

Water Security and Sustainability
Thailand's Water Security Situation
in the context of world
and ASEAN

Assoc. Prof. Dr. Sucharit Koontanakulvong¹

¹Faculty of Engineering, Chulalongkorn University, Thailand

UNESCO Chair on Water, Disaster Management and Climate Change

Full report of Poster presentation at the UNESCO Water Family Meeting,

the UNESCO International Water Conference,

UNESCO Headquarters, Paris,

May 13-14, 2019

Water Security and Sustainability

Thailand's Water Security Situation in the context of world and ASEAN

Assoc. Prof. Dr. Sucharit Koontanakulvong¹

¹*Faculty of Engineering, Chulalongkorn University, Thailand*

Abstract

Worlds nowadays focus on SDG goals to be set as country benchmark for socio-economic environmental development. The successful countries for sustainable water security depend on efficiency of integrated water management, water productivity and provision of water supply and sanitary services. Water security index was another issue that had been proposed to monitor the national socio-economical development which comprised of household, urban water, economic water (including irrigation water), river health and resilience. The study proposed the water security definition and assessed the water security status of Thailand by using water use status and correlated with gross domestic product per capita, water productivity, Government effectiveness (Governance), political stabilities in various countries of the world, Asia and ASEAN which helped to understand the competitiveness and the strength, weakness and potential of water resources development of Thailand compared with the rest of the world and ASEAN countries and their initiatives needed.

Keywords :-water security , sustainability, water resources, Thailand, world, ASEAN.

1. Introduction

Worlds nowadays focus on SDG goals to be set as country benchmark for socio-economic environmental development. The successful countries for sustainable water security depend on efficiency of integrated water management, water productivity and provision of water supply and sanitary services. Water security index was another issue that had been proposed to monitor the national socio-economical development which comprised of household, urban water, economic water (including irrigation water), river health and resilience. The study proposed the water security definition and assessed the water security status of Thailand by using water use

status and correlated with gross domestic product per capita, water productivity, Government effectiveness (Governance), political stabilities in various countries of the world, Asia and ASEAN which helped to understand the competitiveness and the strength, weakness and potential of water resources development of Thailand compared with the rest of the world and ASEAN countries and their initiatives needed.

This study determined the water security status from five dimensions, i.e., WS1: basic water (renewable, supply, hygiene), WS2; sufficient water (water supply, consumption, agricultural water), WS3:development water (irrigation area, industrial water use, water for energy, water for aquaculture), WS4:water disaster (loss from floods and drought), WS5:water for future (population growth, urban population growth, water footprint) (Sucharit et. al., 2014). The index status analysed were correlated with water use unit (cubic meter per capita), water productivity (US \$ per cubic meter of water use), government effectiveness, political stabilities and grouped into four groups of country classified by income per capita of the country. Based on the available data from various sources of the world (World Bank, 2016; ADB, 2016), the index of each country was determined comparatively by weighting equally from each dimensions and ranked by marking equally (1-5 points) of each elements from the average and standard deviation values while the security status in ASIA is based on ADB study (ADB, 2016, 2019; Piyatida et.al., 2019).

2. Water security index concept

Up to now, water resources development process started with project development, implementation, monitoring and system improvement which aimed to facilitate basic needs to people and society. The other portion of water was used for economical development. In recent years, environmental issues were raised and had to be simultaneously considered during water resources planning too. The index described sufficiency, risk and was later developed to water security. The index helped to monitor the development of water management clearer and determined from various aspects, e.g., water sufficiency of both quantitative and qualitative aspects for health, life, ecology preservation, production, disaster relief (Grey and Sadoff, 2007) or the accessibility to clean and safe water with sufficient amount and payable cost for hygiene and good quality life with environment protection (Global Water Partnership, 2010).

The planning of each country normally concerned with the development of economics, society and environment. However the important element for sustainable development is still engaged with water resources. The concept of water security was developed to investigate the actual situations of these basic water developments with socio-economical and environmental development. The security dimensions proposed by ADB comprised of water security of house hold, economics, urban, river health and resilience to disaster (see Fig. 1).

This study determined the water security status from five dimensions, i.e., WSI1: basic water (renewable, supply, sanitation), WSI2: sufficient water (water supply, consumption, agricultural water), WSI3: development water (irrigation area, industrial water use, water for energy, water for aquaculture), WSI4: water disaster (loss from floods and drought), WSI5: water for future (population growth, urban population growth, water footprint). The index status analysed were correlated with water productivity (US\$ per cubic meter of water) with the four groups of country classified by GDP per capita of the country. Based on the available data from various sources of the world (World Bank, 2014; Mackie Black et. al, 2009), the index of each country was determined comparatively by weighting equally from each dimensions and marking equally (1-5 points) of each elements with ranking from the average and standard deviation values.

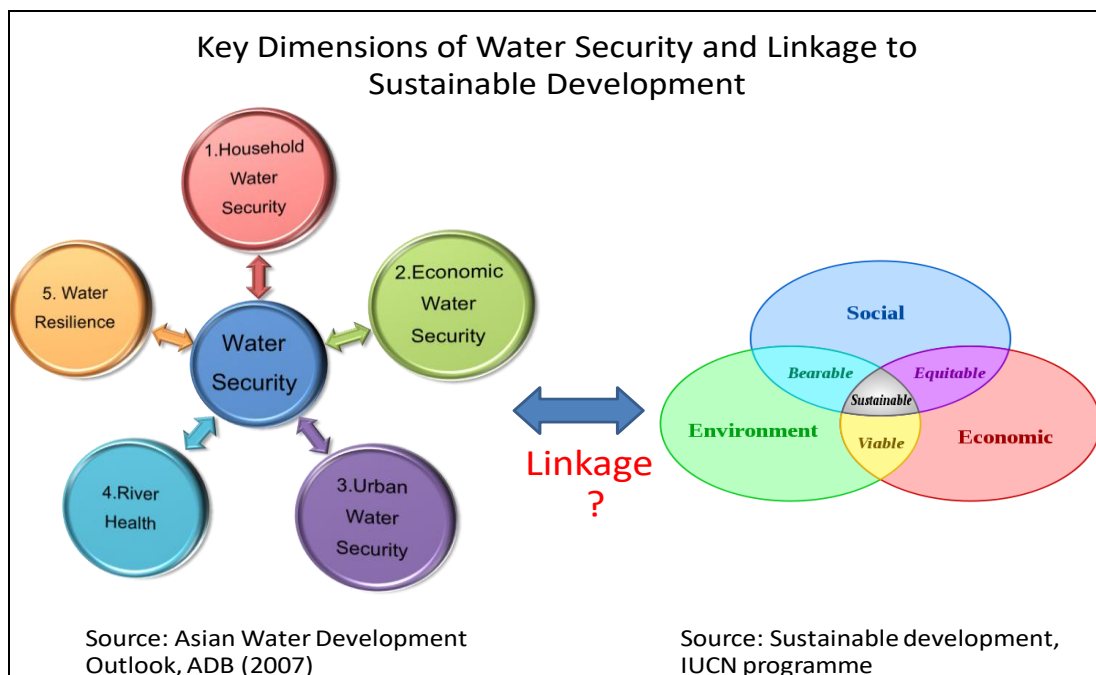


Fig 1 Water security index and linkage with sustainability

3 Study Procedure (เพิ่มอ้างอิงแหล่งข้อมูลด้วย)

ในการคำนวณดัชนีความมั่นคงน้ำ และความยั่งยืน ได้มีรวบรวมข้อมูลของ Gross domestic product : Population, Water productivity, Government Effectiveness (แทน goverance), Political stability index และ National Water Security Index by Economy โดยมีรายละเอียดดังนี้

- 1) รวบรวมข้อมูล Gross domestic product : Population ปี 2016 มาคำนวณ โดยได้นำข้อมูล average annual % growth มาคูณกับพื้นฐานบาทจะออกมาเป็นรายได้ และนำข้อมูลรายได้มาหารกับข้อมูลประชากรจะออกมาเป็นค่า GNP (ที่มา: ข้อมูลจาก World bank Population 2016)
- 2) รวบรวมข้อมูล Water productivity (Annual Water Use 2010/2005 GDP/cm) โดยนำค่า GDP ของทุกประเทศมาบวกกัน และทำการหาค่าเฉลี่ย (ที่มา: World bank, Sucharit 2014)
- 3) รวบรวมข้อมูล Government Effectiveness ปี 2016 โดยใช้ค่า Rank และนำค่าของทุกประเทศมาบวกกัน และทำการหาค่าเฉลี่ย ตามแต่ละกลุ่มรายได้ (ที่มา: ข้อมูลจาก World bank 2016)
- 4) รวบรวมข้อมูล Political stability index ปี 2017 และนำค่าของทุกประเทศมาทำการหาค่าเฉลี่ย (ที่มา: ข้อมูลจาก World bank ระบุ เวป ที่ใช้ด้วย)
- 5) กรณีโลก รวบรวมข้อมูล National Water Security Index by Economy (NWS Score) (full score: 25) ได้นำข้อมูล Water Security Index ของทุกประเทศมาบวกกัน และทำการหาค่าเฉลี่ย (น้ำมี 5 ประเภท ซึ่งน้ำแต่ละประเภทจะมีค่าอยู่ที่ 5 รวมกันแล้วได้ 25 คะแนน) เมื่อหาค่าเฉลี่ยแล้วนำข้อมูลมาจัดตามประเภทของรายได้โดยยึดข้อมูลรายได้ของเดือนกรกฎาคม 2018 ที่ทาง world bank ได้ทำการจัด (ที่มา: ข้อมูลจาก World bank, ADB 2016, Sucharit 2014)
- 6) กรณีเอเชีย ใช้ข้อมูล adb 2016
- 7) ในการคำนวณรายได้ของทุกประเทศ จะใช้เกณฑ์ใหม่ซึ่งจะถูกกำหนดเมื่อเริ่มต้นปีงบประมาณของธนาคารในเดือนกรกฎาคมและคงที่เป็นเวลา 12 เดือนโดยไม่คำนึงถึงการแก้ไขประมาณการตามมา ตั้งแต่วันที่ 1 กรกฎาคม 2018 เกณฑ์ใหม่สำหรับการจำแนกตามรายได้คือ:

Threshold GNI/Capita (current US\$)

Low-income < 995

Lower-middle income 996 - 3,895

Upper-middle income 3,896 - 12,055

High-income > 12,055

4. World water use, water security and sustainability

The data of water use for domestic, industry and agriculture of each country were gathered and grouped up by country income (GDP per capita) into four groups, i.e., high (> 11906 US\$), upper middle (3856-11906 US\$), lower middle (976-3855 US\$), low income (<976 US\$) group of countries with the rate of water use in each categories, i.e., agriculture, households, industry and showed in Fig. 2. It can be seen that average water use rate grows up with the GDP per capita growth up to the moderate level but becomes lower at the very high income group. The water use structure changes with the GDP per capita growth with the increase of industrial water use (as shown in Fig 3 for each dimension) except in the dimension of water disaster which decrease in the high income country group due to the loss from water disaster (which may reflect from the data availability).

Based on the water security index proposed by the study, the distribution of water security status of each country (146 countries shown in Appendix) in the world scale can be shown in Fig. 4. The water productivity, measured by the income per capita per water use unit, was assessed (shown in Fig 5) and compares with the water security index obtained and shown in Fig 6. It can be seen that more water productivity induced better water security status.

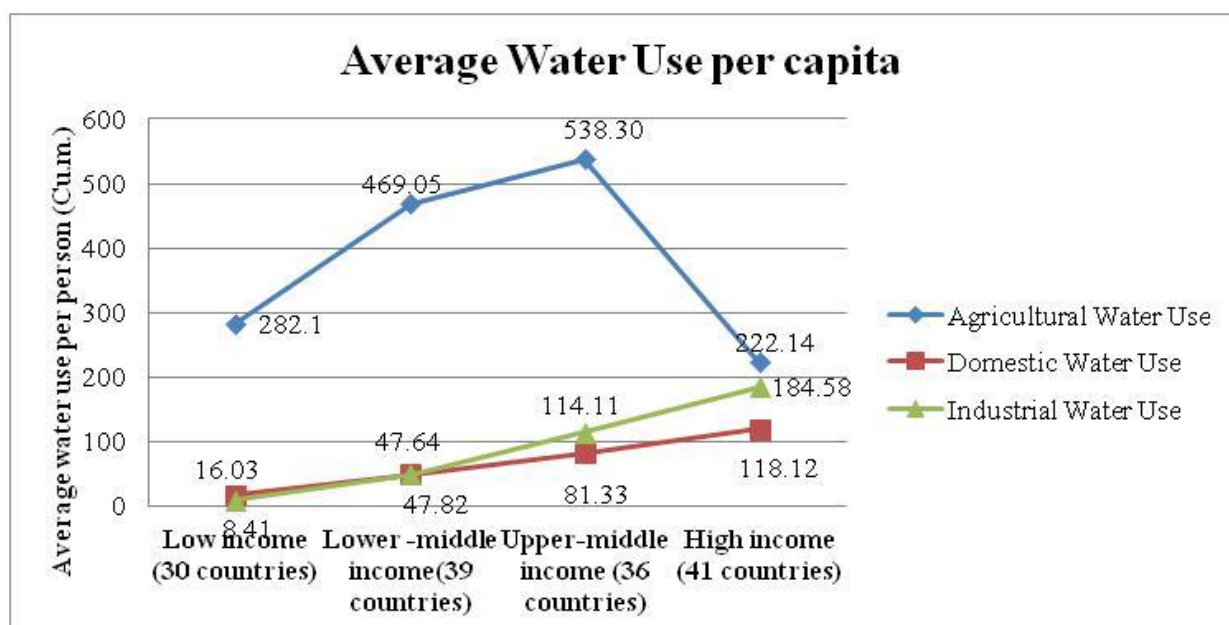


Fig 2 Water use per capita of each income country group

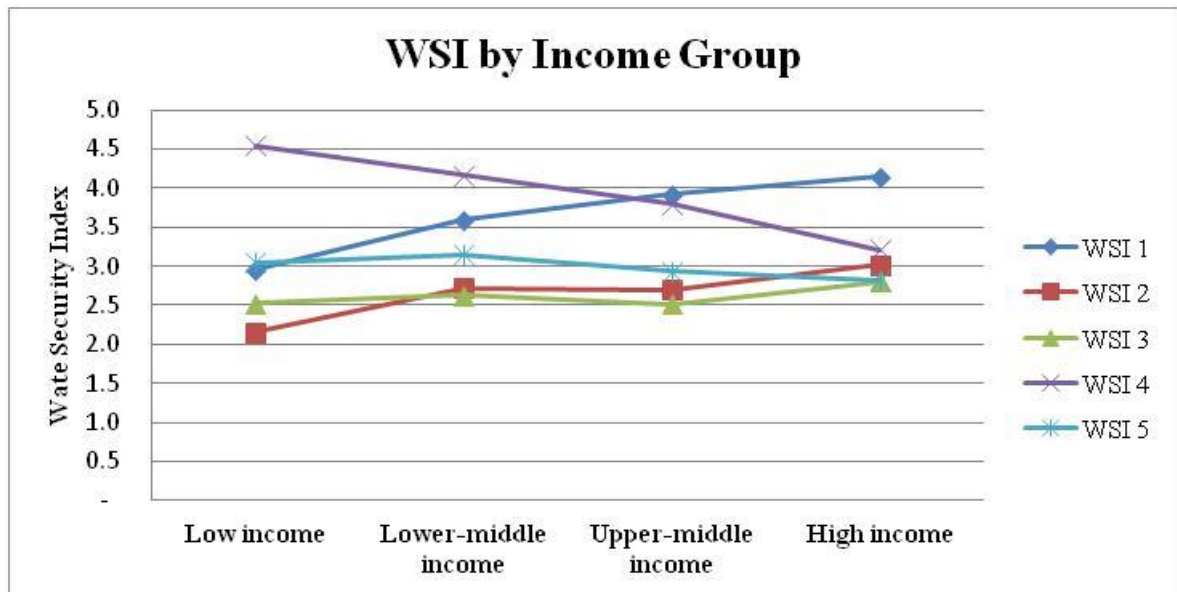


Fig 3 Water security index of the world in each dimension

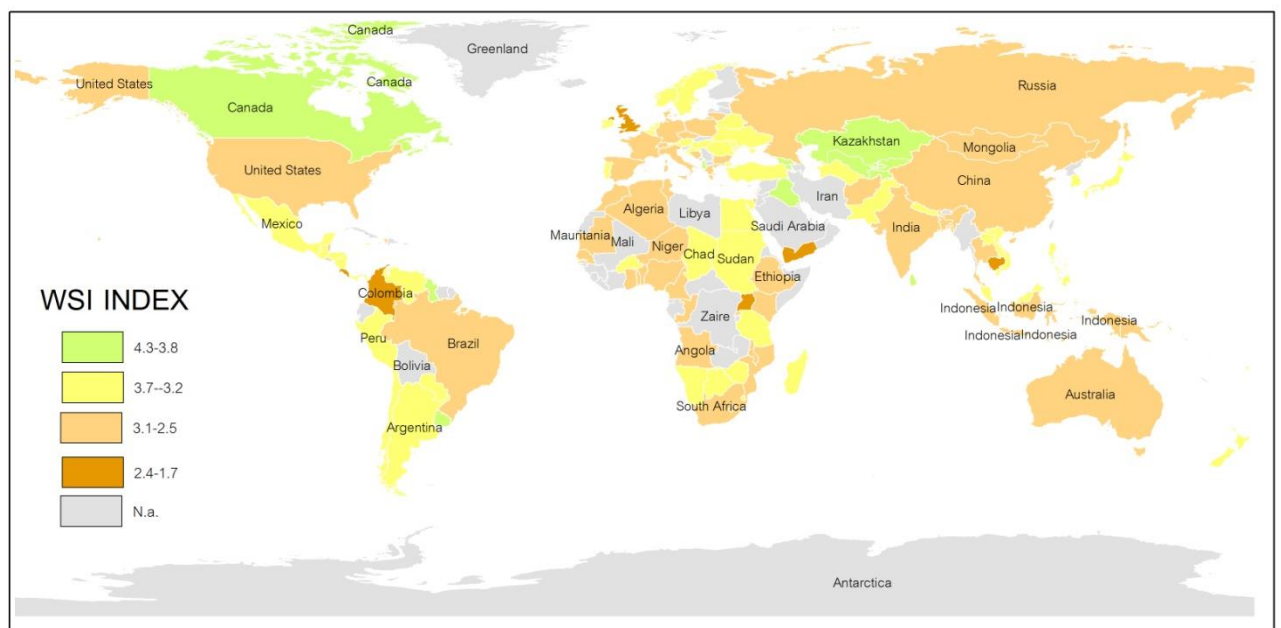


Fig 4 Distribution of water security index of each country in the world

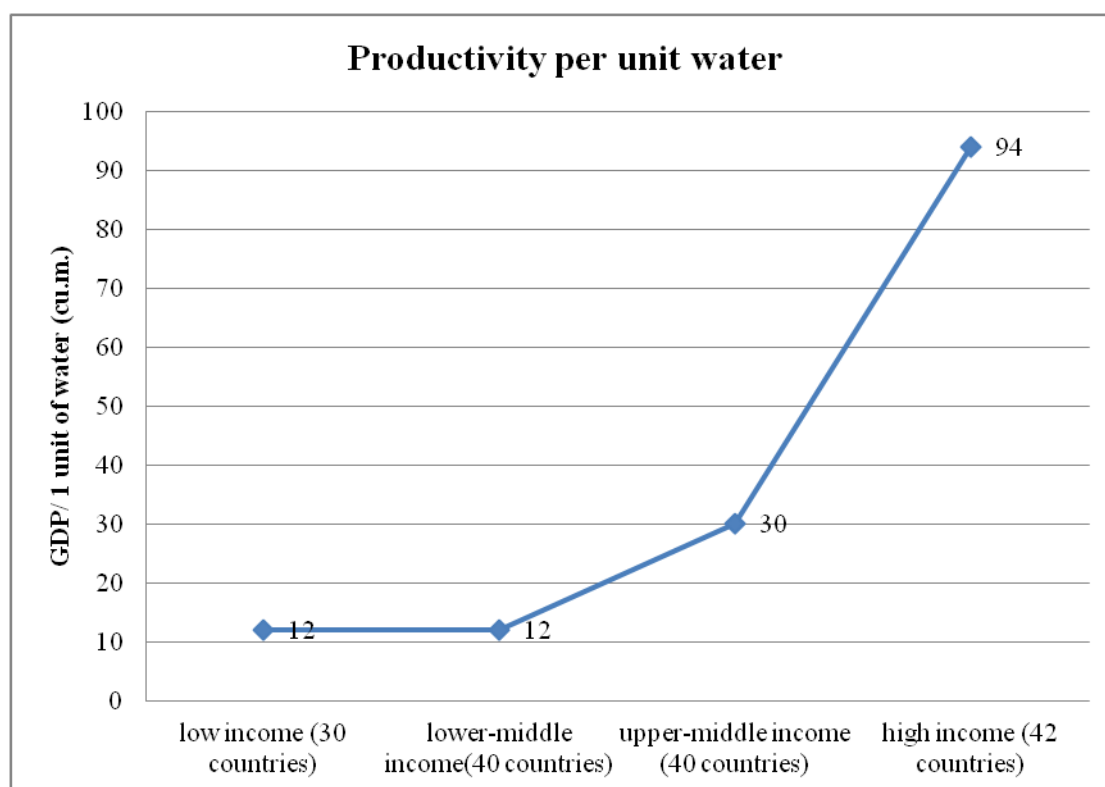


Fig 5 Water productivity of each income country group

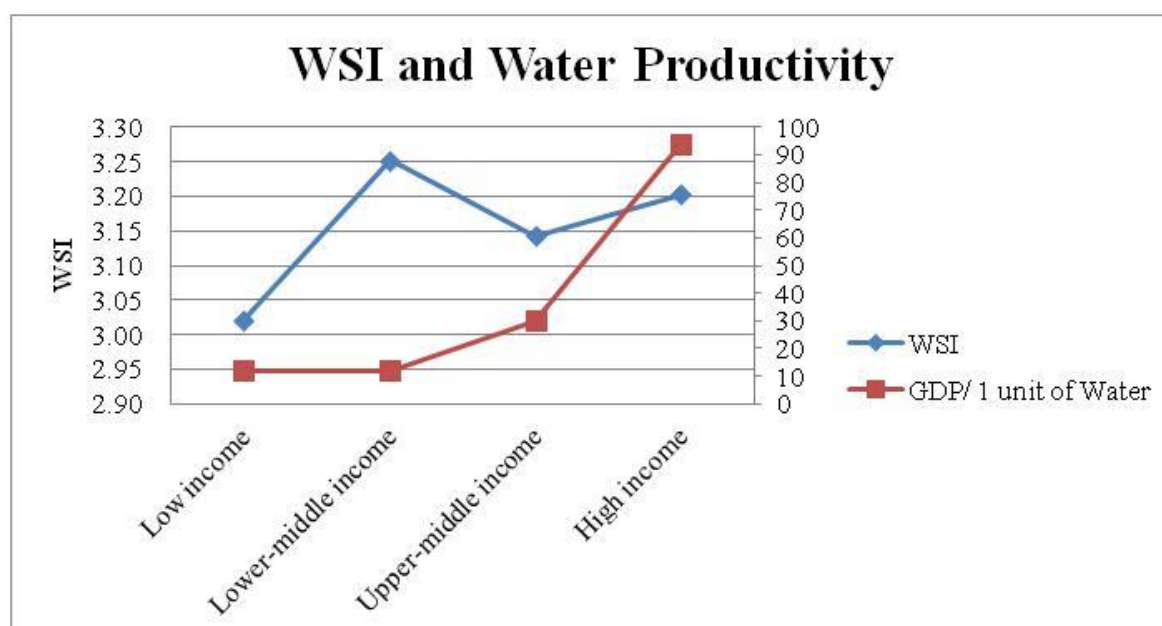


Fig 6 Water security index and water productivity

From the analysis, the average water use unit, water productivity grows up with the GDP per capita growth though the agricultural water use in the high income group decreased due to the change of water use structure. In general, more water productivity induced better water security status. Water security index increased from the less income group to lower middle income group and became stable in the upper middle and high income group due to the loss of water disaster (which may reflect from the data availability). The water productivity, measured by the income per capita and per water use unit, was assessed and compared with the water security index obtained and it showed that more water productivity induced better water security status

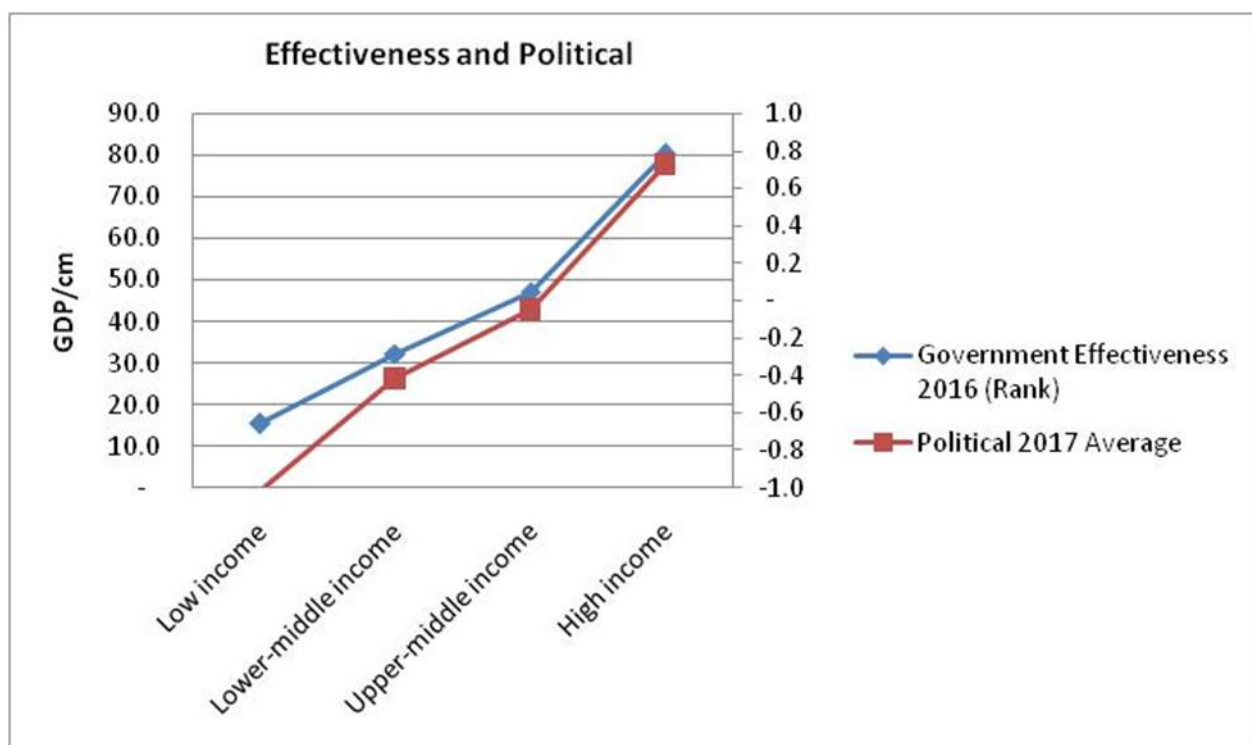


Fig 7 Governance and political stability

5. Thailand's water security and sustainability compared with the rest of the world

The water security status of Thailand, compared with the world, Asia and Asean regions were assessed and shown in Table 1 and the ranking of each dimensions are shown in Table 2 and Fig 7. Within ASEAN countries, the water use, water productivity and water security status of each country were assessed comparatively and shown in Fig. 8, 9 and 10 in the sequence of GDP per capita which showed that Thailand has the highest water use unit, lower

water productivity and moderate in water security ranking. From these figures and tables, the strength and weakness of water security status and development potential of Thailand can be analysed and discussed as follows.

Strength

- High clean water accessibility (98 %) compared with the rest of the world
- High accessible population to improved sanitation facility (96%)
- Moderate irrigation area (25 % of agricultural area) compared with world average of 19%) and ASEAN average of 18%-
- High water use for fresh water aquaculture (1.3 M cu m per capita) with fresh water aquacultural area of 3,750 sq km.

Weakness

- Low runoff amount (6,382 cu m per capita per year) compared with world, Asia, Asean countries.
- High portion of agricultural water use
- High water footprint in agricultural sector (rank 3 of the world) stated the low water use productivity (which may induce low competitiveness of the country).

Development potential

- Still low industrial water use (34 cum/year compared with world (97 cum), Asia (60 cum) and Asean (49 cum)
- Still low water use for energy (4%) compared with world (31%), Asia (20%) and Asean (14%)

The strength, weakness and potential of water resources status in Thailand compared with the rest of the world were summarized in Table 3.

Based on the analysis, it is clear that Thailand had developed and utilized moderate fresh water renewable and used in the higher rate comparatively, looking from available water and high water use per capita especially in the agricultural sector. But when looking at GDP per water use unit, the water use efficiency is low compared with Indonesia, Malaysia and Vietnam. To increase the potential, Thailand needs to have more water storage, improve water use efficiency. Water use for irrigation should be improved in efficiency and used in the selected crops and potential area. The cultivation diversification to higher potential neighboring area should be considered together with higher technology transfer schemes.

The water security status of Thailand, compared with the world, Asia and ASEAN regions were investigated with the ranking in each dimension as shown in Table 1. Within ASEAN countries, the water use, water productivity(Suthidhummajitet.al., 2019) and water security status of each country VS country GDP per capita were assessed comparatively and it showed that Thailand has the highest water use unit, moderate lower water productivity and moderate in water security ranking.

Table 1 The average world, Asia and Asean water use status and the ranking of Thailand's
(ใช้ข้อมูลปีไหน ?)

Items	Elements	World		Asia		ASEAN		Thailand
		average	ranking	average	ranking	average	ranking	
Basic water	1.fresh water renewable (cu.m per capita)	22,167	79	10,854	15	19,205	8	6,382
	2. water supply (cu.m per capita)	84	46	84	9	85	3	98
	3. sanitation water (cu.m per capita)	67	15	70	6	71	2	96
Sufficient water	1. water use per capita (cu.m./capita)	511	12	842	9	531	7	1,391
	1. house holds (cu.m/capita)	84	46	84	9	85	3	98
	2. agricultural water	354	159	712	7	424	1	1,322
Water for development	1.irrigation area (%)	19	49	41	30	18	3	25
	2. industrial water (cu.m/capita)	97	68	60	18	49	4	34
	3. water for energy (%)	31	89	20	23	14	6	4
	4. water for fresh water aquaculture (cu.m/capita)	346,734	4	1,241,323	4	582,458	2	1,385,801
Water disaster	1. flood damage (US\$)	3,543,108	3	8,670,092	2	6,002,888	1	41,051,592
	2. drought damage (US\$)	1,261,531	22	1,896,770	5	239,512	2	424,300
Water for future	1. population growth (%)	1.3	137	1.43	38	1.31	10	0.43
	2. Urban population growth (%)	63	147	59	30	59	7	42
	3. water footprint (cu.m/capita)	1,338	7	1,304	2	1,697	2	2,223
Water productivity	1.GDP (million US\$)	343,530	29	445,799	7	151,224	2	318,907
	2. Productivity(US\$ / cu.m. water)	81	132	41.3	132	117.3	6	3.6
	3. agricultural productivity (US\$ /cu.m. water)	392	124	33.8	18	162.5	7	0.32
	4. industrial productivity(US\$ / cu.m. water)	169.1	63	69.5	8	121.6	4	51.2

Table 2 Water security status of Thailand in each dimension compared with the rest

Item	weight	world	Asia	Asean	Thailand
Basic water	5	4.0	4.0	4.0	4.7
Sufficient water	5	2.7	2.3	2.3	1.3
Water for development	5	2.3	3.0	2.5	2.8
Water disaster	5	2.5	2.0	3.0	2.5
Water for future	5	3.7	3.7	3.3	2.0

Total	5	3.04	3	3.02	2.66
-------	---	------	---	------	------

Table 3 The average world, Asia and ASEAN water security, water productivity and sustainability status and the ranking of Thailand's

Elements	World		Asia		ASEAN		Thailand
	average	ranking	average	ranking	average	ranking	
Gross domestic product : Population	14,260	88	9,546	14	11,117	4	5,980
Water productivity (GDP/cm)	81	132	49	20	82	6	4
Government Effectiveness	48.70	59	46.34	13	56.30	2	66.3
Political stability index	-0.05	118	0.14	32	0.03	8	-0.76
National Water Security Index by Economy (NWS Score) (full score: 25)	15.8	23	16.7	12	17	5	17.3

Remark:

- 1) Gross domestic product Population: World Bank (2016), 2) Water productivity (GDP/cm) : World Bank (2015),
- 3) Government Effectiveness : World Bank (2016), 4) Political stability index : World Bank (2017), 5) National Water Security Index by Economy: ADB 2016, * Sucharit 2014.

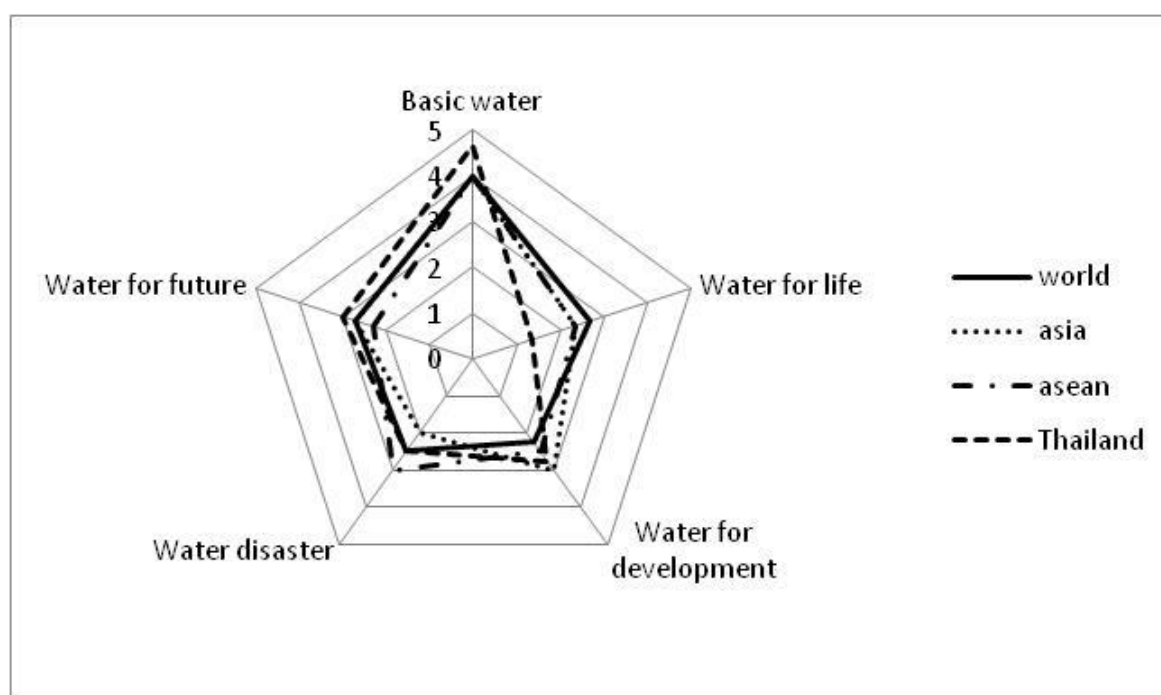


Fig 8 Thailand's water security status compared with the rest of the world

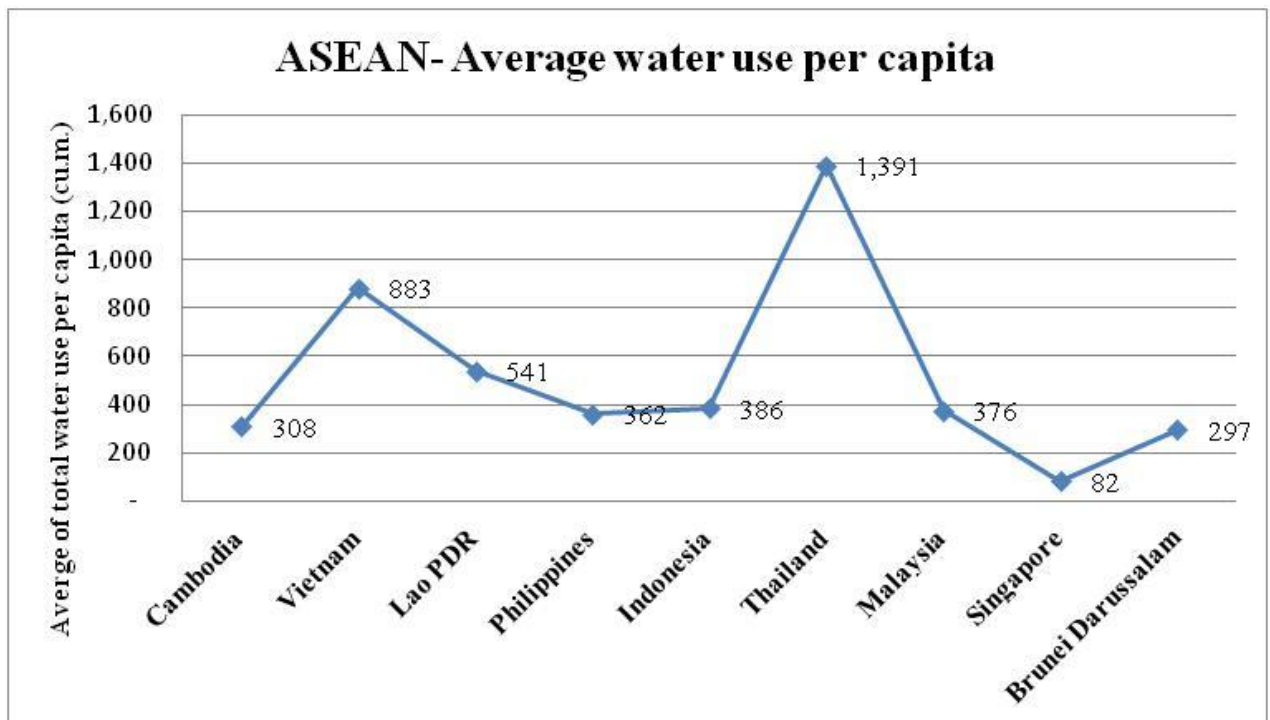


Fig 9 Water Use per capita in ASEAN countries

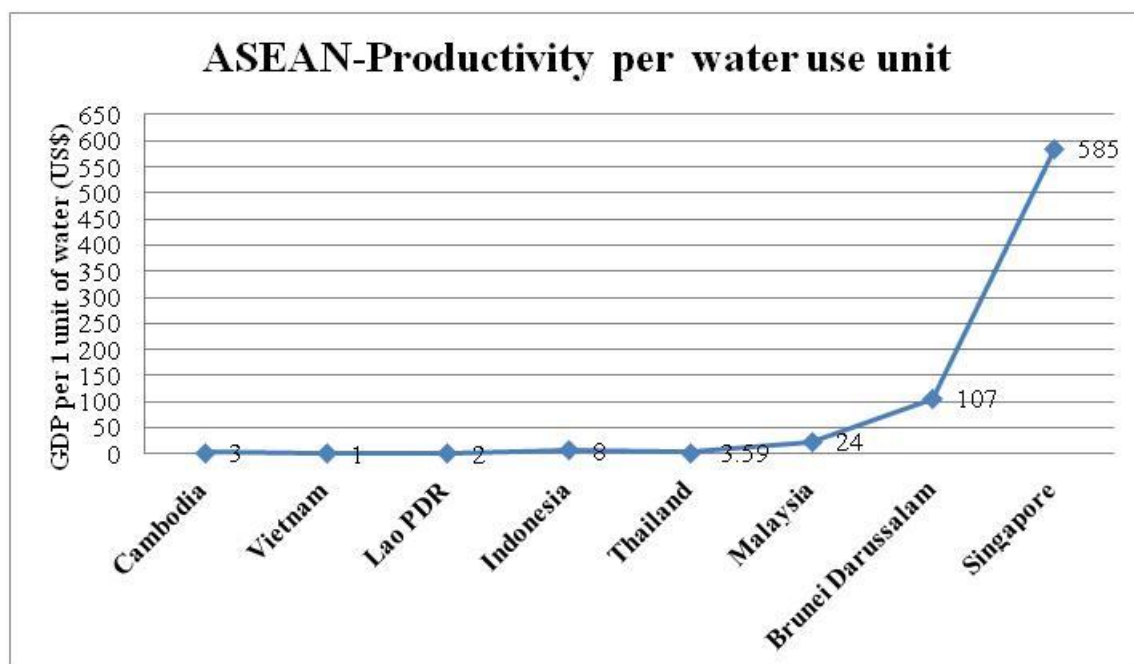


Fig 9 Water Productivity in ASEAN countries

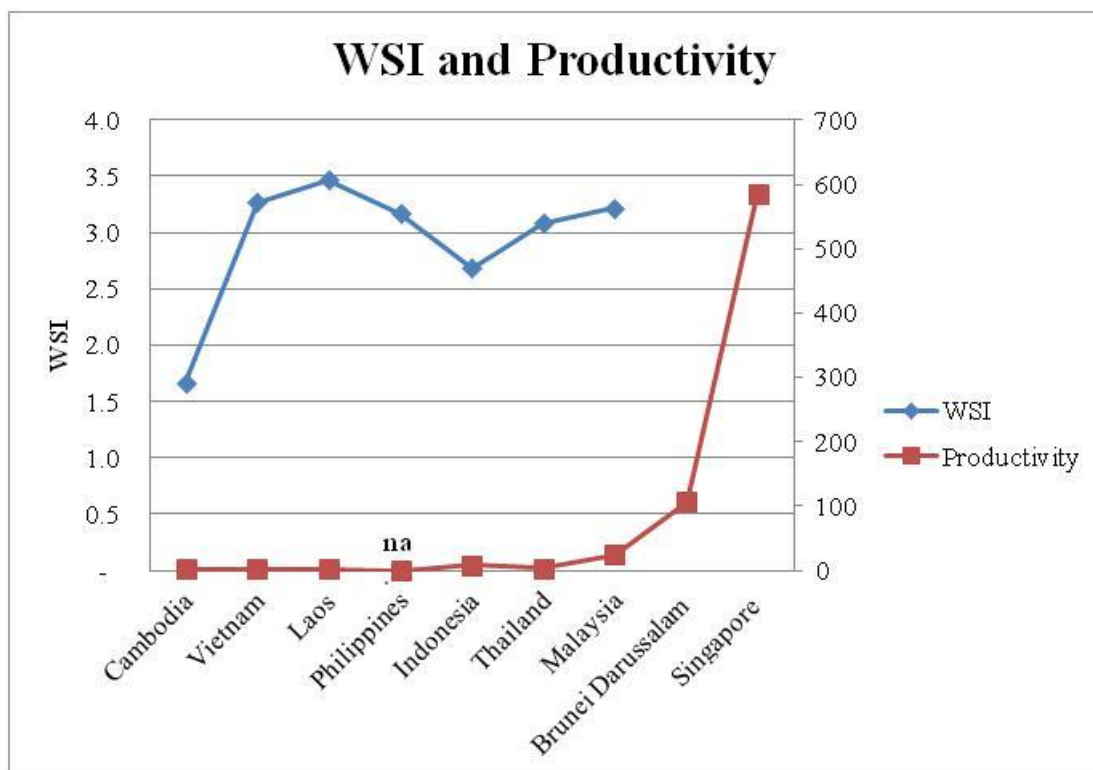


Fig 10 Water security index and water productivity in ASEAN countries

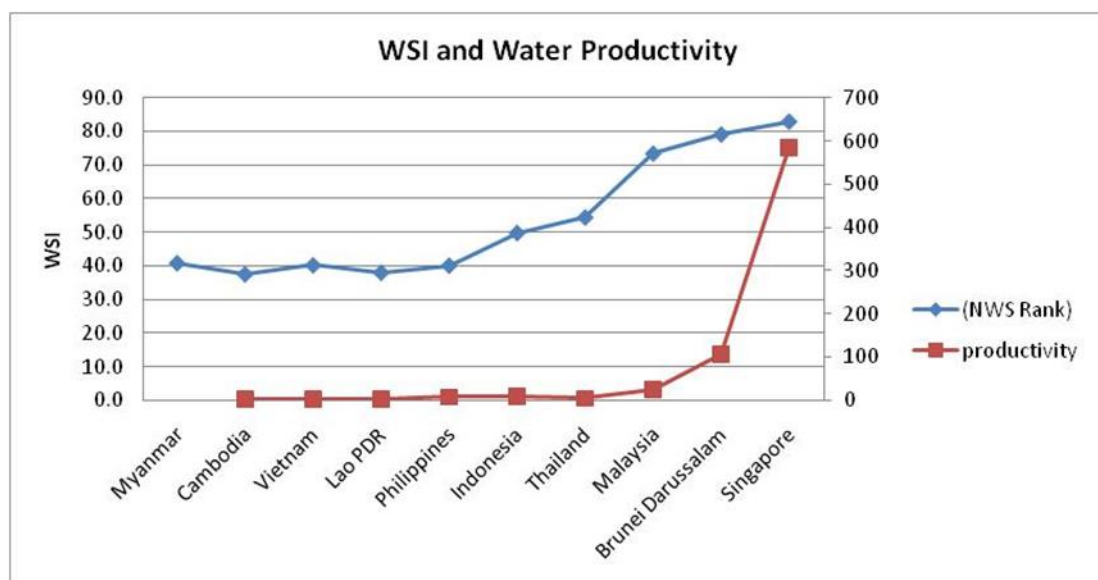


Fig. 10 Asean WSI and Water Productivity (แทนของเก่า ใส่ตัวเลขดอลลาร์เพิ่มได้ใหม่ เหมือนรูป ๙)

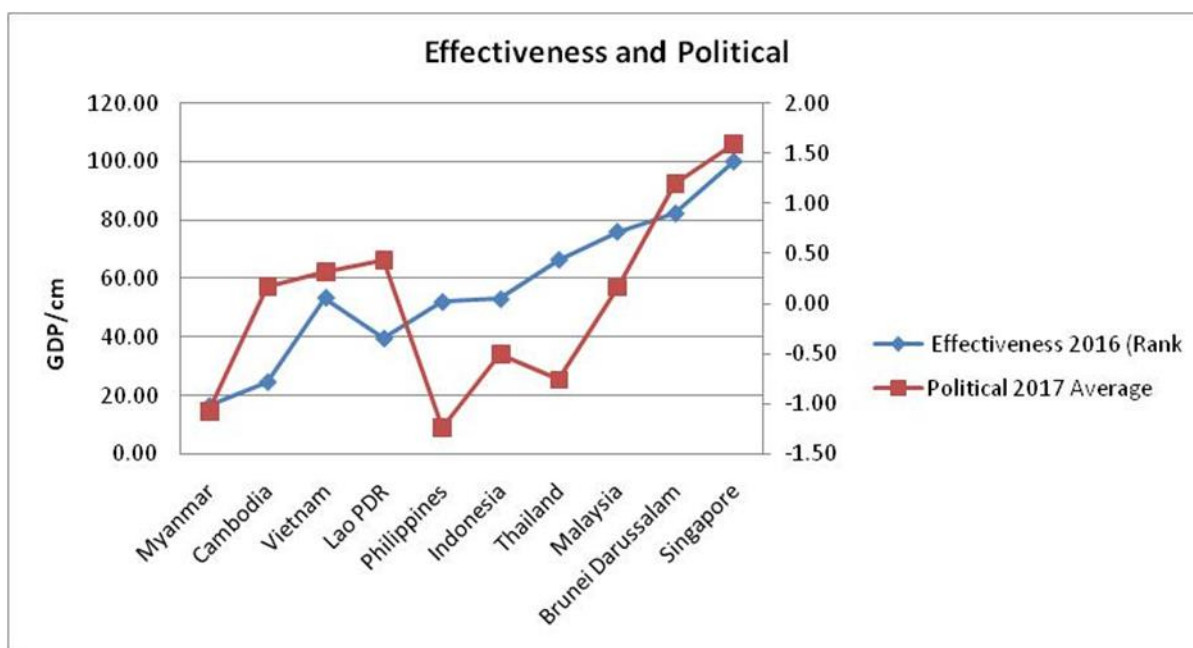


Fig 11 ASEAN's Effectiveness and Political

Table 4 Strength, weakness and water development potential of Thailand's water status

Strength weakness and potential of Thailand water status		
Strength	weakness	potential
<ul style="list-style-type: none"> • access to clean water • access to well sanitary • irrigation area • aquacultural water 	<ul style="list-style-type: none"> • average runoff • agricultural water • water footprint 	<ul style="list-style-type: none"> • industrial water • water for energy

6. National Water Management Strategies

Thailand had set up long term National Strategic Plan and water resources management is an important issue out of 23 issues (NESDB, 2019). The concept of water security was used of the framework and target setup on water security, water productivity, water governance with counter initiatives in lined with SDGs, i.e.,

Group 1 to reduce loss via issues of flood and drought (SDG 13), urban water (SDG 11),

Group 2 to induce more value added and participation via issues of water productivity (SDG 9) and water governance (SDG 16),

Group 3 to upgrade quality of life via issues of environmental water(SDG 6), watersanitary (especially in the rural areas) (SDG 6).

7. Conclusions and recommendations

This study showed the status of water security of Thailand compared with the rest of the world. Thailand has strengths on clean water and sanitation water accessibility and water for development due to the investment in the past. However, water use status in fresh water renewable, agricultural sector, i.e., low efficiency, high water footprint, low productivity, water resilient, urban water seemed to be a weakness compared with other countries. Water governance is comparatively in good handlings. Based on the National Master Plan on water resources management, the urgent issues are to reduce loss, to enhance more value added and to improve quality of life to comply with SDG 6.

~~This study showed the status of water use and water security of Thailand compared with the rest of the world. Thailand has strengths on clean water and sanitation water accessibility from the development investment in the past. However, water use status in fresh water renewable, agricultural sector, i.e., low efficiency, high water footprint low productivity, seemed to be a weakness compared with other country. For future socio economical development, the restructure of water use especially for industrial and urban use is needed to cope with future water demand~~

- From the water use status, the recommendations for possible future development in various sectors can be made as follows.

Agricultural sector

Agricultural sector consumed large portion of raw water at present. When the water demand from other sectors increases, adaptation and water use restructure measures and water should be implemented, e.g., increase water use efficiency, control, water saving etc. to cope with future water demand and reduce water conflict.

- Plan cultivation crop and location matching with water potential (agricultural zoning)
- Diversify cultivation area to other potential area

Industrial sector

- Campaign for water reuse and recycle in industry
- Locate industrial site fit to raw water potential

- Participate in fair water allocation process and increase capacity in water sourcing potential and allocation to cope with the future water demand Household sector

- Apply private management mechanism (demand sided, corporatization etc.) to increase productivity in water management
- Reduce loss in water supply network Water Saving campaign for awareness PR, introduction of new technology system (such as smart city concept)
- Overall

This study introduced the concept of water security to analyse, evaluate the strength and weakness for future planning. If the socio-economical development increases rapidly, the restructure of water use will be needed. When compared with other ASEAN countries (to be linked under Asean Economical Community, AEC), Thailand may have constraints in water resources (limited fresh water renewable, high water use rate, low productivity). More development in water storage capacity, water use efficiency and productivity should be considered.

The introduction of secured and green economy concept into water resources management and disaster resilience with climate change can use water security index as an indicator and needs tool development (physical with socioeconomic aspects) to link measures and outputs closely which will induce clearer policy and higher confidence and also enable sustainable development environments among stakeholders.

8. Acknowledgement

The authors would like to express sincere thanks to NRCT-TRF Spearhead Research Program on Water Resources Management for their research funding, thanks to Chulalongkorn University for her all supports of administrative and working place and utility provision.

9. References

ADB, Asian Development Outlook 2011, 2007

APN, Integrated Model Development for Water and Food Security Assessments and Analysis of the Potential of Mitigation Options and Sustainable Development Opportunities in Temperate Northeast Asia, 2008.

- Firdaus Ali, Development of Water Stress Index as a tool for the Assessment of Water Stress Ares in the Metropolitan Jakarta, Jakarta Water Supply Regulatory Body and Global Envirocom., 2007.
- Grey, D. and Sadoff, C. (2007) *Sink or Swim? Water Security for Growth and Development*. Water Policy, 9(6): 545–571.
- GWP (2010) *Global Water Security*: Submission by the Global Water Partnership to ICE/RAE/CIWEM Report to Professor John Beddington, Chief Scientific Adviser to HM Government, pp 5–6. (Online) Available at http://gwp.org/Global/Activities/News/GWP_on_WaterSecurity_Feb_2010.pdf.
- Kazmierczak, A. and Carter, J., Adaptation to climate change using green and blue infrastructure, the University of Manchester, 2010.
- Maggie Black and Jannet King, The Atlas of Water, ISBN 978-0-520-25934-8, University of California Press, 2009.
- Sucharit Koontanakulvong, Frequently Floods and Droughts, Seminar document in the technical Symposium on Climate Change and Drought and Floods Occurrence, Thai Hydrologist Association, Royal Irrigation Department, Feb 24, 2011 (in Thai).
- Sucharit Koontanakulvong, et.al., Facts and analysis of Floods 2011, Academic Conference on Floods Crisis, organized by the Thailand Research Fund, December 2, 2011 (in Thai).
- Sucharit Koontanakulvong, et. al., Provincial Water Planning – Linkage of water planning and provincial development planning, Public Seminar on Water Management, organized by the Thailand Research Fund, Bangkok, Mar 22, 2012 (in Thai).
- Sucharit Koontanakulvong Piyatida Hoisanwarn, Winai Chaowiwat, Thailand Water Account (2005-2007), Technical Report, Chulalongkorn University, March 2012.
- Sucharit Koontanakulvong et al., Concept of Water Security of Thailand and international communities, Research Report, the Thailand Reserch Fund, March 2013 (in Thai).
- UN-Water Deliverables for Rio+20 - released on 30 March 2012 (www.unwater.org) 2012
- UN-Water Status Report on the Application of Integrated Approaches to Water Resources Management (www.unwater.org/rio2012/report/index.html). UNEP, Freshwater under Threat South Asia, 2008
- UNSGAB, Water and Disaster, Technical Report from High level Expert Panel, March 2009.
- Water Situation 2008 and Flood Situation 2011 of Thailand (www.cuwater.eng.chula.ac.th).

World Bank, <http://data.worldbank.org/indicator/NY.GDP.MKTP.CD>, 2014

เพิ่มเอกสารอ้างอิงที่ใช้ของปีนี้ พร้อมจัดเรียงใหม่

7)——References

ADB (2016) ASIAN Water Development Outlook, ISBN 978-92-9257-543-4 (Print), 978-92-9257-544-1 (e-ISBN), Publication Stock No. RPT168317-2

ADB (2019) Asian Water Development Outlook 2020, Asia Pacific Water Forum, Report on 1st Coordination Workshop, 27 and 28 February 2019.

Piyatida H., et. al., Water security, Water Productivity, Water Resilience Assessment for Water Masterplan Preparation, Progress report, Feb 2019 (in Thai).

NESDB, Master Plan under National Strategic Plan, Water System Management, Report No. 19, 2019 (in Thai).

Sucharit Koontanakulvong, PiamchanDOUNGmanee and PiyatidaHOISUNGwan. “Thailand’s Water Security Situation in the context of world and ASEAN.” Hydrological Sciences and Water Security: Past, Present and Future (from Proceedings of the 11th Kovacs Colloquium, Paris, France, June 2014). IAHS Publ. 366, (2014): 2 pp. (IAHS Press doi:10.5194/piahs-366-117-2015)

Suthidhummajit S. and Koontanakulvong S. The study report of Water Balance Analysis, Water Accounting and Water Productivity, 2019.

Suthidhummajit S. and Koontanakulvong S., Evaluation of Water Productivity of Thailand and Improvement Measure Proposals, Proc. KWRA, May 2019.

World Bank, <http://data.worldbank.org/indicator/NY.GDP.MKTP.CD>, 2016

Appendix
Water Security, Water Productivity, Governance Effectiveness, Political Stability
Indexes of each country

(เพิ่มตารางของทุกค่า ระดับ โลก เอเชีย อาเซียน ที่ใช้ ทำเป็นตารางเพิ่ม)

Water Security Index of each country								
No.	Country	1.Basic water	2.Sufficient water	3.Water for development	4.Water disaster	5.Water for future	Total	Average
	Weight	5	5	5	5	5	25	5
1	Afghanistan	2	3	4	4	3	16	3
2	Albania	5	3	2	5	3	19	4
3	Algeria	3	3	4	2	3	15	3
4	Antigua and Barbuda	4	3	5	-	3	15	4
5	Argentina	5	3	3	3	3	17	3
6	Armenia	5	2	3	3	4	17	3
7	Australia	5	4	3	1	3	15	3
8	Austria	4	3	2	3	3	15	3
9	Azerbaijan	4	-	1	4	3	12	3
10	Bahrain	3	3	4	-	3	14	3
11	Bangladesh	4	3	3	2	4	16	3
12	Barbados	5	4	4	-	3	15	4
13	Belarus	3	4	3	5	3	18	4
14	Belgium	4	4	3	5	2	17	3
15	Belize	3	4	4	5	2	17	3
16	Benin	4	3	5	5	3	20	4
17	Bhutan	4	3	3	-	3	13	3
18	Bolivia	5	-	3	2	4	13	3
19	Botswana	5	3	3	5	3	19	4
20	Brazil	5	4	3	3	2	17	3
21	Bulgaria	2	4	4	5	2	16	3
22	Burkina Faso	4	4	4	5	3	20	4
23	Burundi	3	4	4	-	3	14	4
24	Cameroon	4	3	3	4	3	17	3
25	Canada	5	3	3	5	2	18	4
26	Cambodia	2	4	5	2	1	14	3
27	Cape Verde	3	4	5	-	3	15	4
28	Chad	5	3	3	4	2	17	3
29	Chile	3	3	4	4	4	18	4
30	China	5	3	3	1	3	14	3
31	Colombia	3	4	5	3	3	17	3
32	Comoros	3	4	3	-	2	11	3
33	Congo, Dem. Rep.	5	-	-	-	5	10	5
34	Costa Rica	3	3	4	5	2	11	2
35	Cote d' Ivoire	5	-	3	-	3	11	4

Water Security Index of each country								
No.	Country	1.Basic water	2.Sufficient water	3.Water for development	4.Water disaster	5.Water for future	Total	Average
	Weight	5	5	5	5	5	25	5
36	Cyprus	4	3	4	-	2	13	3
37	Czech Republic	4	3	4	3	3	16	3
38	Denmark	3	3	1	3	2	12	2
39	Dominican Republic	3	-	-	5	3	11	4
40	Ecuador	5	3	4	-	3	14	4
41	Egypt	3	3	3	5	3	17	3
42	El Salvador	4	3	3	3	3	16	3
43	Equatorial Guinea	3	3	4	-	2	12	3
44	Estonia	5	3	4	-	4	16	4
45	Ethiopia	2	4	4	5	3	17	3
46	Fiji	3	3	3	5	4	19	4
47	Finland	5	4	3	-	3	15	4
48	France	5	4	4	2	2	16	3
49	Gabon	4	3	3	-	2	12	3
50	Gambia	4	4	5	5	2	19	4
51	Georgia	5	3	2	4	4	19	4
52	Germany	4	4	4	2	3	16	3
53	Ghana	3	3	3	5	2	16	3
54	Greece	5	3	4	2	3	16	3
55	Guatemala	4	3	4	5	3	19	4
56	Guinea	3	3	5	-	2	14	3
57	Guinea-Bissau	3	4	5	-	2	14	4
58	Guyana	5	3	3	5	3	19	4
59	Haiti	2	4	4	5	3	18	4
60	Honduras	4	3	4	5	3	19	4
61	Hungary	5	4	4	4	4	20	4
62	Iceland	5	3	1	-	3	12	3
63	India	3	3	4	2	4	15	3
64	Indonesia	4	3	5	3	3	18	4
65	Iraq	4	2	3	5	2	16	3
66	Ireland	5	4	4	5	3	20	4
67	Israel	3	3	3	4	2	16	3
68	Italy	4	3	3	2	3	15	3
69	Jamaica	4	3	4	5	4	20	4
70	Japan	5	3	4	2	4	17	3

Water Security Index of each country								
No.	Country	1.Basic water	2.Sufficient water	3.Water for development	4.Water disaster	5.Water for future	Total	Average
	Weight	5	5	5	5	5	25	5
71	Jordan	3	3	4	-	2	12	3
72	Kazakhstan	5	3	3	5	2	18	4
73	Kenya	2	3	3	5	3	17	3
74	Korea, South	4	3	4	5	3	19	4
75	Kuwait	1	3	4	-	2	9	2
76	Kyrgyzstan	4	3	2	5	3	17	3
77	Laos	3	4	3	5	3	18	4
78	Latvia	5	3	3	-	4	12	3
79	Lebanon	4	3	3	-	3	10	2
80	Lesotho	3	3	3	5	4	18	4
81	Liberia	3	4	5	-	2	14	4
82	Lithuania	4	3	4	3	4	17	3
83	Madagascar	3	3	3	5	2	16	3
84	Malawi	3	3	4	5	2	17	3
85	Malaysia	5	3	4	5	1	19	4
86	Mali	3	4	4	-	2	12	3
87	Malta	3	3	4	-	2	15	4
88	Mauritania	3	3	5	4	2	17	3
89	Mauritius	4	3	3	3	3	16	3
90	Mexico	4	3	4	3	3	16	3
91	Moldova	4	4	3	4	3	18	4
92	Mongolia	4	4	5	5	3	19	4
93	Morocco	3	3	4	4	2	16	3
94	Mozambique	3	4	3	5	3	17	3
95	Namibia	4	3	3	5	4	18	4
96	Nepal	3	3	3	5	3	17	3
97	Netherlands	5	4	3	5	3	20	4
98	New Zealand	5	3	4	4	3	18	4
99	Nicaragua	4	4	4	5	3	20	4
100	Niger	2	4	4	5	3	17	3
101	Nigeria	2	3	4	5	1	15	3
102	Norway	5	3	3	5	3	19	4
103	Oman	1	3	3	-	1	8	2
104	Pakistan	3	3	3	3	3	15	3
105	Panama	4	3	3	5	3	18	4
106	Paraguay	4	3	3	5	3	18	4
107	Peru	4	3	3	4	3	17	3
108	Philippines	4	3	4	5	2	18	4

Water Security Index of each country								
No.	Country	1.Basic water	2.Sufficient water	3.Water for development	4.Water disaster	5.Water for future	Total	Average
	Weight	5	5	5	5	5	25	5
109	Poland	2	4	4	2	4	15	3
110	Portugal	5	3	3	2	3	15	3
111	Qatar	4	3	3	0	2	12	2
112	Romania	4	3	3	3	3	15	3
113	Russia	5	4	4	2	3	17	3
114	Rwanda	2	4	4	5	3	17	3
115	Saudi Arabia	1	3	4	2	2	11	2
116	Senegal	3	4	4	4	1	16	3
117	Seychelles	4	3	3 -		4	14	4
118	Sierra Leone	3	4	5 -		3	14	4
119	South Africa	3	3	4	2	4	16	3
120	Spain	4	3	4	2	2	15	3
121	Sri Lanka	4	3	3	5	4	19	4
122	Sudan	3	3	3	5	1	16	3
123	Suriname	5	3	2 -		3	13	3
124	Swaziland	3	4	4	5	4	20	4
125	Sweden	5	3	3	5	3	19	4
126	Switzerland	5	4	3	2	3	16	3
127	Syria	4	3	3 -		1	11	3
128	Tajikistan	4	3	2	5	3	17	3
129	Tanzania	3	3	3	5	3	17	3
130	Thailand	5	3	4	2	3	17	3
131	Togo	2	3	4	5	2	16	3
132	Trinidad and Tobago	4	3	5 -		4	13	3
133	Tunisia	3	4	4	5	3	18	4
134	Turkey	4	3	4	5	2	18	4
135	Turkmenistan	3	3	3	5	2	16	3
136	Uganda	3	4	4	5 -		15	4
137	Ukraine	5	3	3	2	3	17	3
138	United Arab Emirates	4	3	3 -		1	10	3
139	United Kingdom	3	4	4	1	3	15	3
140	Uruguay	5	3	3	4	3	17	3
141	Uzbekistan	4	3	3	4	4	17	3
142	Venezuela	4	3	3	5	3	17	3
143	Vietnam	4	3	4	3	3	16	3
144	Yemen	2	3	4	2	3	15	3
145	Zambia	3	3	3 -		3	12	3
146	Zimbabwe	3	3	3	5	4	17	3
Remarks: - means not available.								