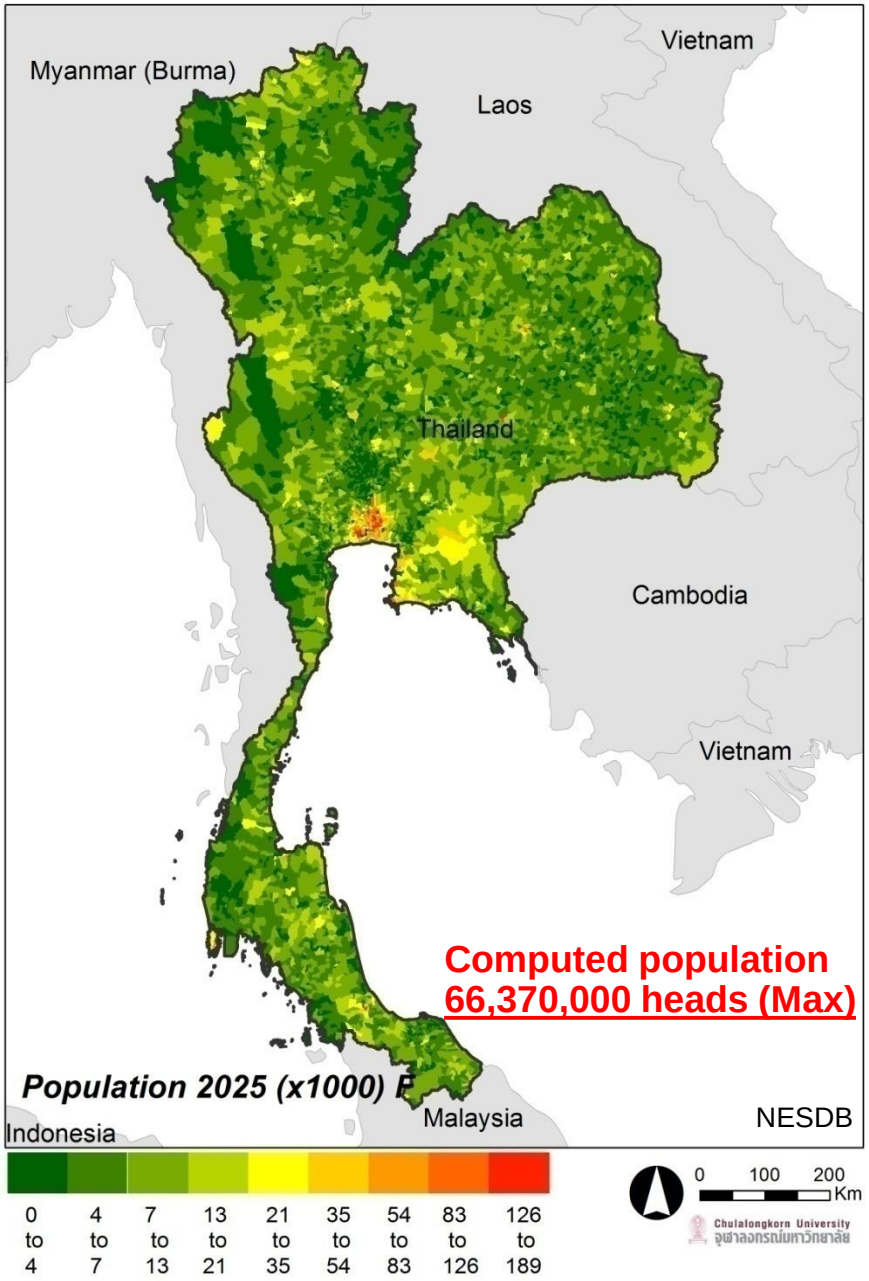
Observed and computed population in sub-district level



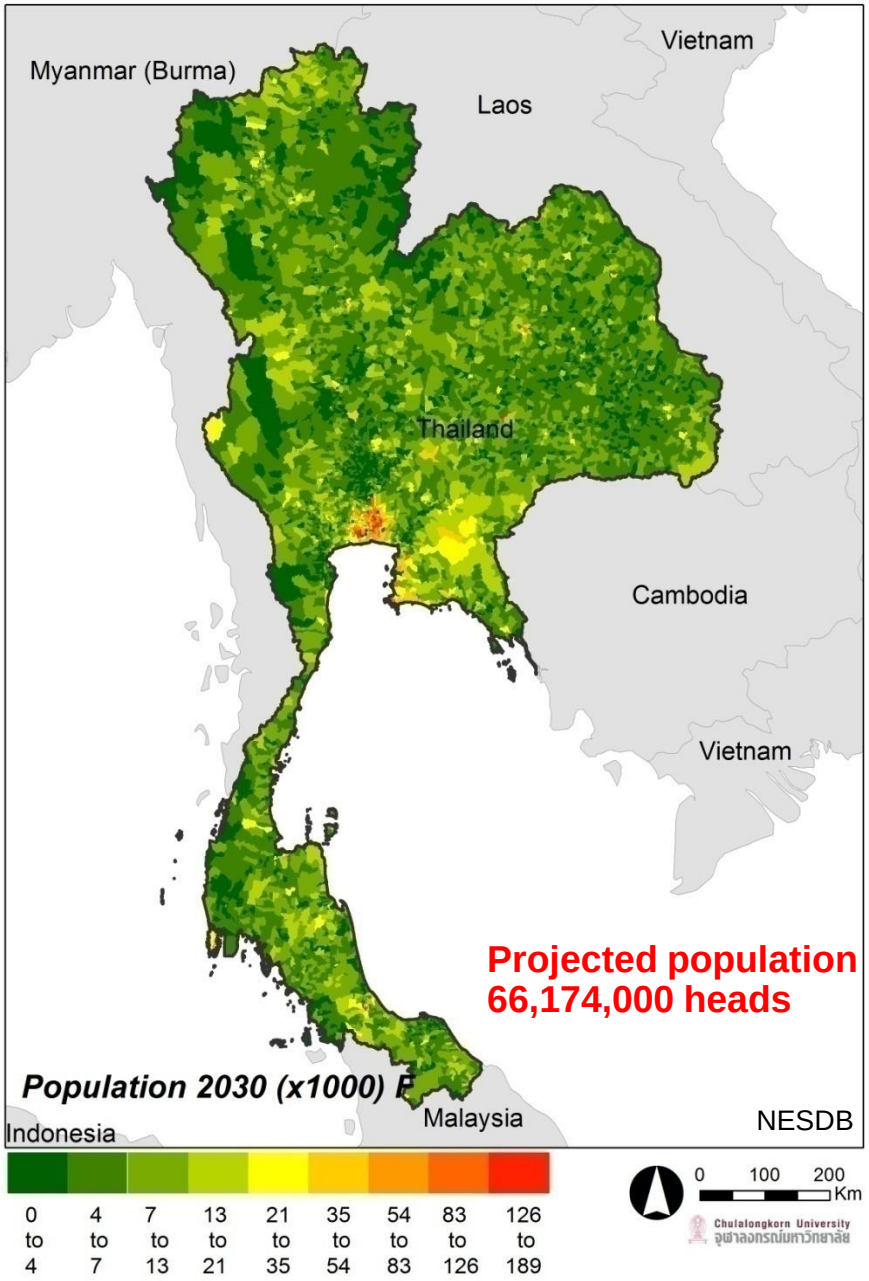


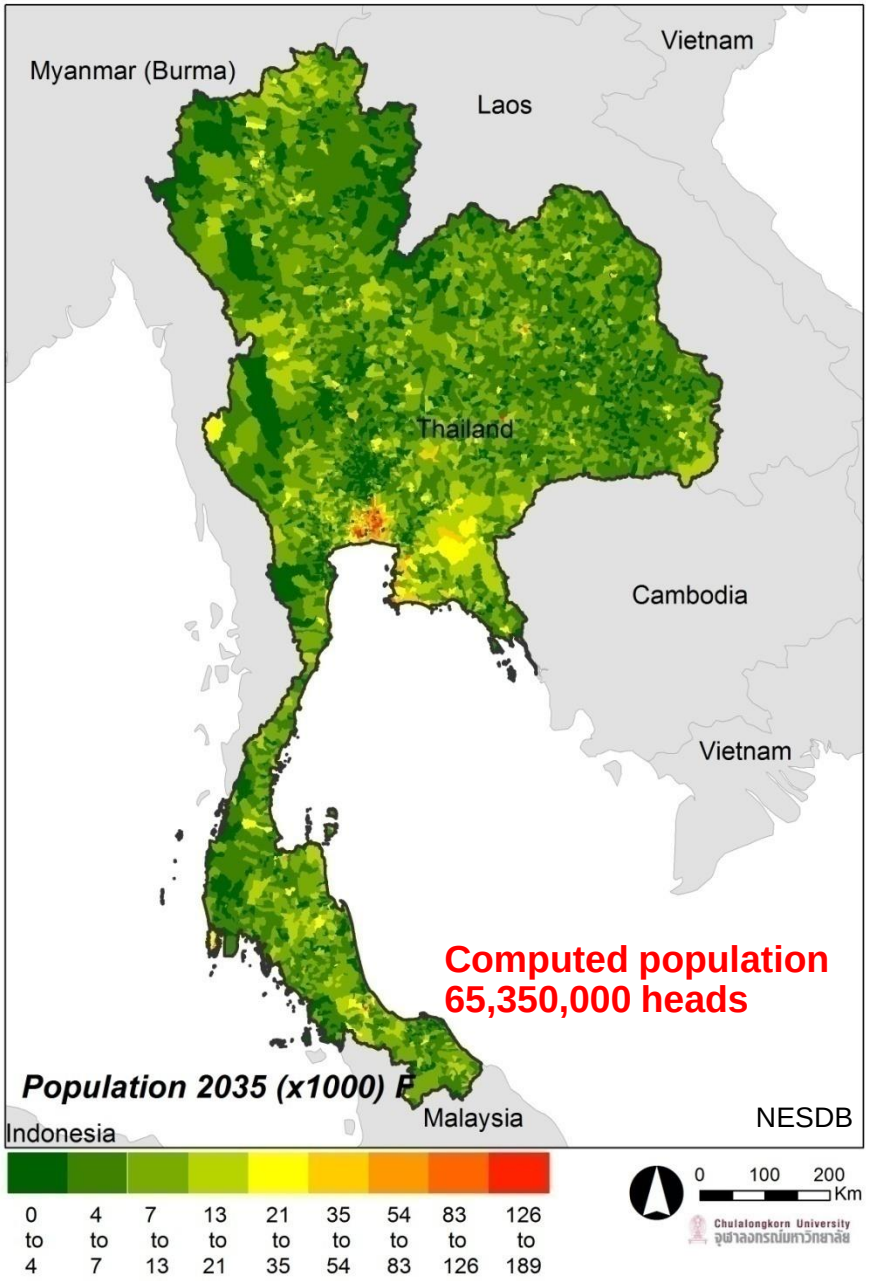
Projected population in sub-district level in year 2020, **2025**





Projected population in sub-district level in year 2030, 2035





Main issues

- Decreasing number of population after year 2025 with aging society
- Increasing urbanization from 50% now to 60 % in 2030

Question

- Impact to society
- future trend of economic development

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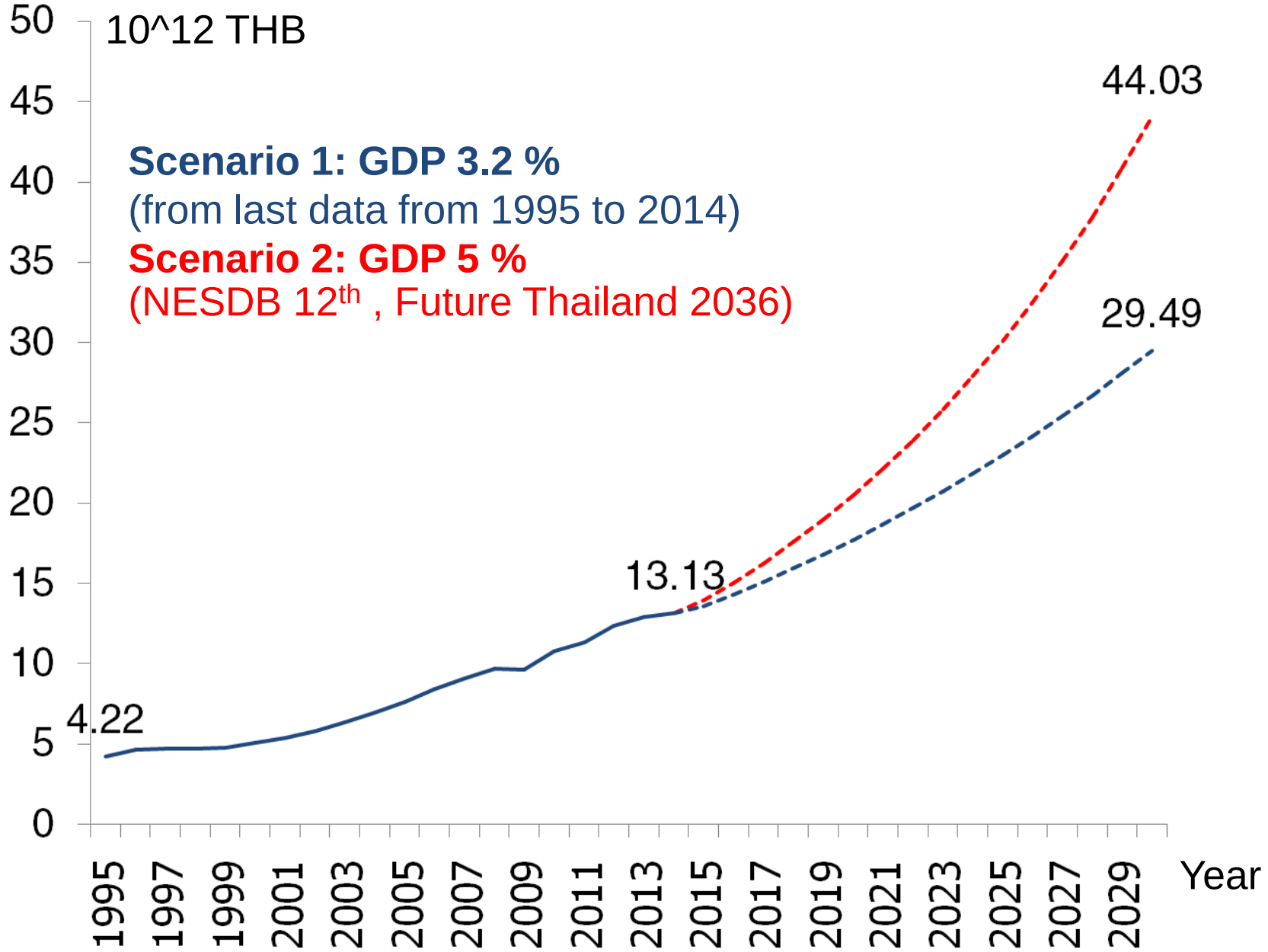
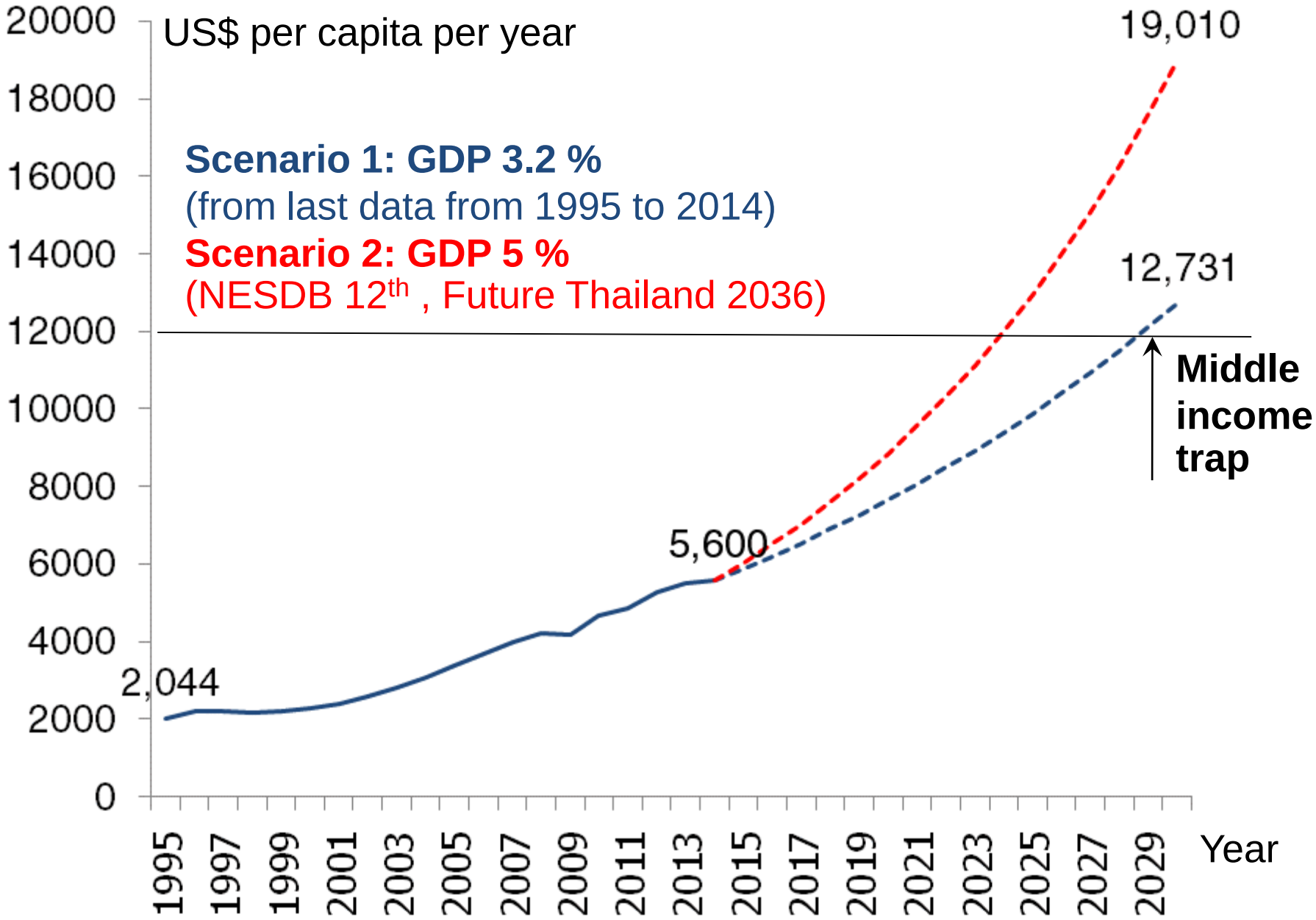
GDP at market price in each scenario

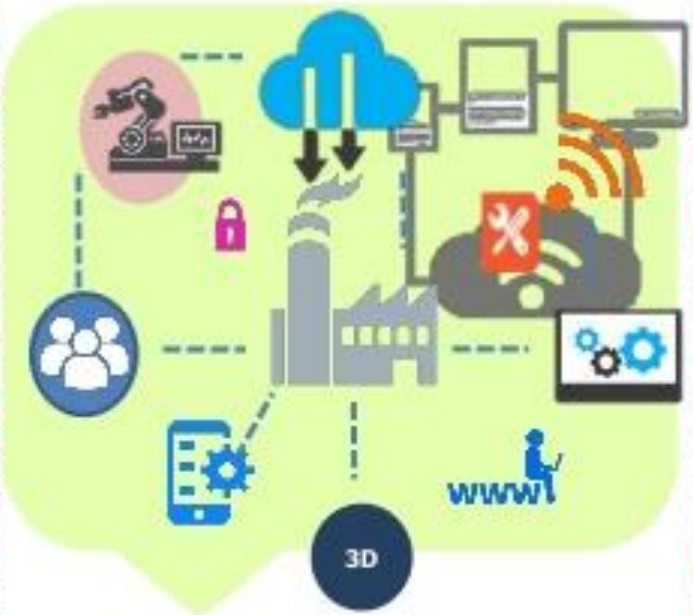


GDP per capita in each scenario



Thailand 4.0

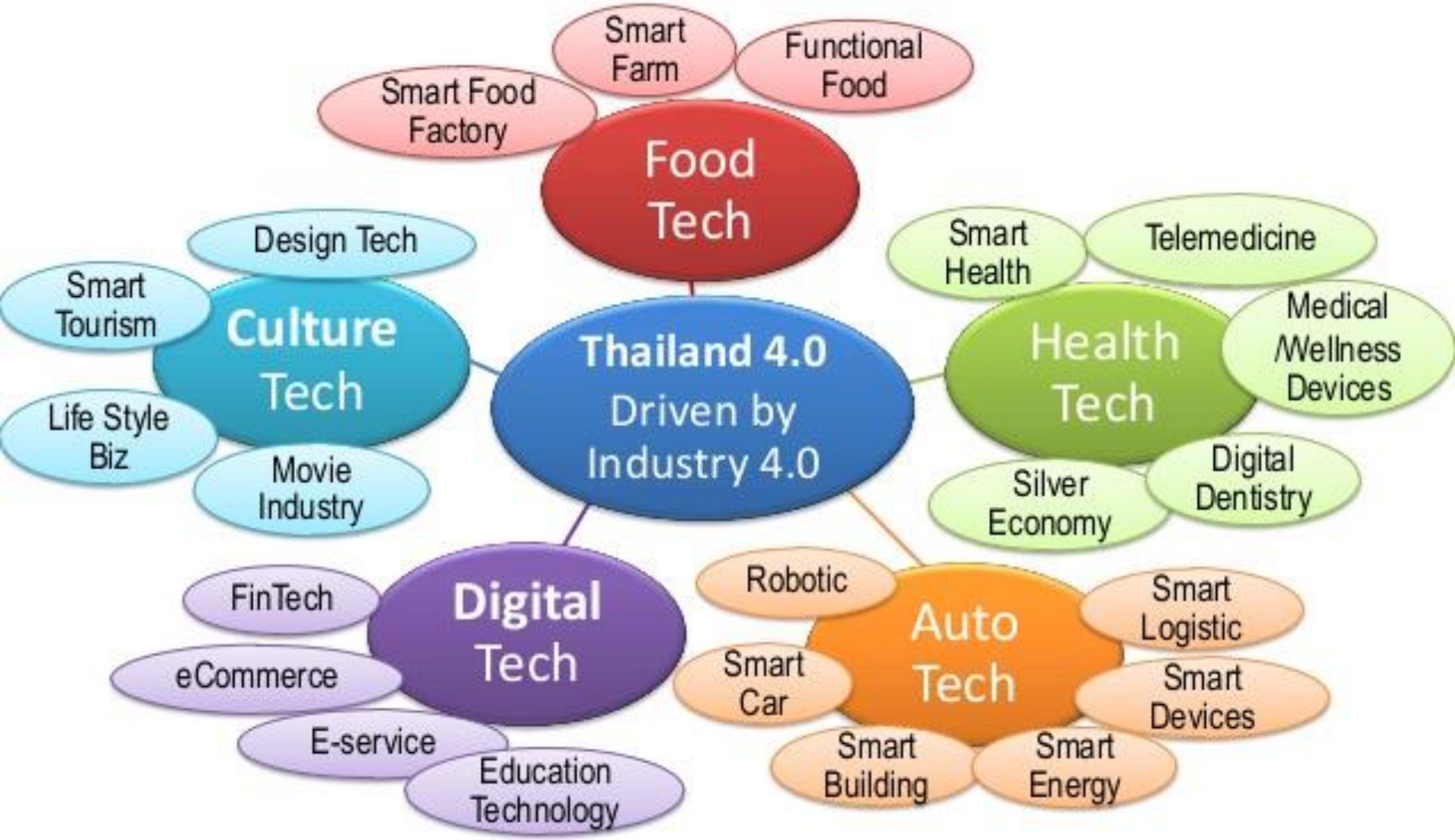
(Smart Industry + Smart City + Smart People)



Thailand 1.0	Thailand 2.0	Thailand 3.0	Thailand 4.0
Agriculture	Light Industry Low wages	Heavy Industry Advanced Machine	Creativity + Innovation Smart Thailand

NSTDA

Thailand 4.0 : New Growth Industry



Source: NSTDA

FUTURE FARMS
small and smart

SURVEY DRONES

Aerial drones survey the fields, mapping weeds, yield and soil variation. This enables precise application of inputs, mapping spread of pernicious weed blackgrass could increasing Wheat yields by 2-5%.

FLEET OF AGRIBOTS

A herd of specialised agribots tend to crops, weeding, fertilising and harvesting. Robots capable of microdot application of fertiliser reduce fertiliser cost by 99.9%.

FARMING DATA

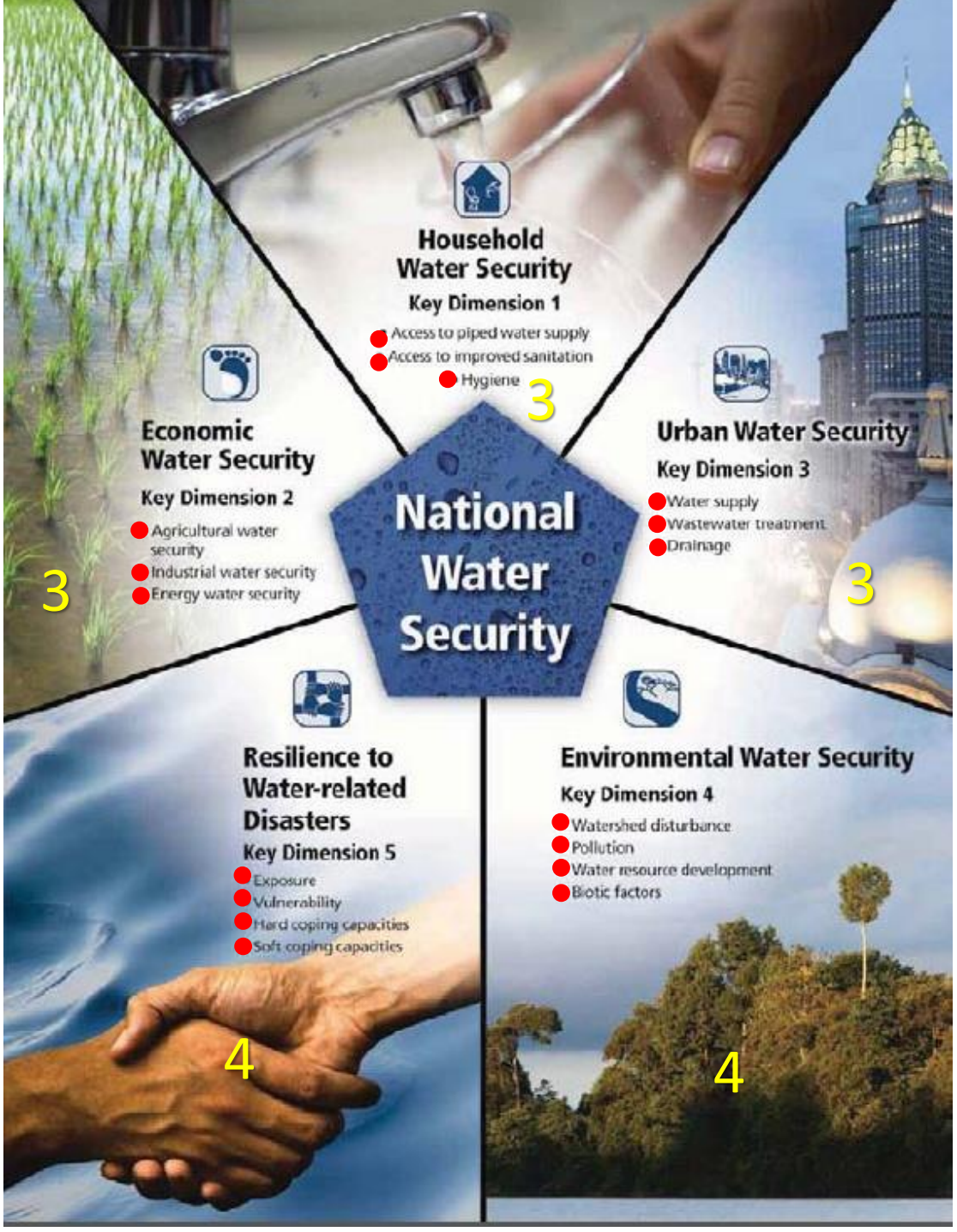
The farm generates vast quantities of rich and varied data. This is stored in the cloud. Data can be used as digital evidence reducing time spent completing grant applications or carrying out farm inspections saving on average £5,500 per farm per year.

TEXTING COWS

Sensors attached to livestock allowing monitoring of animal health and wellbeing. They can send texts to alert farmers when a cow goes into labour or develops infection increasing herd survival and increasing milk yields by 10%.

SMART TRACTORS

GPS controlled steering and optimised route planning reduces soil erosion, saving fuel costs by 10%.



Key Dimension 1: Household Water Security

The foundation and cornerstone of water security is what happens at the household level. Providing all people with reliable, safe water and sanitation services should be the top priority of Asia's leaders. Household water security is an essential foundation for efforts to eradicate poverty and support economic development.

Key Dimension 2: Economic Water Security

Water grows our food, powers our industry, and cools our energy-generating plants. The use of water in these sectors must no longer be seen in isolation from each other. Debate about the water–food–energy nexus has begun to raise general awareness about the critical interaction among water uses to support economic activities. Economic water security measures the productive use of water to sustain economic growth in the food production, industry, and energy sectors of the economy.

Key Dimension 3: Urban Water Security

In Asia and the Pacific, about 43% of the population currently lives in urban areas; however, the urban proportion has risen by 29% over the past 20 years, more rapidly than in any other region.[11] After a century of transformation from agrarian rural societies to urban centers, and the creation of the world's largest number of megacities, Asia's cities have become important drivers of the economy. The urban water security indicators measure the creation of better water management and services to support vibrant and livable water-sensitive cities.

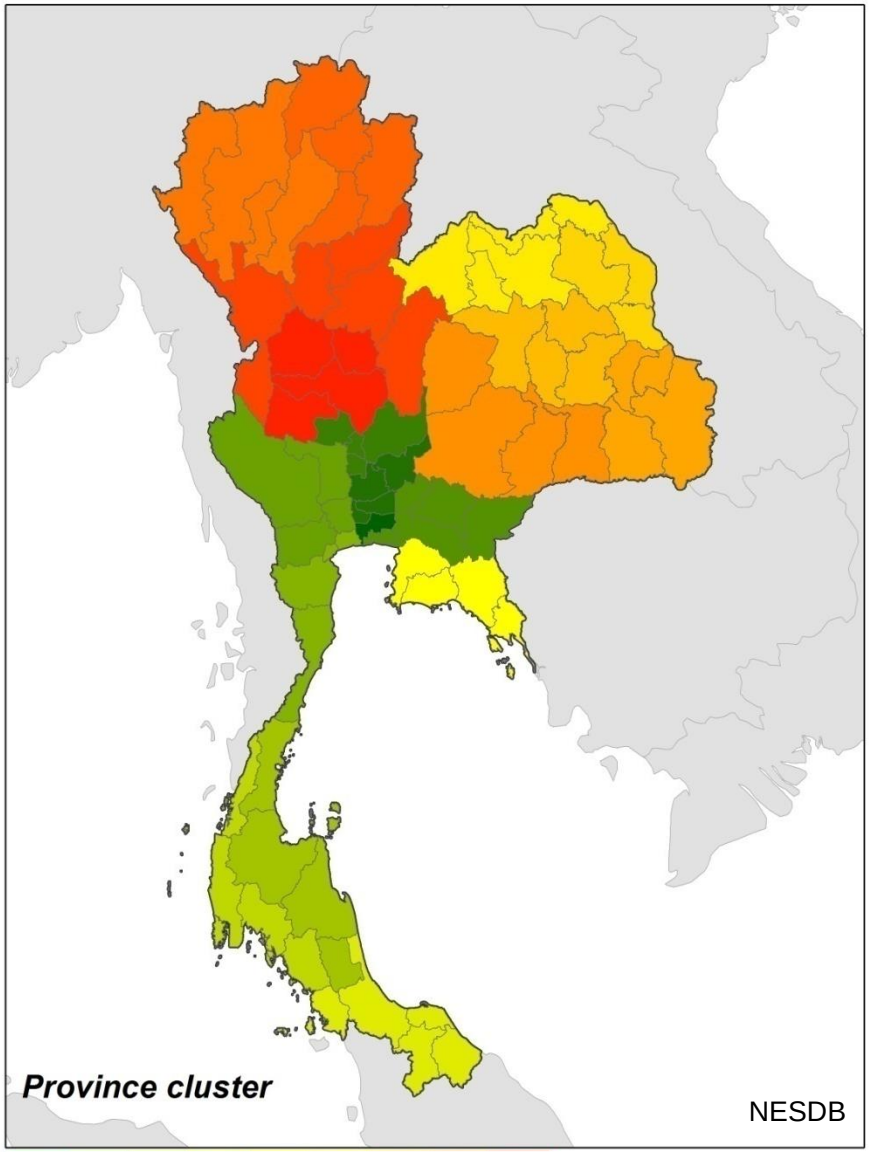
Key Dimension 4: Environmental Water Security

Asia's environment and precious natural resources have suffered greatly from decades of neglect as governments across the region prioritized rapid economic growth over environmental objectives. Asia's leaders are now starting to green their economies as a broader focus on sustainable development and inclusive growth gains ground. The environmental water security indicator assesses the health of rivers and measures progress on restoring rivers and ecosystems to health on a national and regional scale. The sustainability of development and improved lives depends on these natural resources.

Key Dimension 5: Resilience to Water-Related Disasters

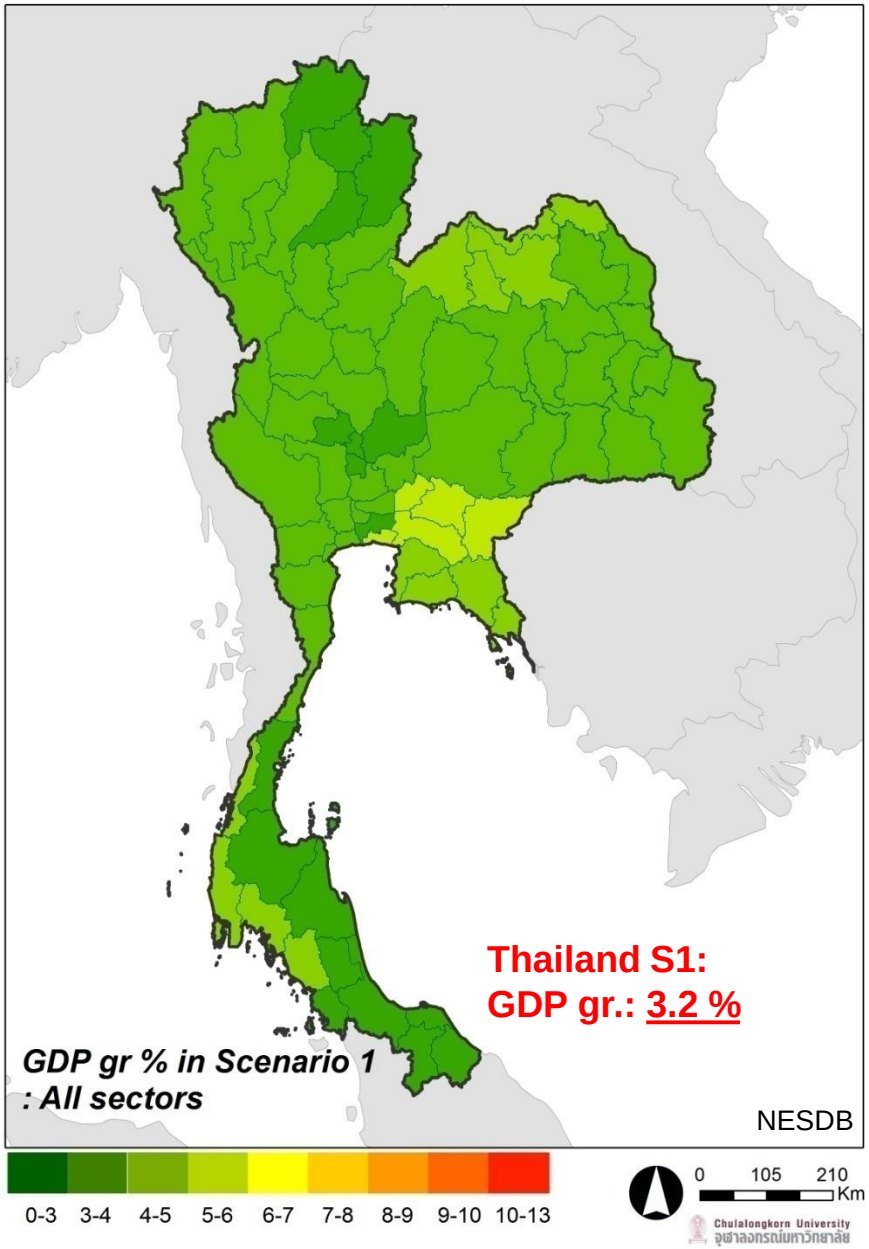
The region's growing prosperity has involved unprecedented changes in economic activity, urbanization, diets, trade, culture, and communication. It has also brought increasing levels of uncertainty and risk from climate variability and change. The resilience of communities in Asia and the Pacific to these changes, and especially to water-related disaster risks, is assessed with the indicator of resilience to water-related disasters. The building of resilient communities that can adapt to change and are able to reduce risk from natural disasters related to water must be accelerated to minimize the impact of future disasters.

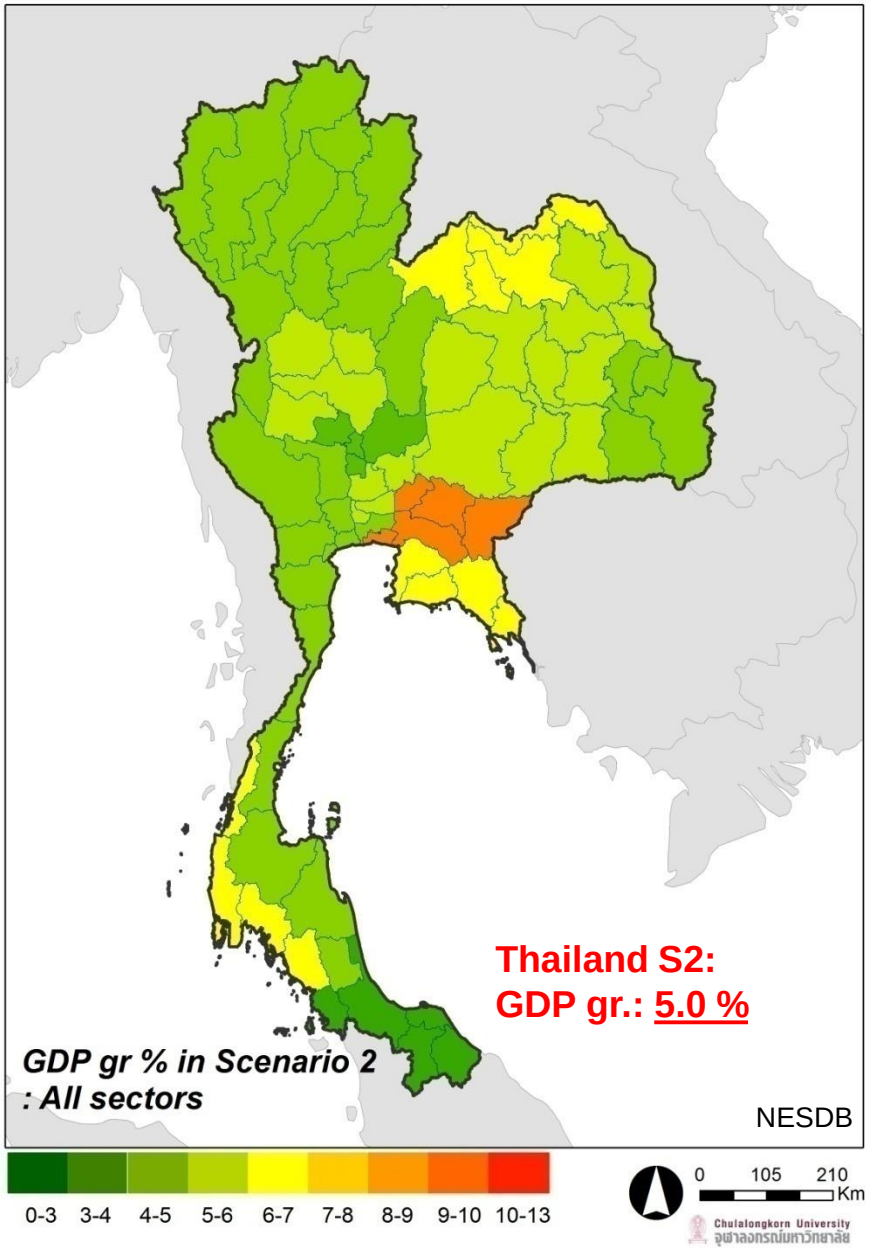
Projected population in sub-district level in year 2030, 2035



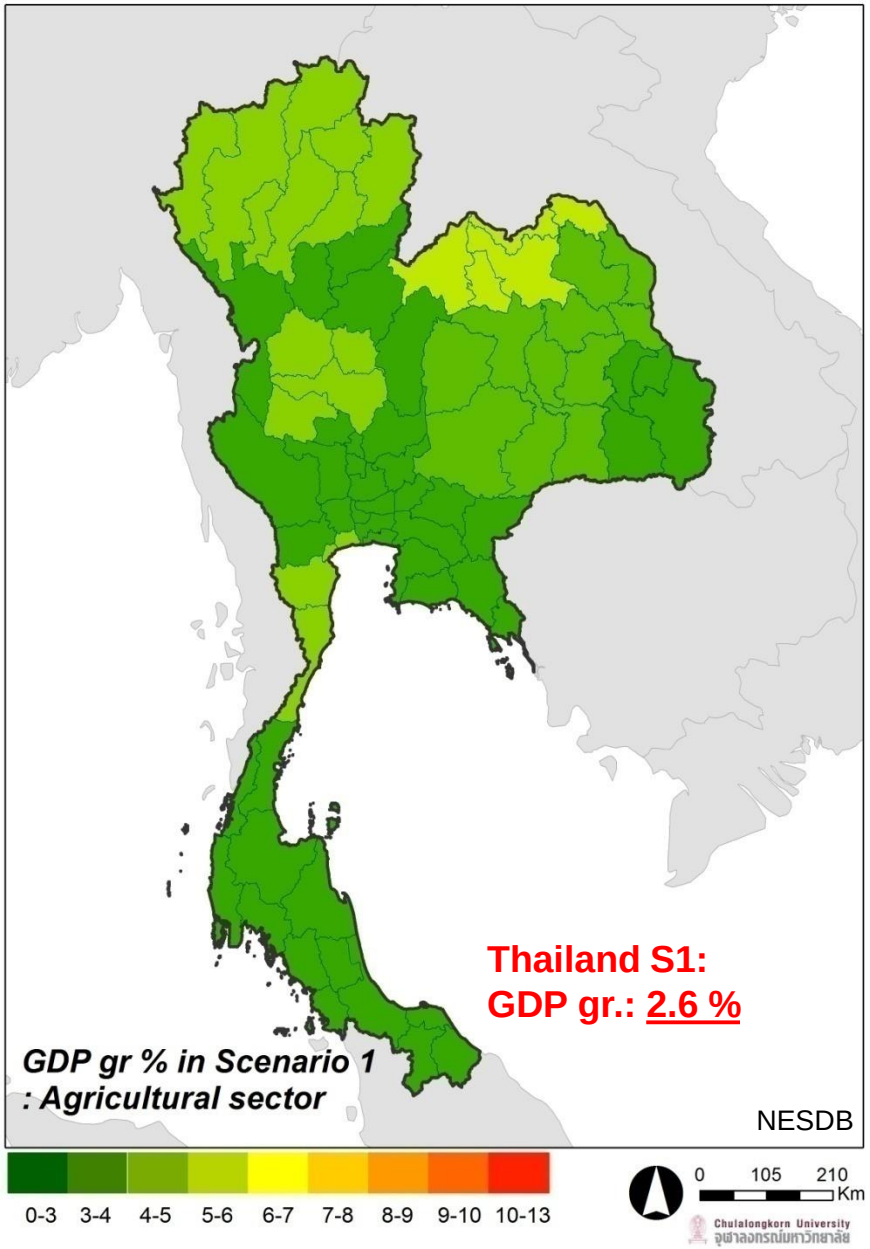
ที่	กลุ่มจังหวัด	จังหวัด
1	ภาคกลางตอนบน 1	นนทบุรี ปทุมธานี พระนครศรีอยุธยา สระบุรี
2	ภาคกลางตอนบน 2	ชัยนาท ลพบุรี สิงห์บุรี อ่างทอง
3	ภาคกลางตอนกลาง	ฉะเชิงเทรา นครนายก ปราจีนบุรี สมุทรปราการ สระแก้ว
4	ภาคกลางตอนล่าง 1	กาญจนบุรี นครปฐม ราชบุรี สุพรรณบุรี
5	ภาคกลางตอนล่าง 2	ประจวบคีรีขันธ์ เพชรบุรี สมุทรสงคราม สมุทรสาคร
6	ภาคใต้ฝั่งอ่าวไทย	ชุมพร นครศรีธรรมราช พัทลุง สุราษฎร์ธานี
7	ภาคใต้ฝั่งอันดามัน	กระบี่ ตรัง พังงา ภูเก็ต ระนอง
8	ภาคใต้ชายแดน	นราธิวาส ปัตตานี ยะลา สงขลา สตูล
9	ภาคตะวันออก	จันทบุรี ชลบุรี ตราด ระยอง
10	ภาคอีสานตอนบน 1	เลย หนองคาย บึงกาฬ หนองบัวลำภู อุดรธานี
11	ภาคอีสานตอนบน 2	นครพนม มุกดาหาร สกลนคร
12	ภาคอีสานตอนกลาง	กาฬสินธุ์ ขอนแก่น มหาสารคาม ร้อยเอ็ด
13	ภาคอีสานตอนล่าง 1	ประกอบด้วยนครราชสีมา ชัยภูมิ บุรีรัมย์ สุรินทร์
14	ภาคอีสานตอนล่าง 2	ยโสธร ศรีสะเกษ อำนาจเจริญ อุบลราชธานี
15	ภาคเหนือตอนบน 1	เชียงใหม่ แม่ฮ่องสอน ลำปาง ลำพูน
16	ภาคเหนือตอนบน 2	เชียงราย น่าน พะเยา แพร่
17	ภาคเหนือตอนล่าง 1	ตาก พิษณุโลก เพชรบูรณ์ สุโขทัย อุตรดิตถ์
18	ภาคเหนือตอนล่าง 2	กำแพงเพชร นครสวรรค์ พิจิตร อุทัยธานี

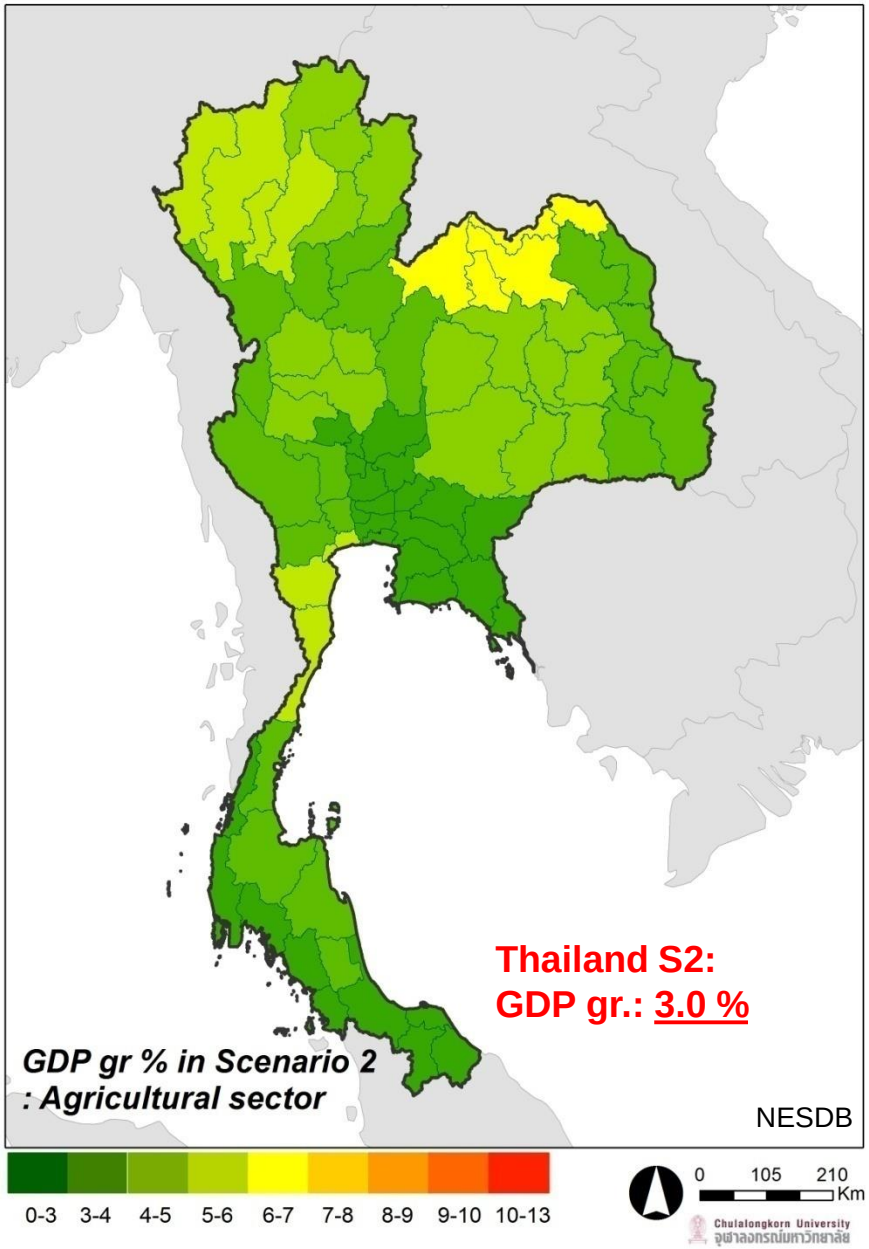
GDP growth rate in each development scenario



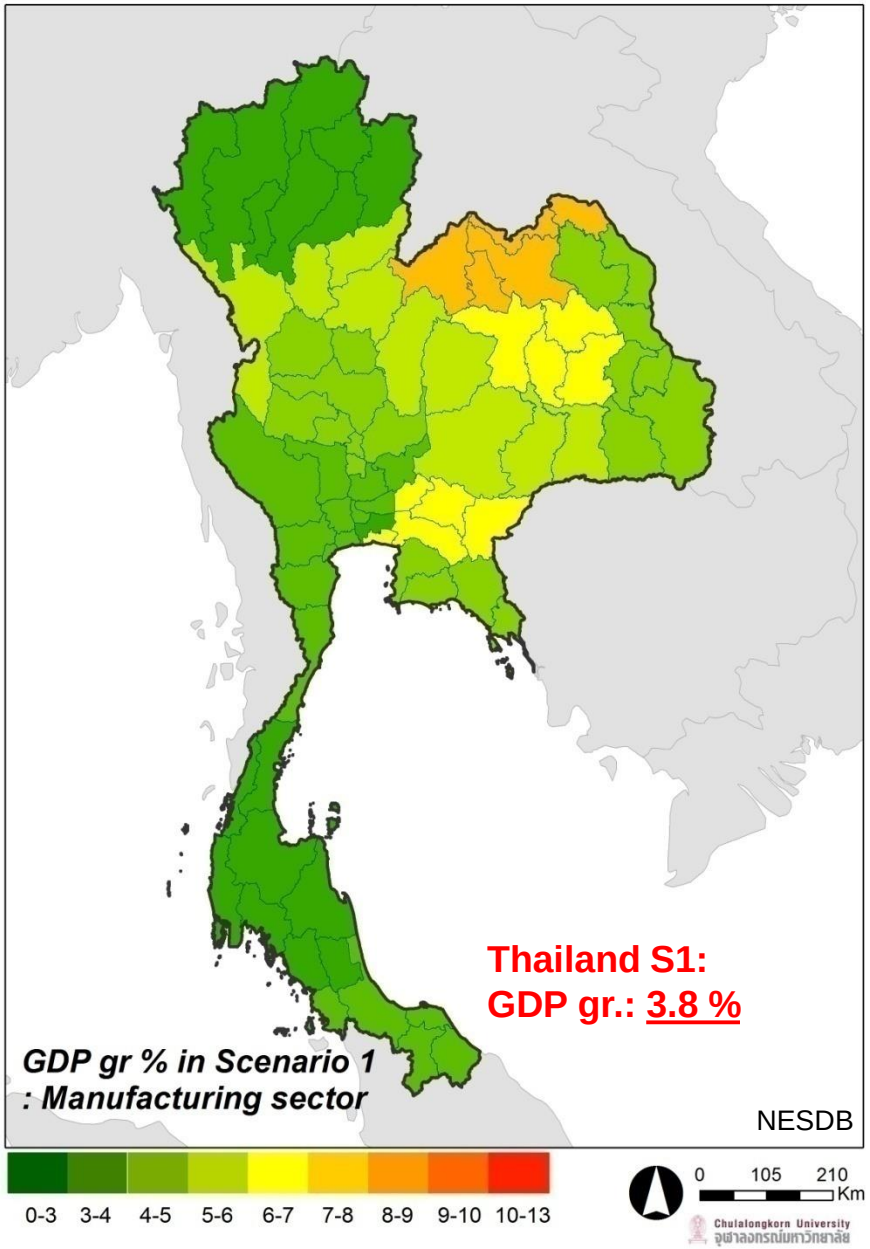


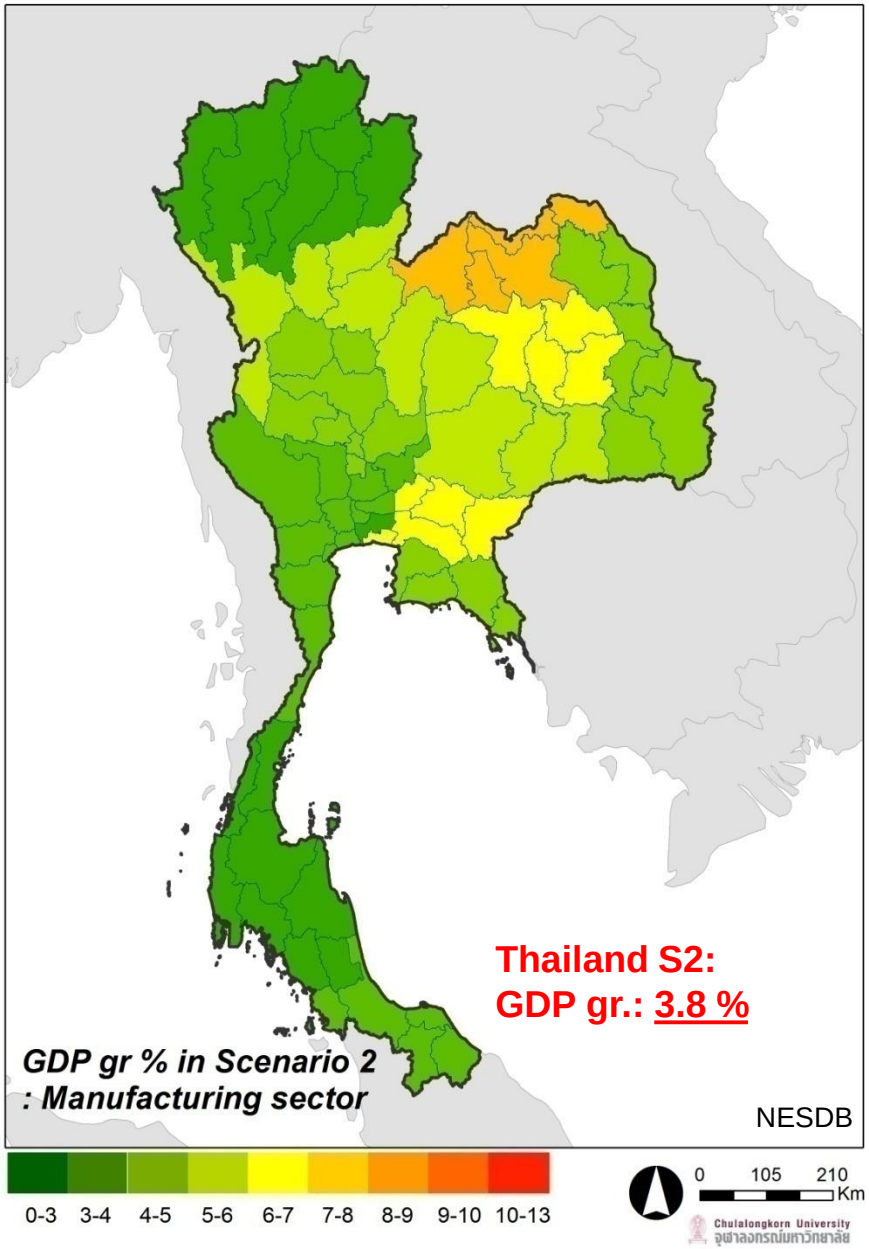
Agricultural GDP growth rate in each development scenario



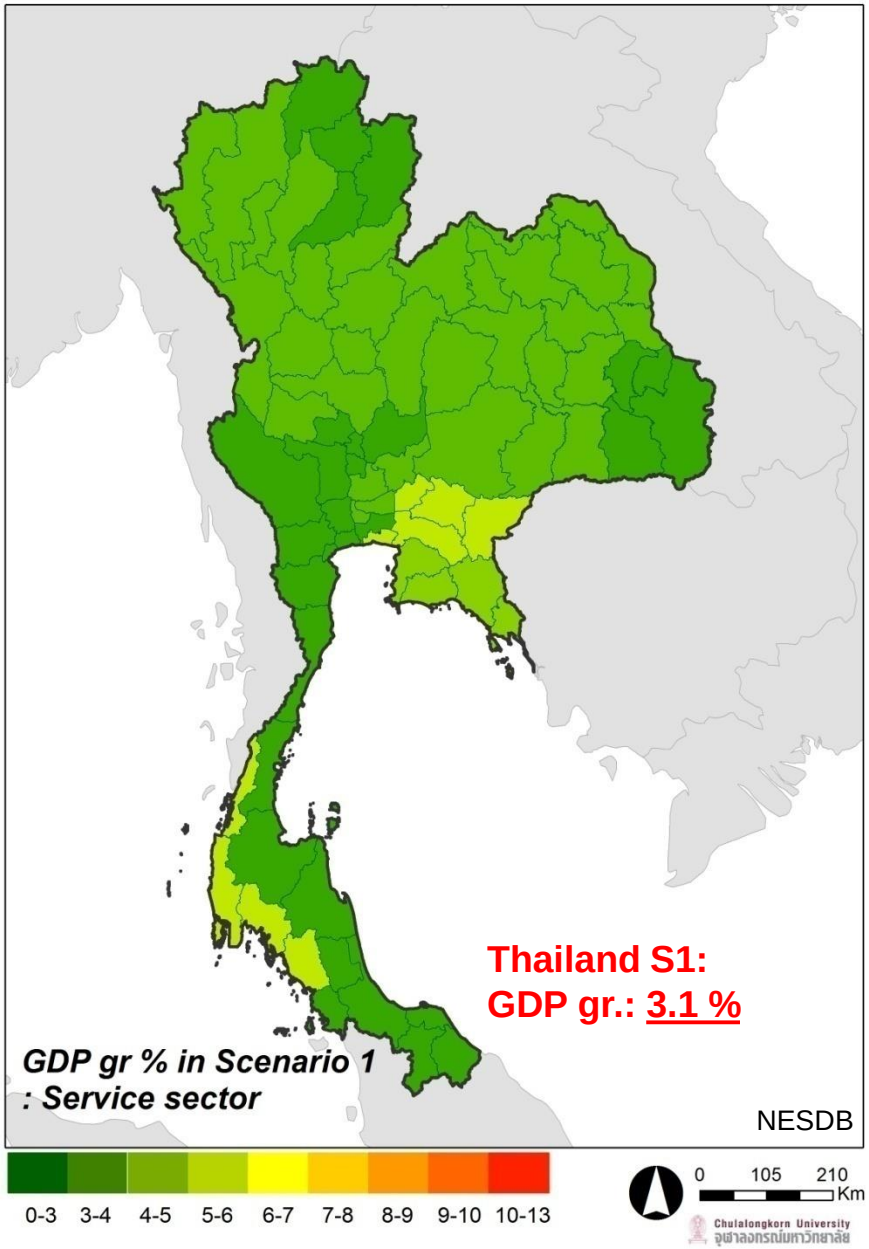


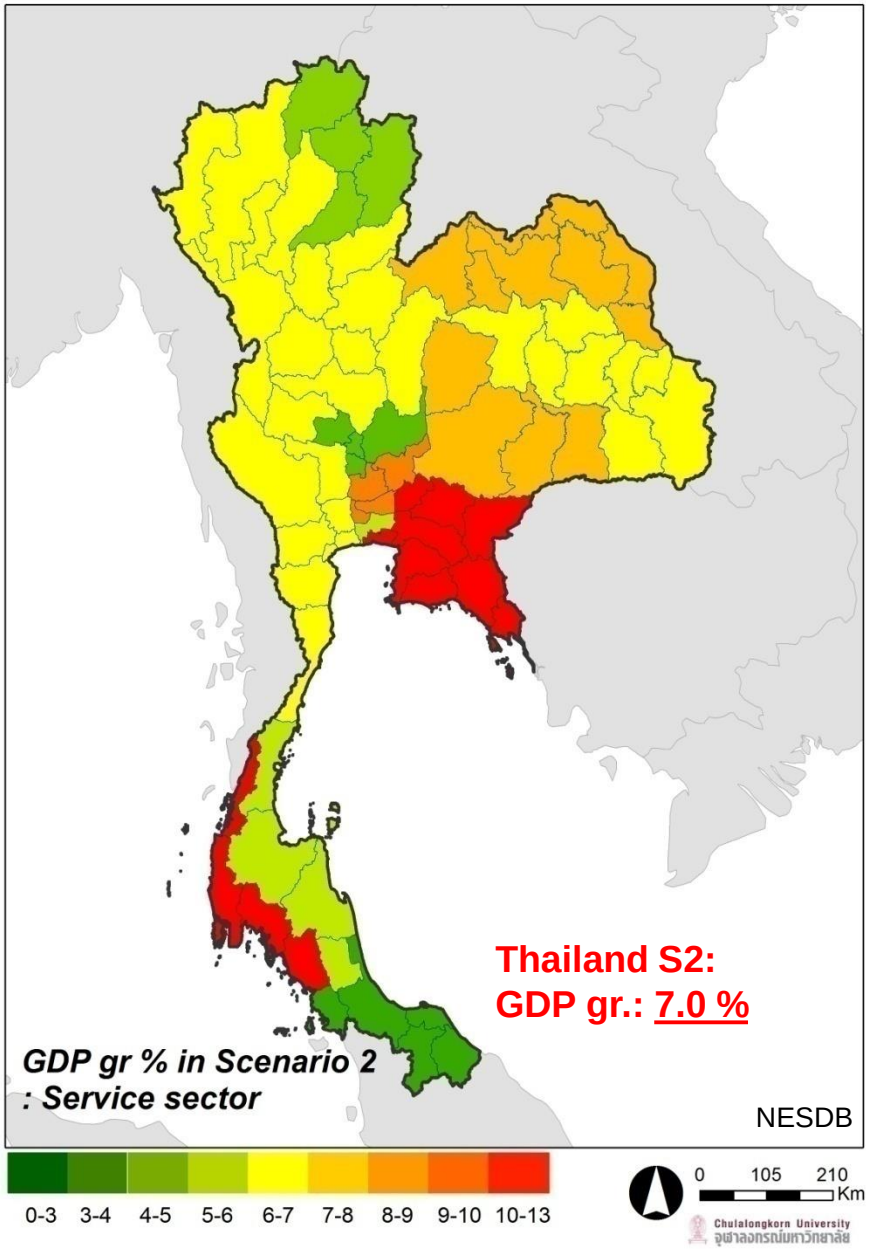
Manufacturing GDP growth rate in each development scenario





Service GDP growth rate in each development scenario





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    - Water

Strategic Plan for Water Resources Management 2015 -2026

1. Climate change impact
2. Impact form this plan to other issues such as energy

Domestic

Production (Agri, Manf)

Flood

Water quality

Forestation

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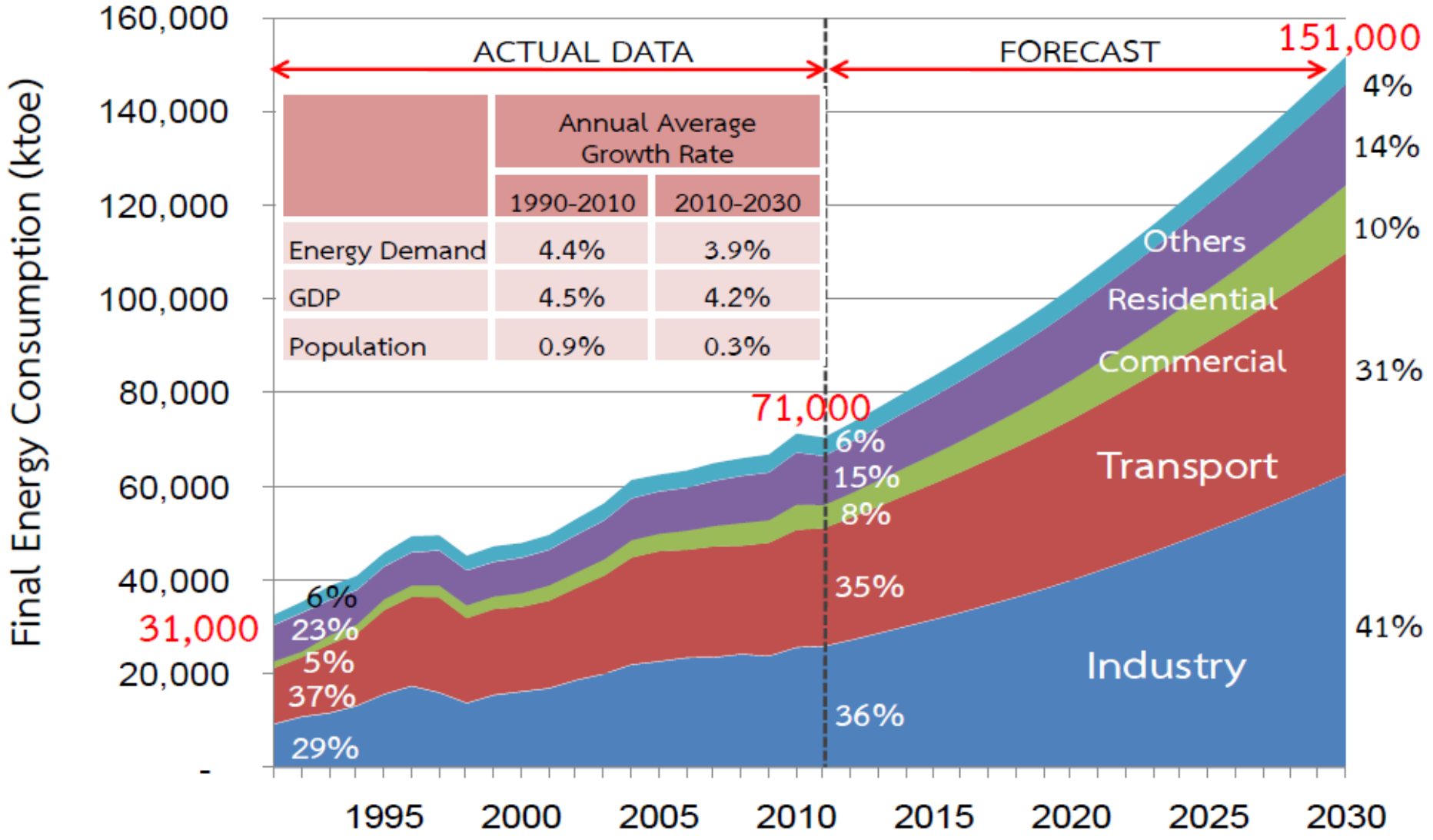
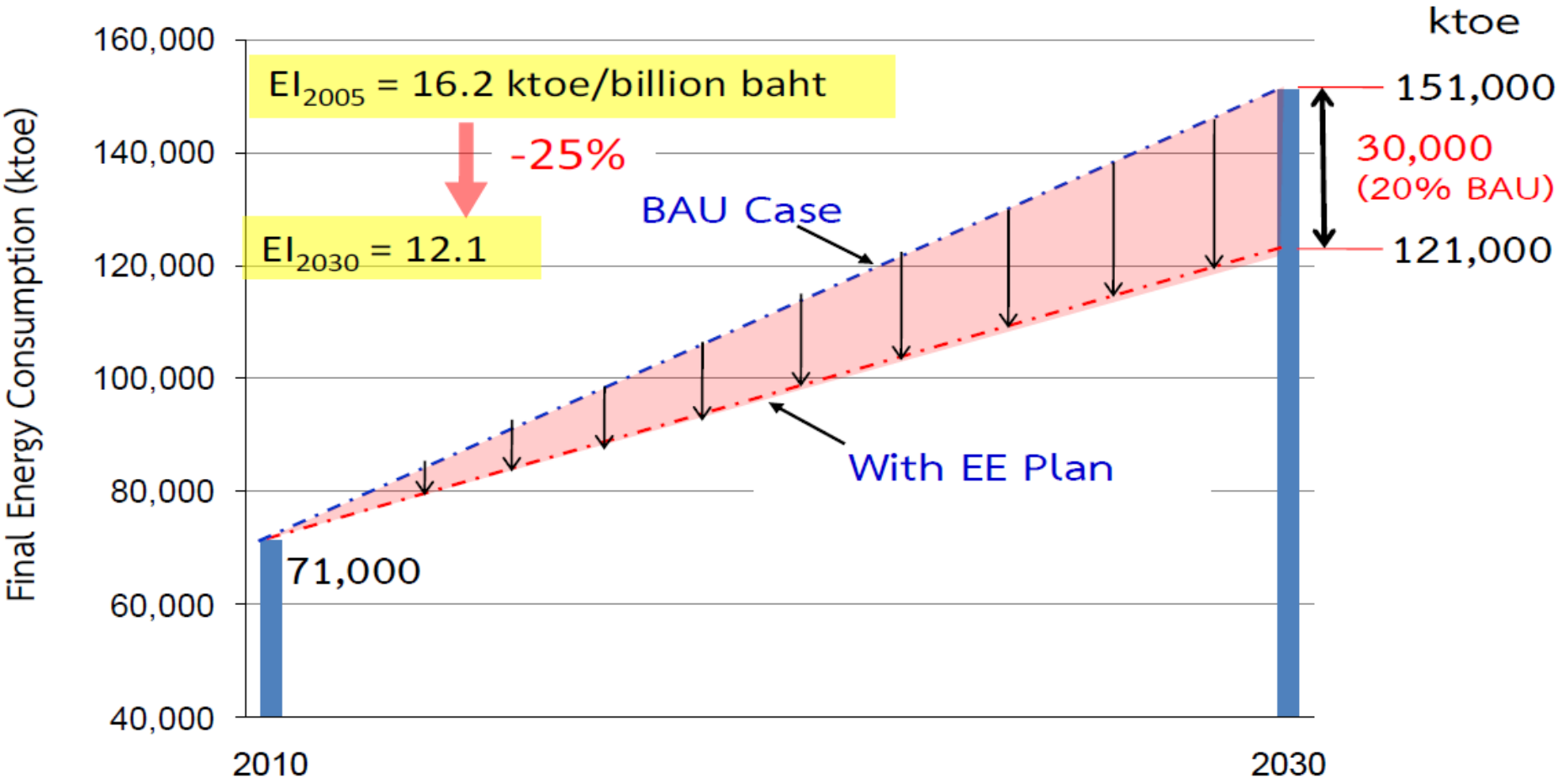
Energy Consumption in the Past and Future Demand Trend



Source: Thailand Energy Efficiency Development Plan (2011-2030)

Energy Conservation Target in 20 Years



Source: Thailand Energy Efficiency Development Plan (2011-2030)

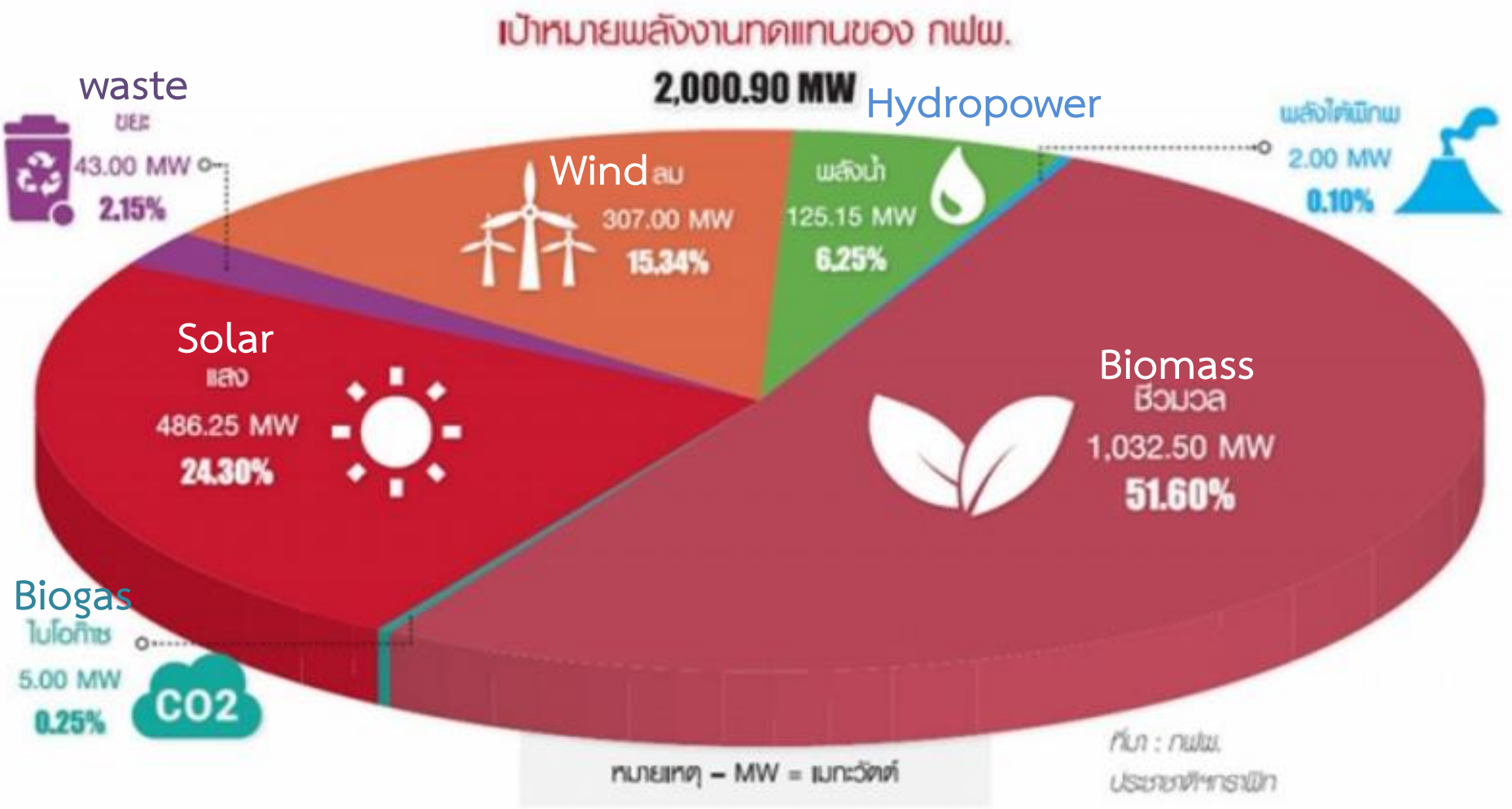
Share of Energy Saving by Economic Sector in 2030

Economic Sector	Technical Potential			Specified Target (ktoe)	Share (%)
	Heat (ktoe)	Electricity (GWh)	Total (ktoe)		
Transportation	16,250	-	16,250	13,400	44.7
Industry	10,950	33,500	13,790	11,300	37.7
Commercial Building & Residential					
- Large Commercial Building	410	27,420	2,740	2,300	7.6
- Small Commercial Building & Residential	1,690	23,220	3,670	3,000	10.0
Total	**29,300**	**84,140**	**36,450**	**30,000**	**100.0**

Implementation plan: (1) Mandatory Requirements via Rules, Regulations and Standards, (2) Energy Conservation Promotion and Support, (3) Public Awareness (PA) Creation and Behavioral Change, (4) Promotion of Technology Development and Innovation, (5) Human Resources and Institutional Capability Development

Source: Thailand Energy Efficiency Development Plan (2011-2030)

Alternative energy target by EGAT



http://www.prachachat.net/news_detail.php?newsid=1485069077

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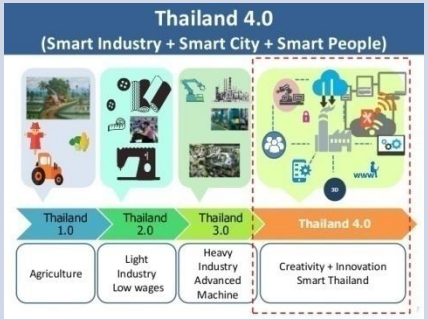
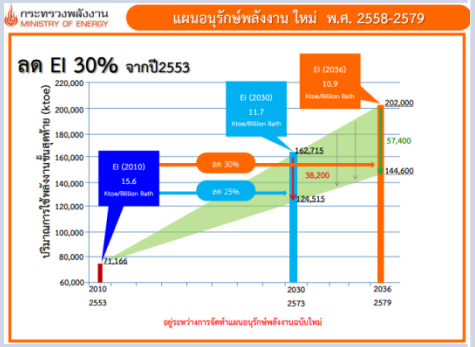
    - Social issue: Population and food
    - Economic development
    - Water
    - Energy
    - Cross cutting issues

National policy

- It is about balancing different resource user goals and interests – while mainstreaming the integrity of ecosystems: FAO 2014

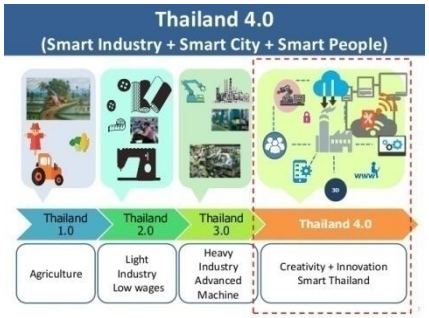
Development	Water security	Energy security	Food security
			

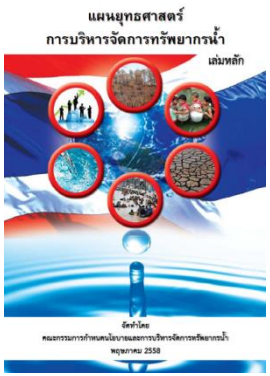
Each discipline has own target without the integration

- Tradeoffs -

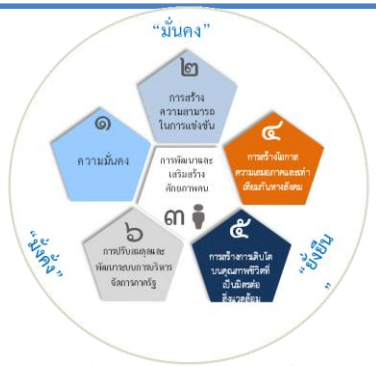
Energy production	Primary production
-Water: all steps energy value chain -Water storage for hydropower -Water for biofuels	-Agriculture -Forestry -Fisheries
Eco service	**Industrialization, urbanization**
-Water quality -biodiversity -Flood and drought protection	-Domestic -Industrial -Waste water treatment

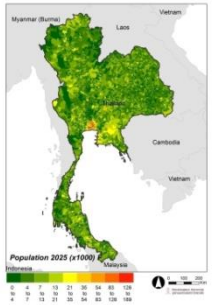

THE GLOBAL GOALS


Thailand 4.0
(Smart Industry + Smart City + Smart People)
Thailand 1.0
Thailand 2.0
Thailand 3.0
Thailand 4.0
Agriculture
Light Industry Low wages
Heavy Industry Advanced Machine
Creativity + Innovation Smart Thailand


แผนยุทธศาสตร์
การบริหารจัดการทรัพยากรน้ำ
ฉบับหลัก

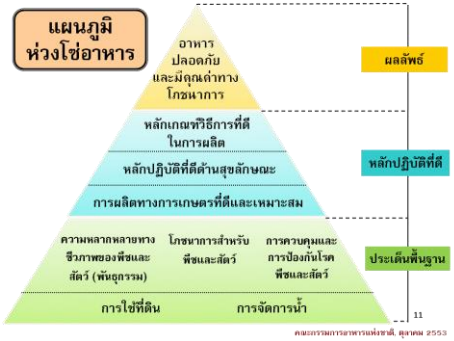

ร่าง แผนพัฒนาเศรษฐกิจและสังคมแห่งชาติ
ฉบับที่ ๑๒ (พ.ศ. ๒๕๖๐-๒๕๖๔)

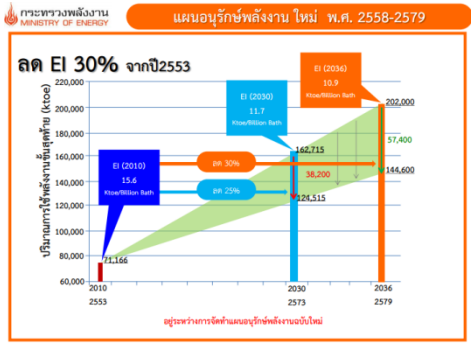

"มั่นคง"
"มั่งคั่ง"
"ยั่งยืน"


Population 2025 (x1000)

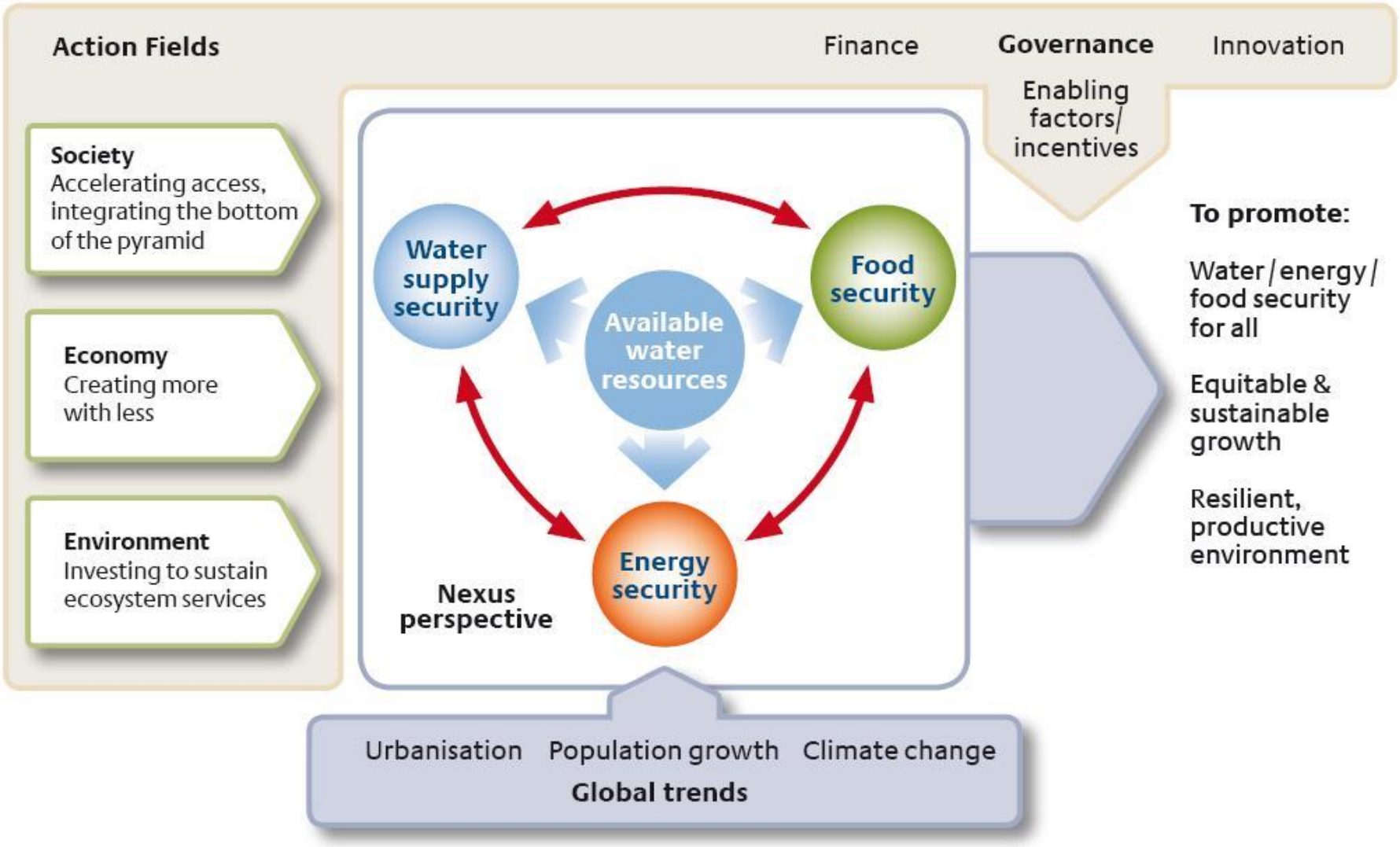

ยุทธศาสตร์การบริหารจัดการทรัพยากรน้ำ ปี พ.ศ. 2558-2569
การบริหารจัดการ

Linkage?


แผนภูมิ
ห่วงโซ่อาหาร
อาหาร ปลอดภัย และมีคุณค่าทางโภชนาการ
หลักเกณฑ์วิธีการที่ดีในการผลิต
หลักปฏิบัติที่ดีด้านสุขลักษณะ
การผลิตทางการเกษตรที่ดีและเหมาะสม
ความหลากหลายทางชีวภาพของพืชและสัตว์ (พันธุกรรม)
โภชนาการสำหรับพืชและสัตว์
การควบคุมและการป้องกันโรคพืชและสัตว์
การใช้ที่ดิน
การจัดการน้ำ
ผลลัพธ์
หลักปฏิบัติที่ดี
ประเด็นพื้นฐาน


กระทรวงพลังงาน
แผนอนุรักษ์พลังงาน ใหม่ พ.ศ. 2558-2579
ลด EI 30% จากปี2553
EI (2010) 15.6 Ktoe/Billion Baht
EI (2030) 11.7 Ktoe/Billion Baht
EI (2036) 10.9 Ktoe/Billion Baht
202,000
57,400
144,600
162,715
38,200
124,515
71,166
2010 2553
2030 2573
2036 2579

Water-Energy-Food NEXUS for Socio-Economic Dev.



(source: In Focus: Water, Energy, Food Nexus – Report, https://climatecommercial.wordpress.com/2011/11/09/in-focus-water-energy-food-nexus-report/)

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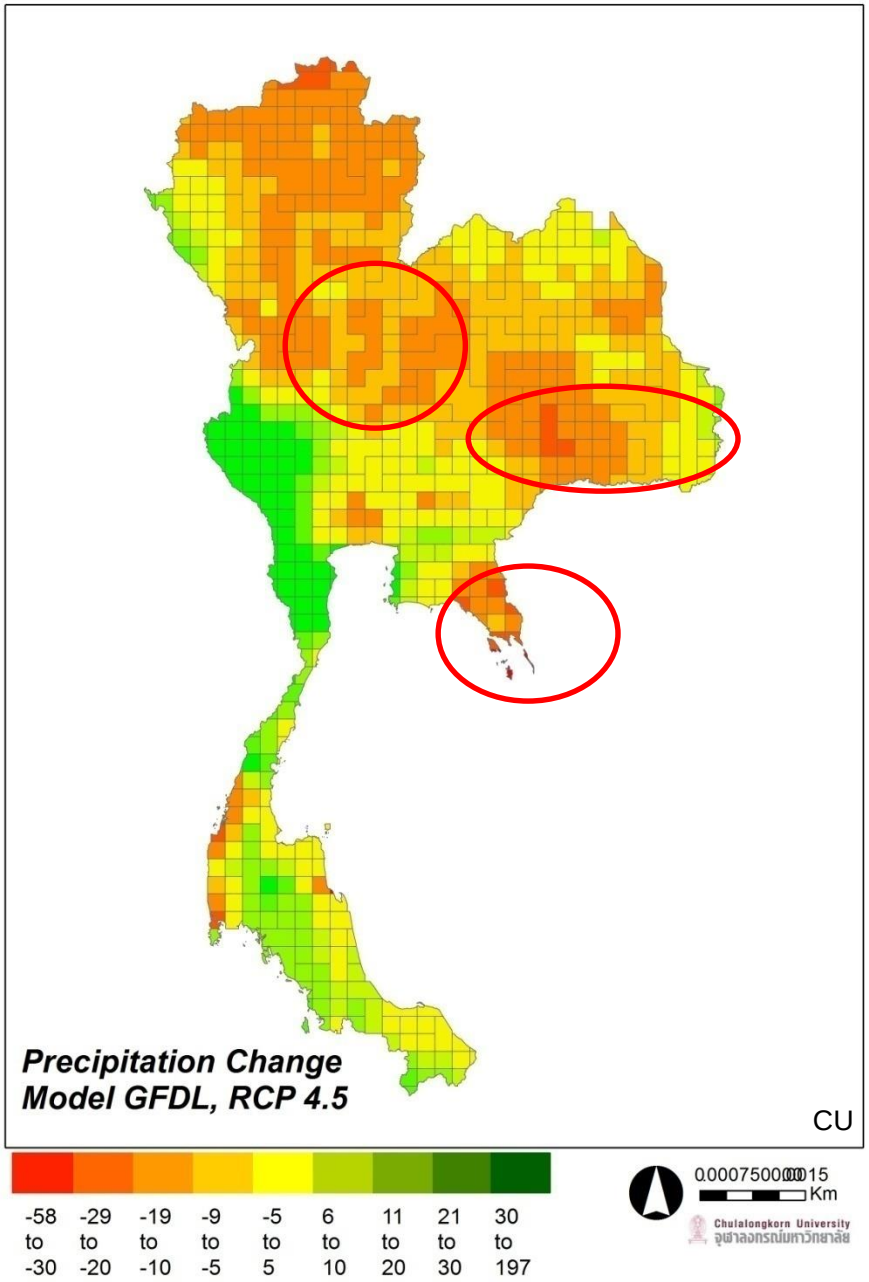
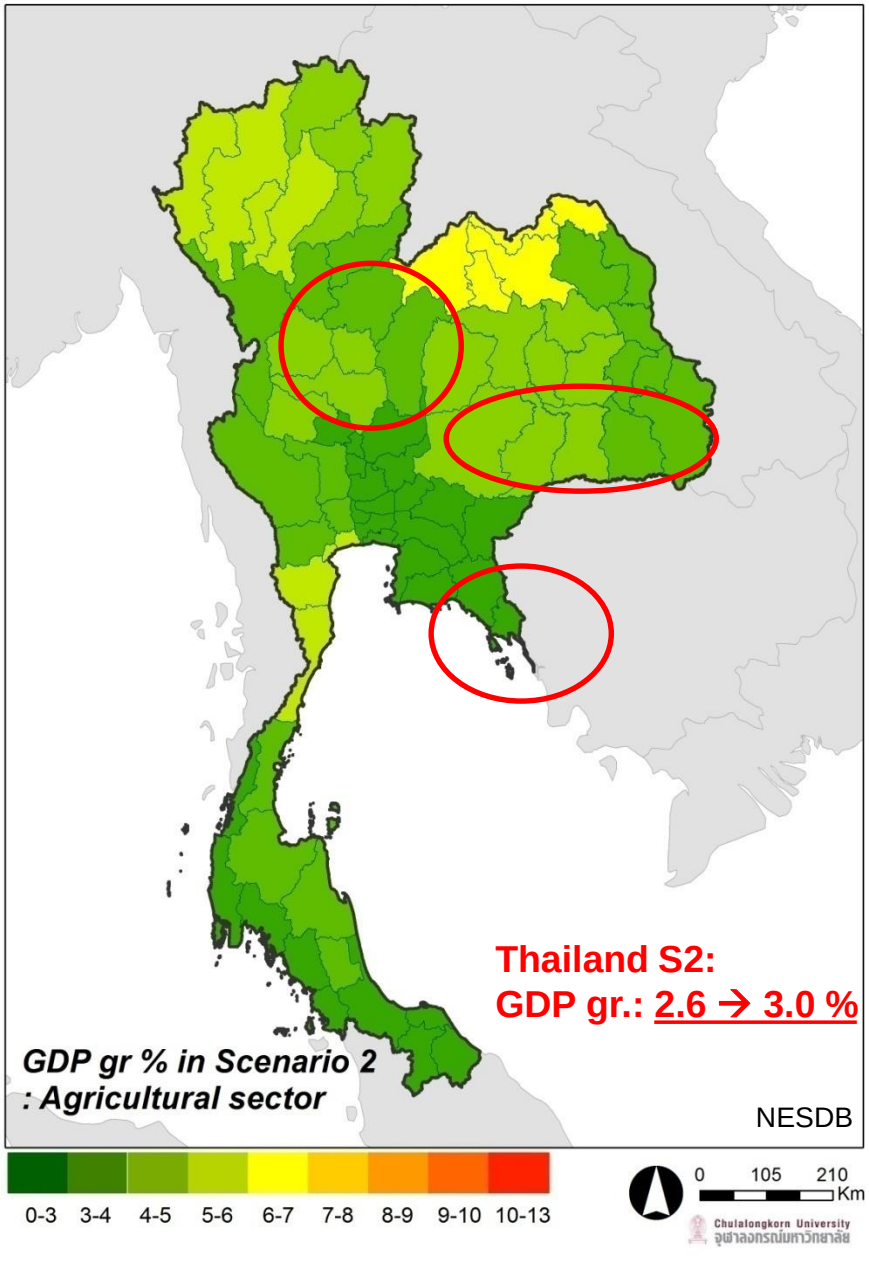
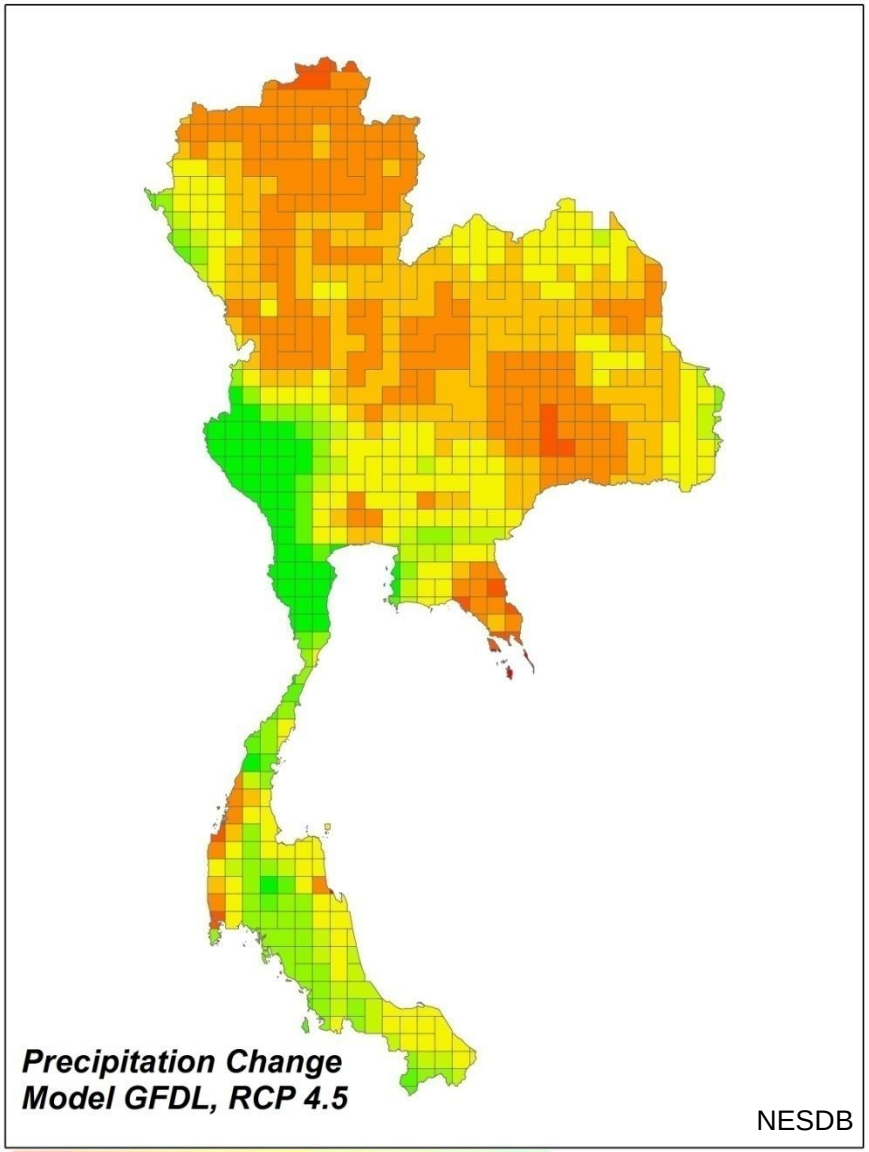
    - Energy
    - Cross cutting issues: cc → water → con

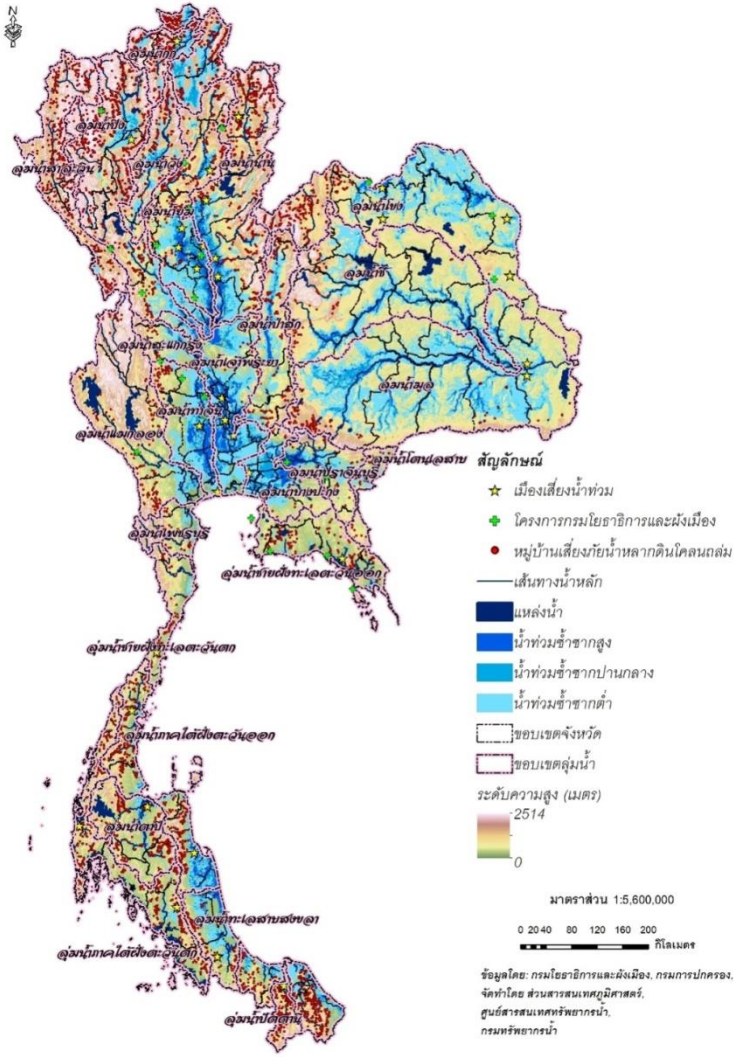
CC risk in agricultural sector: food security



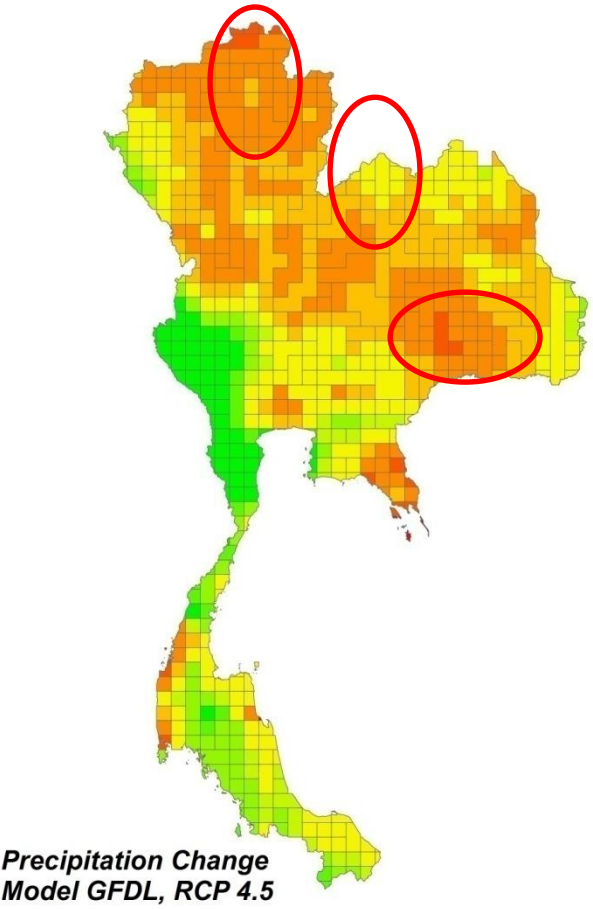


CC risk in water resources sector: Flood & Drought

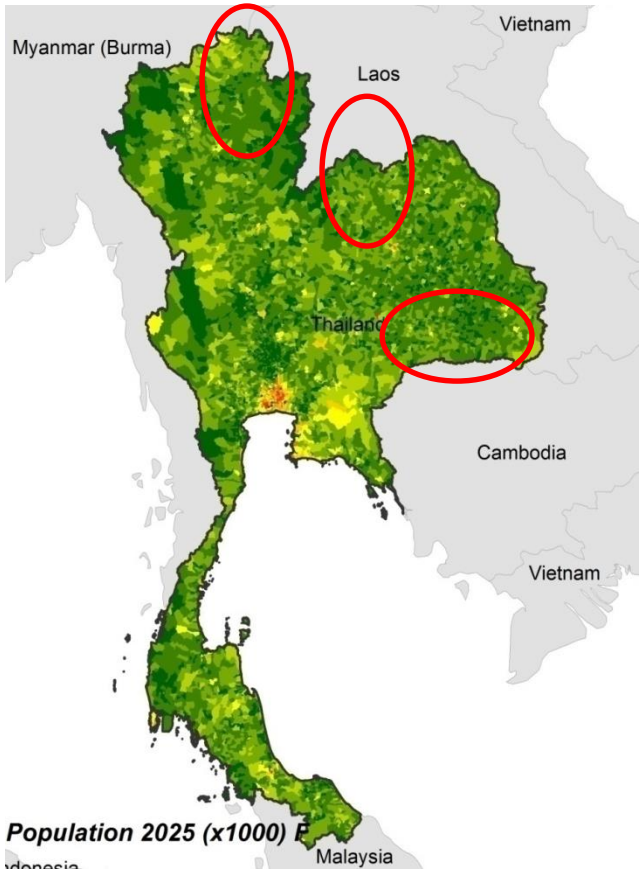




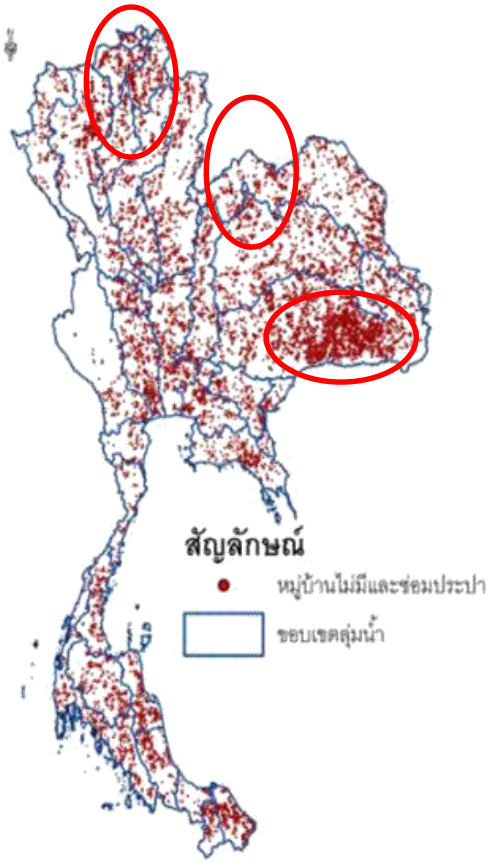
CC risk in Human-settlement and health sectors: tap water



Precipitation Change
Model GFDL, RCP 4.5



Population 2025 (x1000) P



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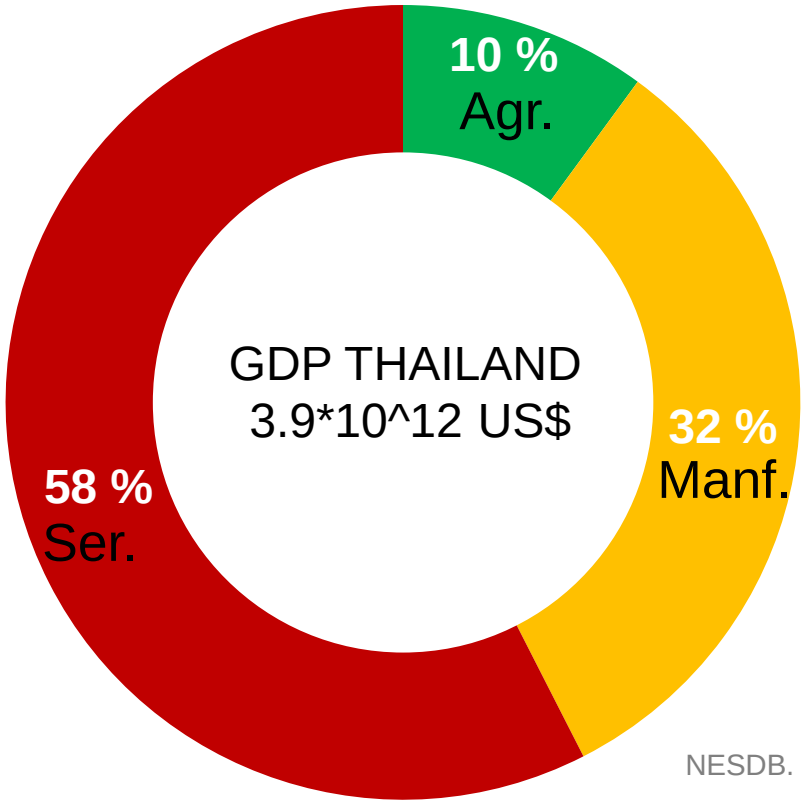
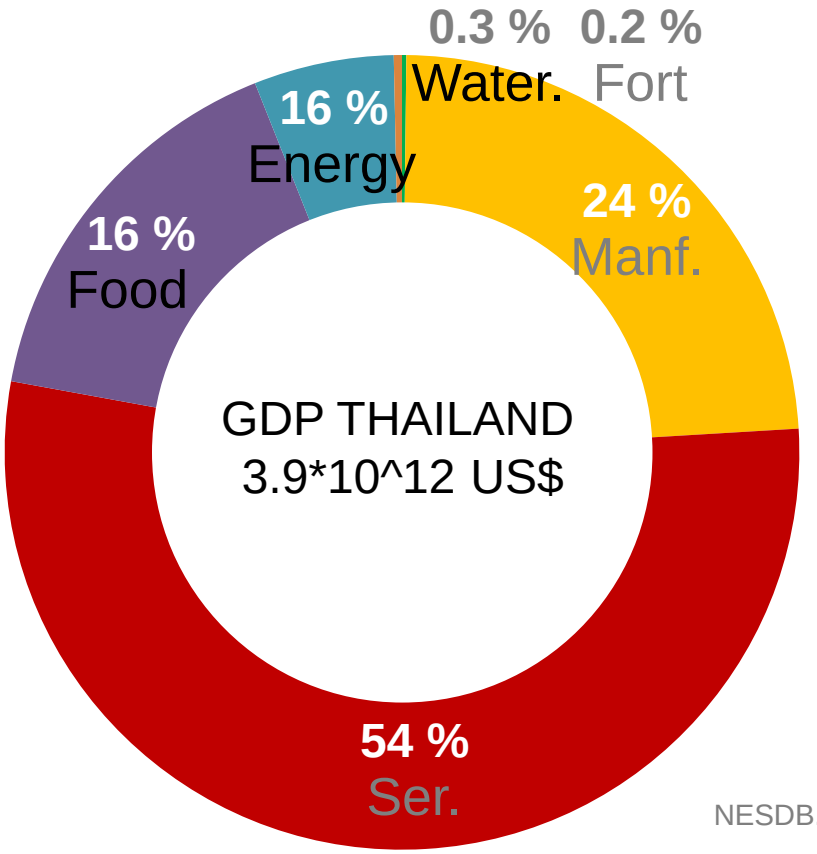
GDP of Thailand





Note: data from IO table (NESDB), AGR = Agriculture, FORT = Forestry, MFG = Mining, Manufacturing, SER = Services, COAL = Coal and Lignite, PETO = Petroleum and Natural Gas, ELEC = Electricity, GAS = GAS-Pipe Line, FOOD = Crops + Livestock + Fishery + Food Manufacturing + Beverages Products, ENER = Energy, WATR = Water Supply System

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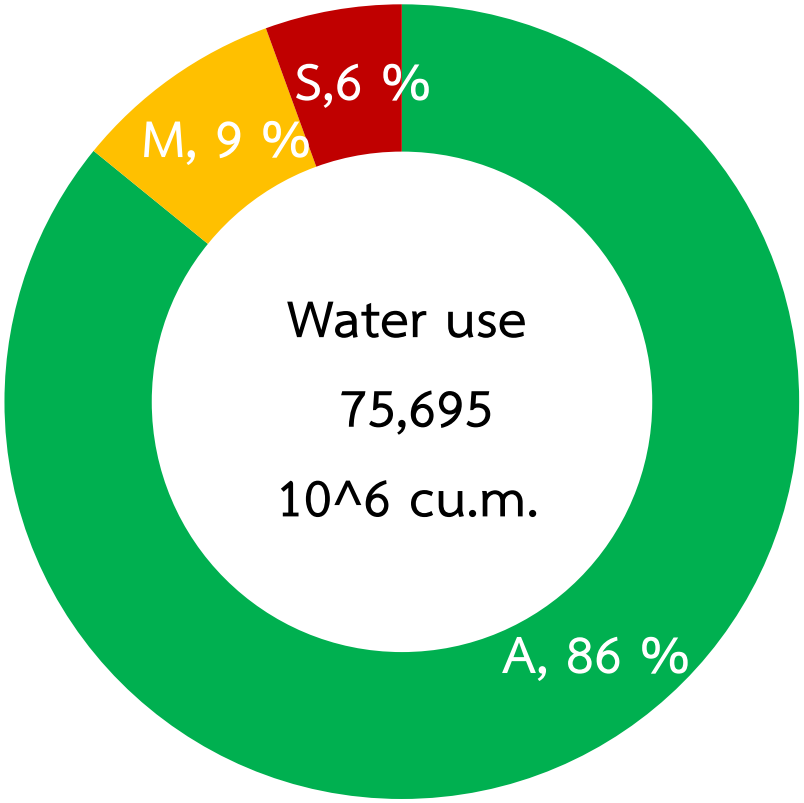
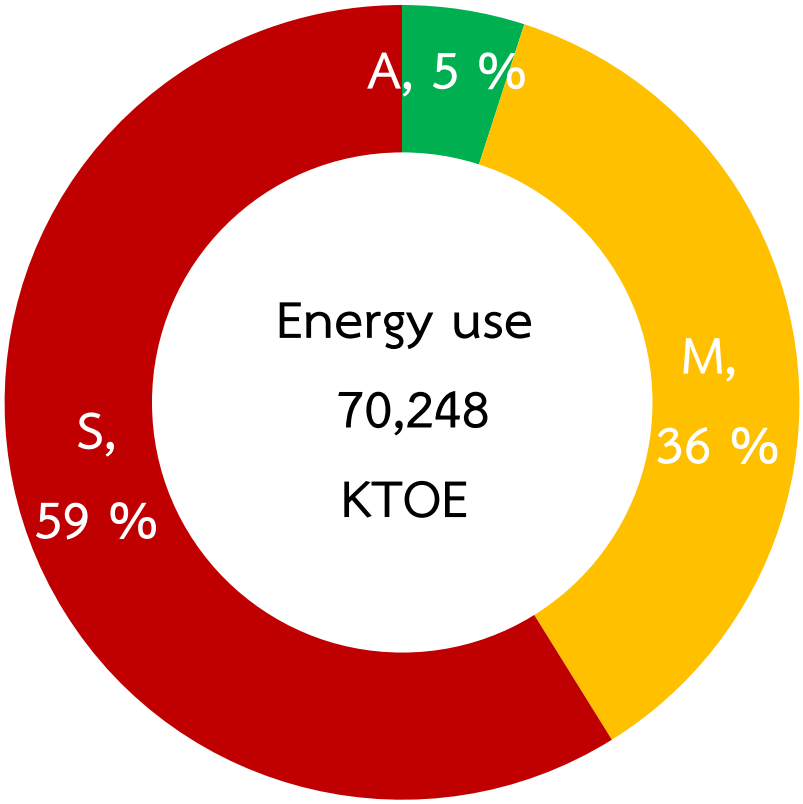
Water and Energy Use in Thailand (Physical Unit)





Note: A = Agriculture, M = Mining, Manufacturing, S = Services, KTOE = kilo ton of oil equivalent
Source: Water information from Thailand Water Management Strategy
Energy information from Thailand 20-Year Energy Efficiency Development Plan (2011 – 2030)

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Water-Energy-Food Linkage (M.US$)

Water for Food
Water for Energy

Energy for Food
Energy for Water

Food for Energy

Intermediate transaction

	FORT	MFG	SER	FOOD	ENER	WATR
FORT	349	12,276	2,723	367	83	
MFG	1,203	2,428,873	750,646	170,276	56,054	1,660
SER	335	154,017	500,080	50,517	43,358	2,201
FOOD	220	77,775	156,651	578,915	528	
ENER	10	435,275	88,736	20,142	208,823	3,148
WATR	1	3,379	4,620	1,350	133	639

Export, Import

305+306	409
2,915	- 2,081
1,867,360	- 1,708,534
273,079	- 185,322
337,512	- 129,321
16,854	- 346,955
0	0

Domestic

World Market

Note: data from IO table (NESDB), AGR = Agriculture, FORT = Forestry, MFG = Mining, Manufacturing, SER = Services, COAL = Coal and Lignite, PETO = Petroleum and Natural Gas, ELEC = Electricity, GAS = GAS-Pipe Line, FOOD = Crops + Livestock + Fishery + Food Manufacturing + Beverages Products, ENER = Energy, WATR = Water Supply System, 201 Wages and Salaries, 202 Operating Surplus, 203 Depreciation, 204 Indirect Taxes less Subsidies, 305 Exports (F.O.B.), 306 Special Exports, 409 Total Imports

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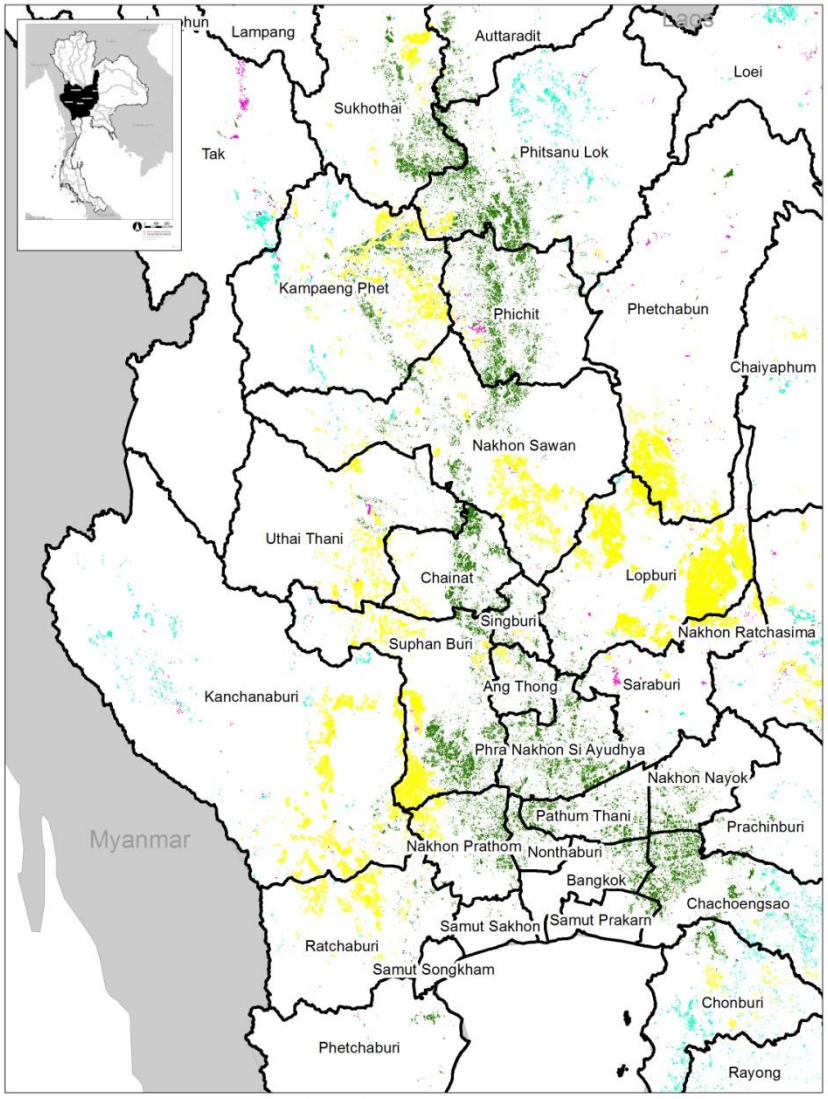
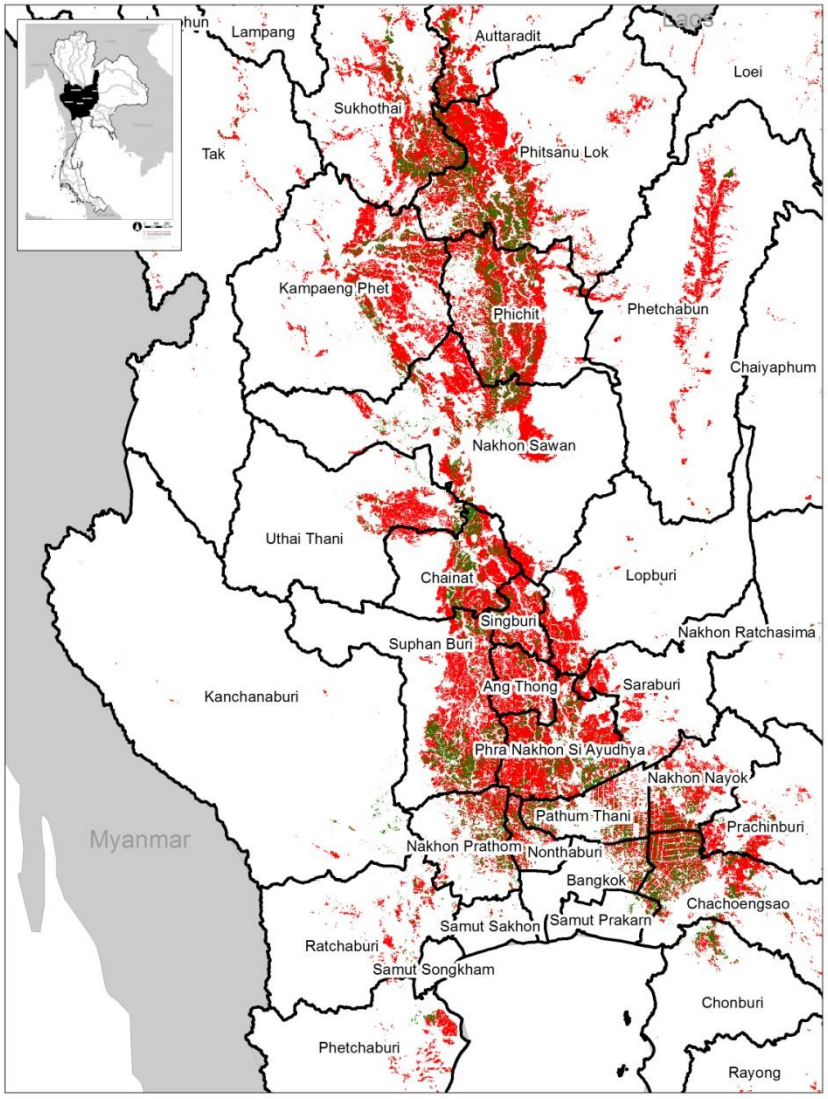
Cropped area data





Gistda

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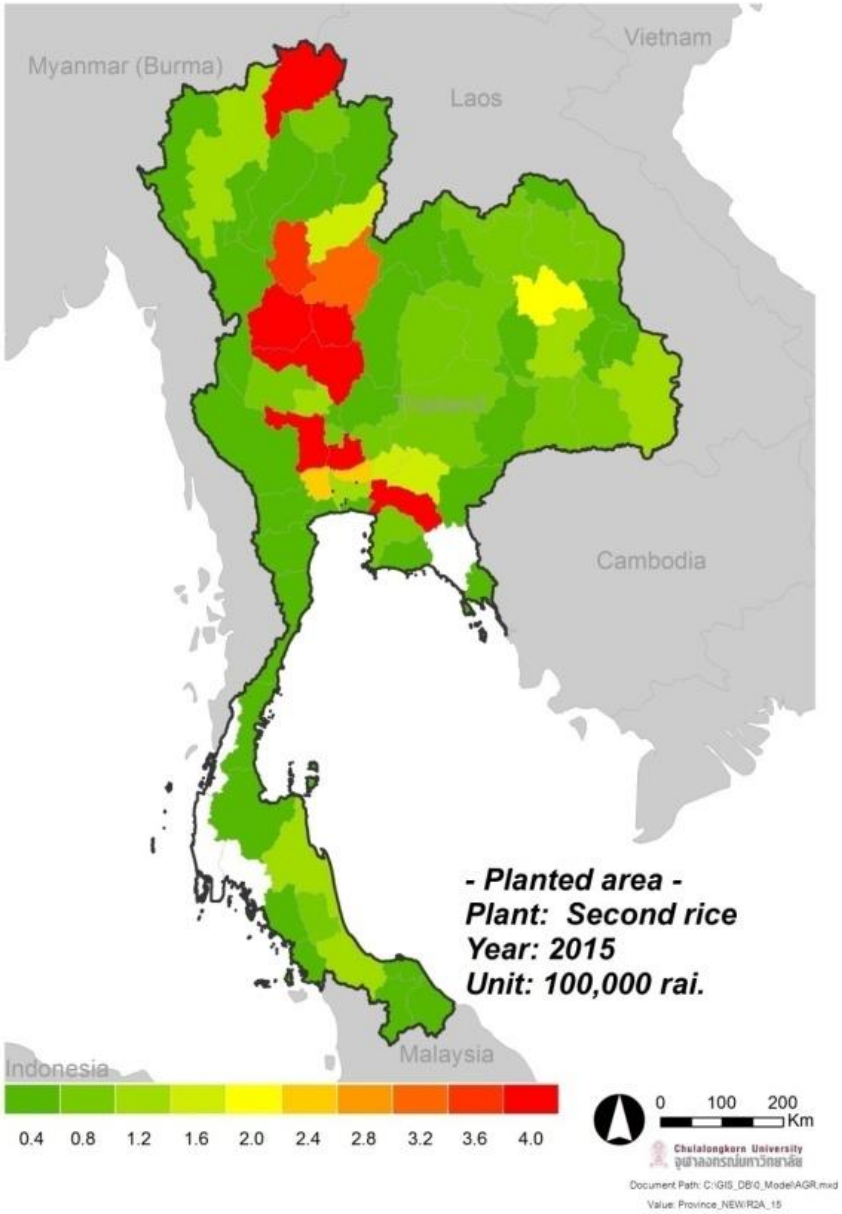
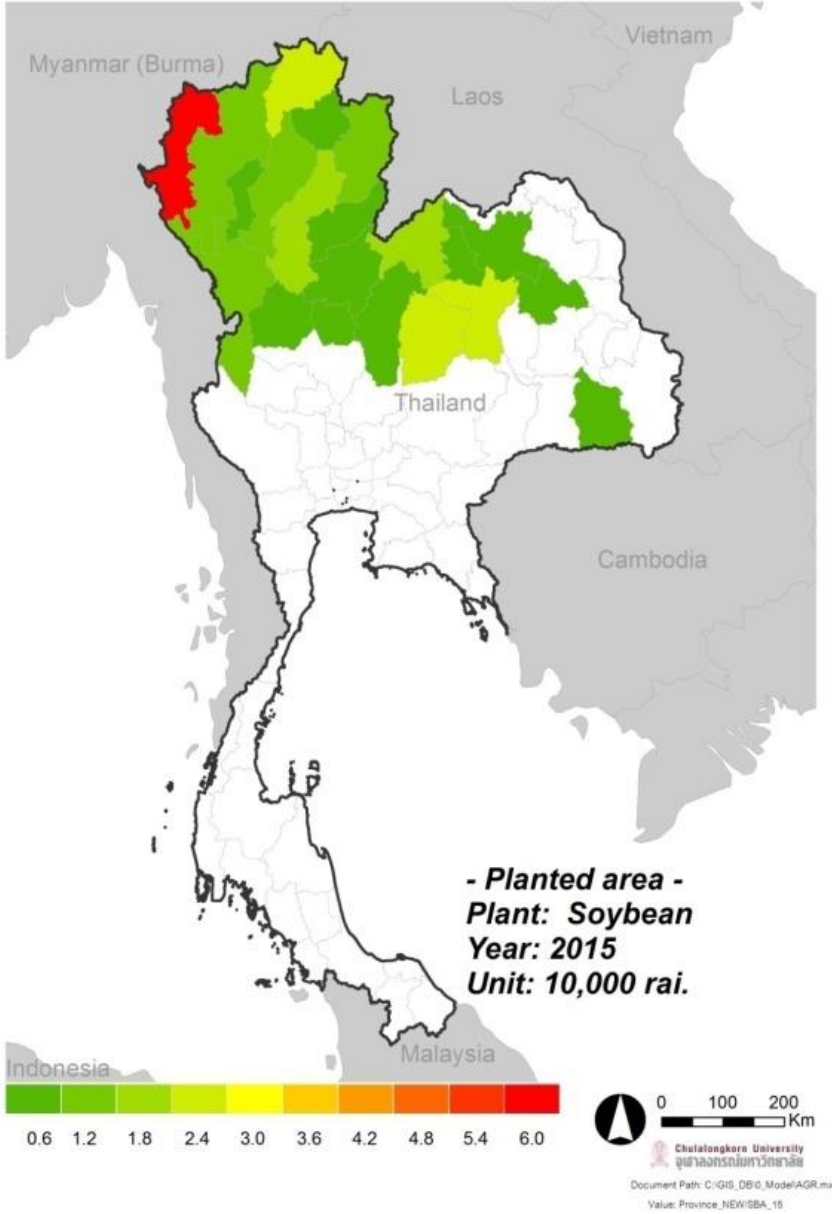
Cropped area data





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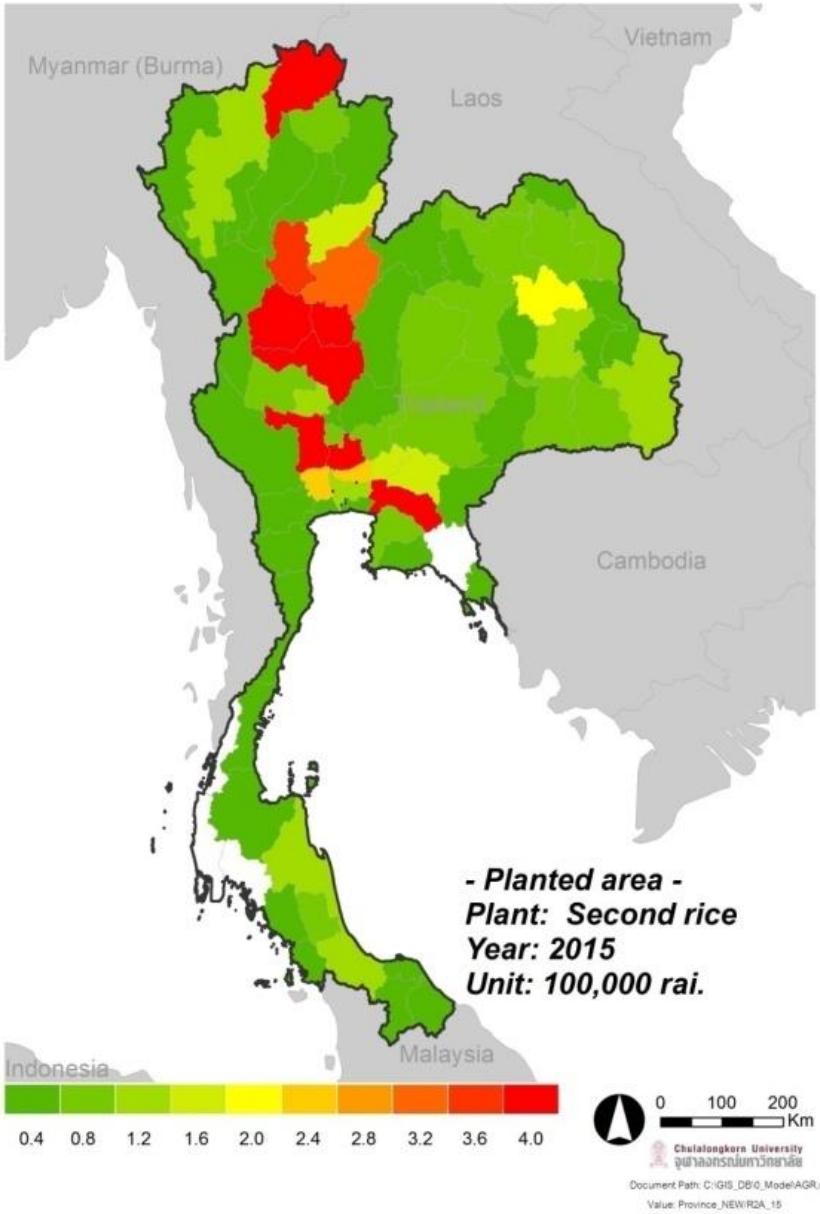

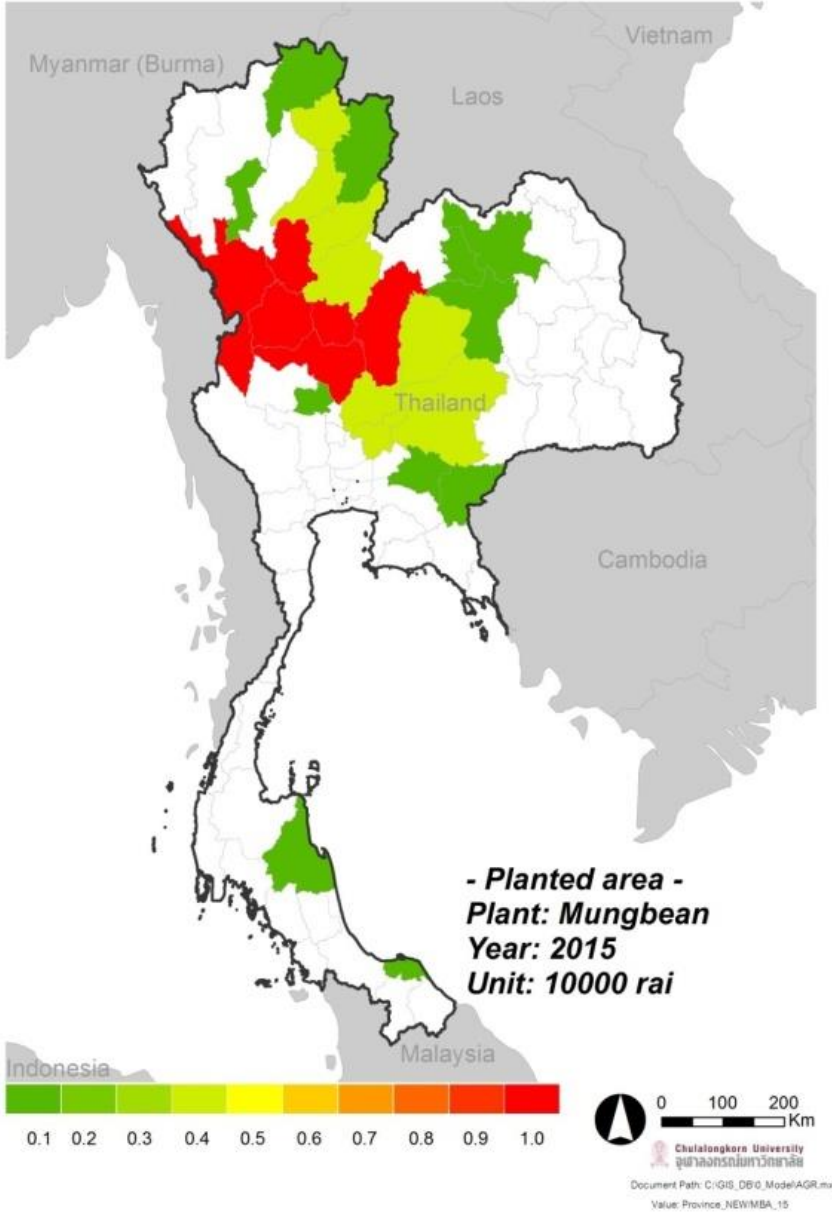

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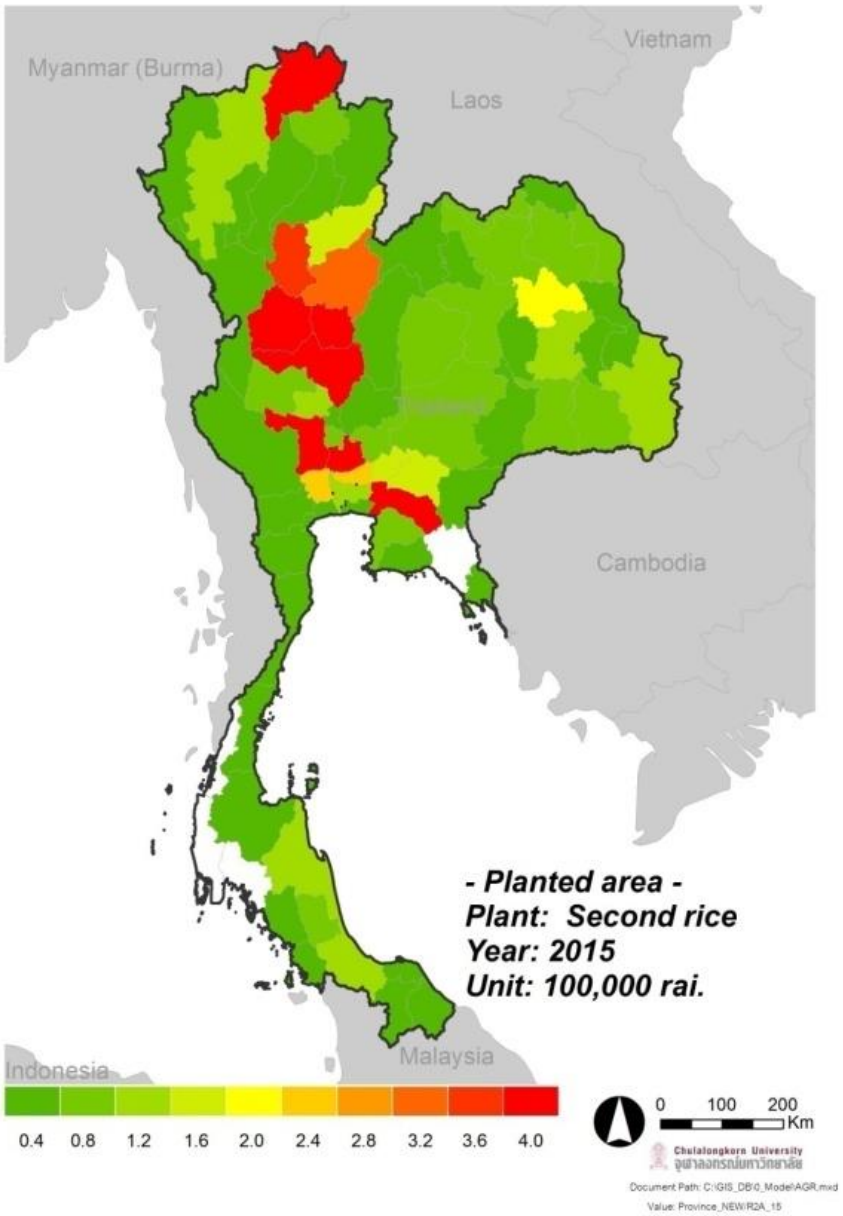
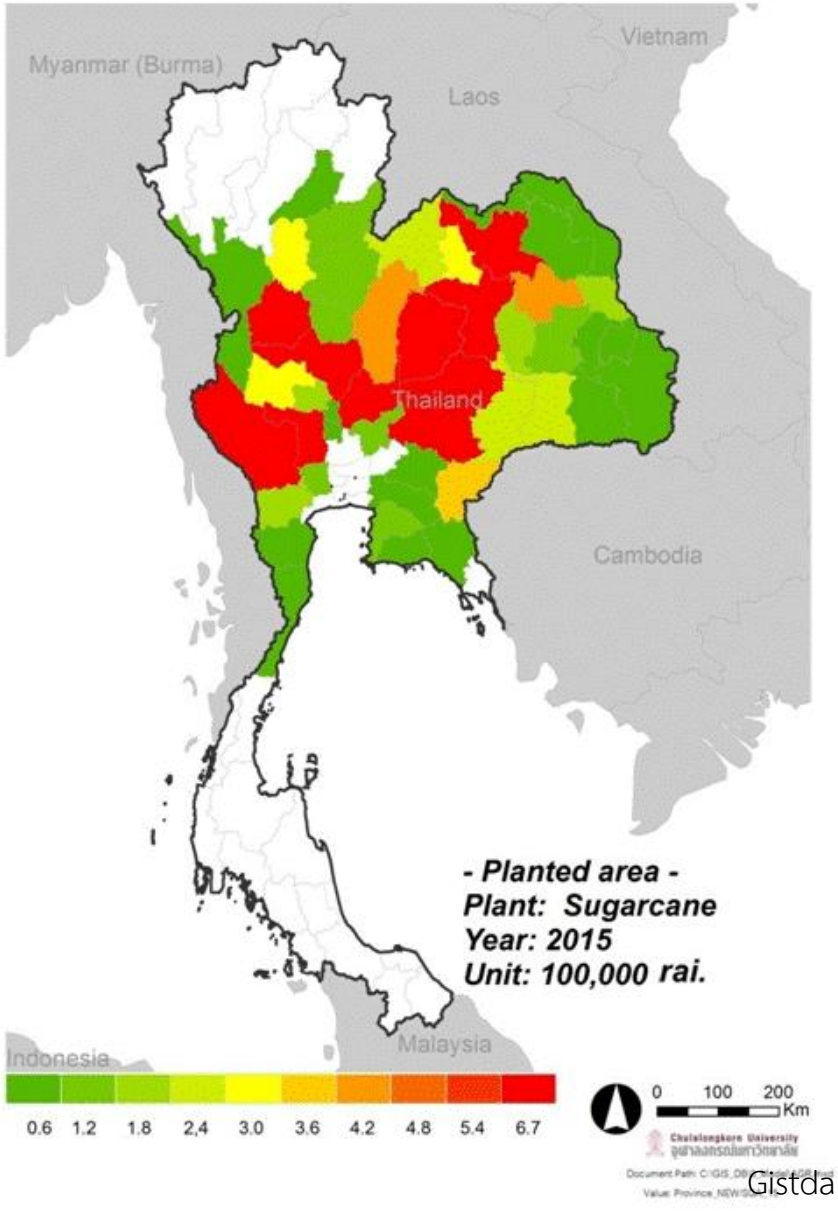
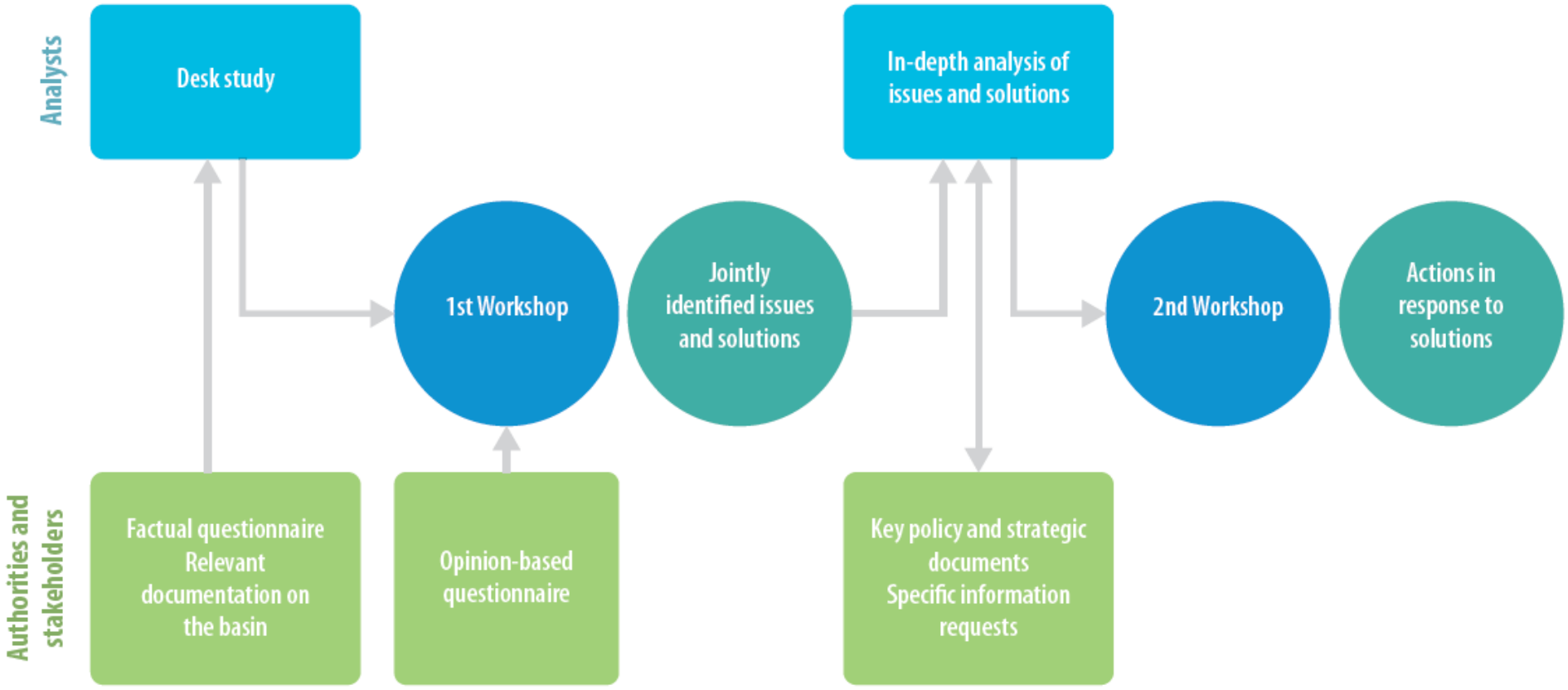




Contents

Information exchange in the nexus assessment of a basin



UN (2016) Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus

Steps of the nexus assessment of a basin

Step	Actors	Location	Sectors
1. Identification of basin conditions and the socioeconomic context	Analysts	Desk study	General. Information normally used to underpin sectoral planning. Key elements include general socioeconomic goals and targets.
2. Identification of key sectors and stakeholders to be included in the assessment	Analysts and authorities	Desk study	General. Requires expert judgment and understanding of local context and governance.
3. Analysis of the key sectors	Analysts and authorities	Desk study/ first workshop	Individual sector experts and plans. Key elements include identification of the resource base and uses, as well as institutional mapping.
4. Identification of intersectoral issues	Stakeholders	First workshop	Sectoral group discussion on interlinkages (input needs, impacts and trade-offs), and discussion on sectoral plans.
5. Nexus dialogue and future developments	Stakeholders	First workshop	Agree on a prioritization of main interlinkages, including how they are expected to change, according to jointly identified development trends, noting key uncertainties and most important drivers.
6. Identification of opportunities for improvement (across the sectors and countries)	Stakeholders and analysts	Desk study, first and second workshops	Identification of solutions with multiple impacts between sectors, scales and boundaries. Such solutions could eventually be integrated into policies and programmes in the countries/basins.

UN (2016) Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus

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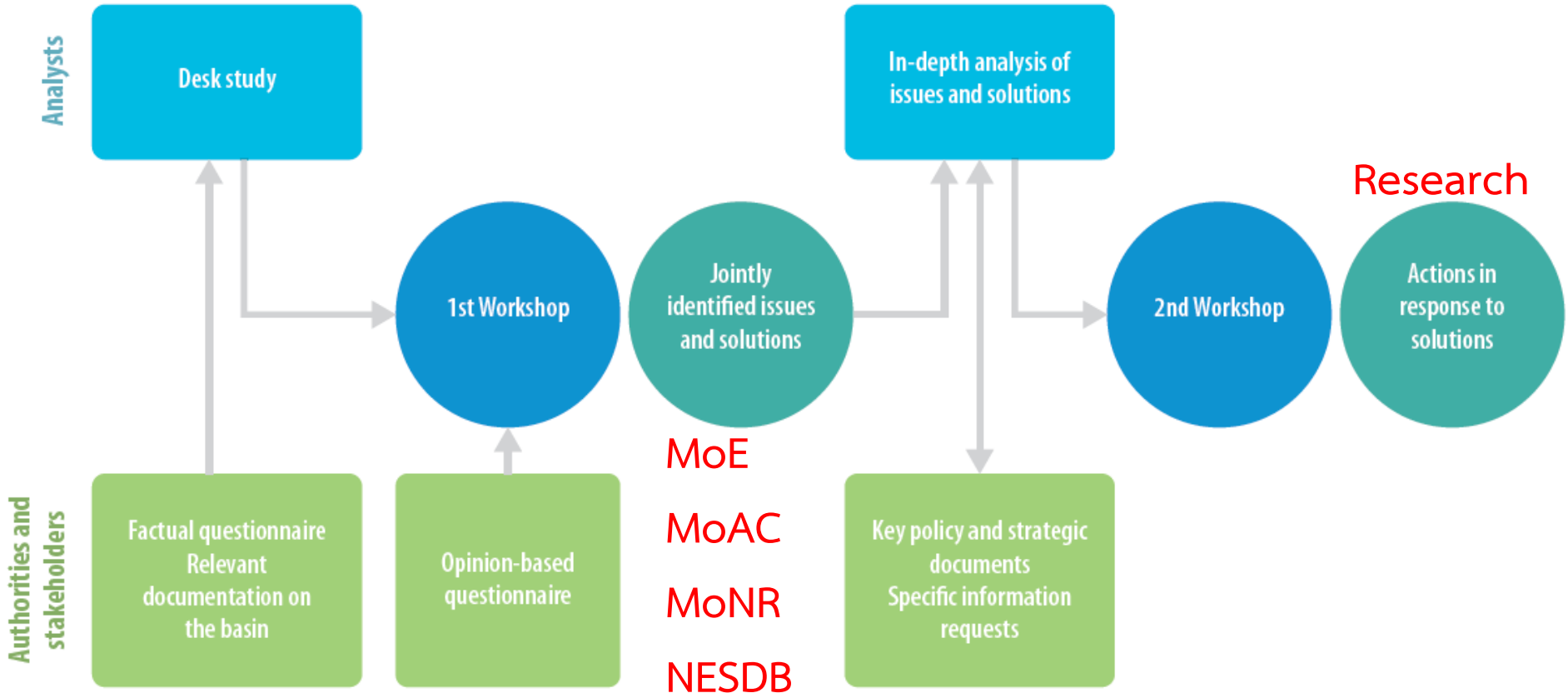
Steps of the nexus assessment in Thailand

Project: Conceptual Framework for Water, Food, Energy Nexus Research towards Sustainable Development Planning

Funded by Thailand Research Fund, 2017 (6 months)



ขอขอบคุณ

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