Executive Summary Report

THA 2022 International Conference on

Moving Towards a Sustainable Water and Climate Change Management After COVID-19

January 26-28, 2022

Online platform

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SESSION B: NEW TECHNOLOGY IN WATER AND IRRIGATION MANAGEMENT

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SESSION C: WATER MANAGEMENT TOWARDS SDGS

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Preface

After an unusual situation of COVID-19 pandemic, the THA 2022 International Conference on "Moving Towards Sustainable Water and Climate Management After COVID-19" was organized in online format via Zoom platform to make the conference as accessible as possible for participants around the world without travel anxiety. This year the THA2022 was held online, from January 26th to 28th. The event was organized by Chulalongkorn University, in association with 9 national partners, 4 international collaborative agencies and 1 supportive agency. The 9 national co-organizers are the Thai Hydrologist Association (THA), Office of the National Water Resources (ONWR), Royal Irrigation Department (RID), Department of Water Resources (DWR), Department of Groundwater Resources (DGR), Kasetsart University (KU) Kamphaengsaen Campus, Asian Institute of Technology (AIT), Thailand Science Research and Innovation (TSRI), and National Research Council of Thailand (NRCT). The 4 international collaborative agencies include Kyoto University, National Taiwan University (NTU), Korea Water Resources Association (KWRA), Japan International Cooperation Agency (JICA). The supporting agency is Electricity Generating Authority of Thailand (EGAT). The objective is to provide a platform for researchers, scientists, practitioners, policy makers and private executives to share and present new advances, research findings, perspectives, and experiences in water management and climate change, new technology, and water management towards SDGs. Special attention will be given to developing certain skills, competence, or general upgrading of performance ability for climate change adaptation, applied technology for predictions, and sustainable development in the monsoon Asia. The conference will bring together leading researchers, engineers, scientists, private executives and officials in the domain of interest from around the world.

The THA 2022 international conference was successful according to the main objective of serving as the public assembly. Welcome speech of the THA 2022 international conference was given by Prof.Dr.Supot Teachavorasinskun, Dean of Faculty of Engineering, Chulalongkorn University. The opening remarks was given by Air Chief Marshal Chalit Pukbhasuk, the Privy Council of Thailand. At this conference we had three keynote speakers. Over 290 attendees from 16 countries discussed and shared the latest in water-related research throughout the three-day long conference.

THA2022 hosted three keynote presentations emphasizing water and disaster management under climate change and post COVID-19. Also there were 25 guested papers and 69 technical paper selected papers to present under 3 subthemes: Theme A: Water Management and Climate Change, Theme B: New Technology in Water and Irrigation Management, and Theme C: Water Management Towards SDGs.

Apart from the technical presentations based on the above-mentioned themes, three workshops were organized: Workshop A: Training courses for hydrologic analysis using GCM climate projection outputs, Workshop B: Training courses for water security index, and Workshop C: Science-Policy interface dialogue on water and climate change. Applications, opportunities for further research direction and collaboration were discussed among the participants.

Virtual exhibition at the THA 2022 International Conference consisted of 5 VDO clips from DWR, DGR, ONWR, RID and CU-SIP showing water and disaster management principles, applications, models, tools, modern technologies, and research initiatives.

Major outputs obtained from the THA 2022 can be summarized below:

- Knowledge dissemination and exchange from the presentations. At this conference and workshops we had 3 keynote speakers, 290 participants from 16 countries including Thailand, Japan, Korea, Switzerland, Myanmar, Cambodia, Taiwan, Lao, India, Malaysia, Philippines, Nepal, Vietnam, United States, Australia, Indonesia.

- A technical training on “Hydrologic analysis using GCM climate projection outputs”, “Water security index”, and “Science-Policy interface dialogue on water and climate change”.
- Virtual exhibition displaying water-related technologies, products and services from governmental agencies, universities, research institutions and private companies

Major outcomes are listed below:

- Creating an opportunity for being a coordinator in research and education regarding Water & Disaster Management and Climate Change which has already started.
- Presenting technologies and water management in Thailand to other countries outside.
- Strengthening collaboration internationally in the area of water and climate change and bringing it towards the achievement of SDGs.

This document presents main conclusions from the THA 2022 International Conference on “Moving Towards Sustainable Water and Climate Management After COVID-19”. Related materials that will be issued separately are the THA 2022 proceedings.

We would like to thank all attendees for their support and enthusiastic participation at our first ever online conference that driving the THA 2022 International Conference toward the desired objectives and achievement.

Assoc. Prof. Dr. Sucharit Koontanakulvong
Assist. Prof. Dr. Supattra Visessri
Editors of THA 2022 Summary Report

The organizers of the THA 2022 International Conference on “Moving Towards Sustainable Water and Climate Management After COVID-19”

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Thailand

Thai Hydrologist Association,
Thailand

Office of the National Water Resources,
Thailand

Royal Irrigation Department,
Thailand

General of Department of Water Resources,
Thailand

Conference Organizing Institutes (con't)

Department of Groundwater Resources,
Thailand

Faculty of Engineering at Kamphaengsaen,
Kasetsart University,
Thailand

Asian Institute of Technology,
Thailand

Thailand Science Research and Innovation,
Thailand

National Research Council of Thailand

Collaborative agency

Kyoto University, Japan

National Taiwan University, Taiwan

Korea Water Resources Association, Republic of Korea

Japan International Cooperation Agency

AIMS AND SCOPE

The objective is to provide a platform for researchers, scientists, practitioners, and policy makers to share and present new advances, research findings, perspectives, and experiences in water management and climate change, new technology, and water management towards SDGs. Special attention will be given to developing certain skills, competence, or general upgrading of performance ability for climate change adaptation, applied technology for predictions, and sustainable development in the monsoon Asia. The conference will bring together leading researchers, engineers, scientists, and officials in the domain of interest from around the world.

Topics of the conference are:

1. **Water Management and Climate Change**
    - 1.1) Climate Change Projections
    - 1.2) Water-Related Disasters
    - 1.3) Economic Impacts caused by Climate Change and Water Security Issues
    - 1.4) Climate Change Adaptation
2. **New Technology in Water and Irrigation Management**
    - 2.1) Weather Forecast
    - 2.2) Reservoir Operations
    - 2.3) Irrigation Technology
    - 2.4) Technology for Improving Water Quality
3. **Water Management Towards SDGs**
    - 3.1) Water Management towards SDGs
    - 3.2) Groundwater Management towards SDGs
    - 3.3) Water Security (Urban, Productivity etc.)
    - 3.4) NEXUS (Food, Energy, Water, Land) towards SDGs

Welcome Speech

THA 2022 International Conference on Moving Towards Sustainable Water and Climate Management After COVID-19
(January 26, 2022, Online via Zoom)

Given by Prof.Dr.Supot Teachavorasinskun,
Dean of Faculty of Engineering, Chulalongkorn University

1) Dear His Excellency Air Chief Marshal Chalit Pukpasuk, the Privy Councilor of Thailand; co-organizing agencies; collaborative agencies; supporting agencies; keynote speakers; and all honorable guests.
2) It's my privilege and pleasure to welcome you to the THA 2022 International Conference on Moving Towards Sustainable Water and Climate Management After COVID-19.
3) Today's conference in 2022 is the fourth in the series. We have had this conference since 2015 and continued for every two years. Unfortunately, this year we have to have the conference online due to the pandemic of COVID-19.
4) The theme of the THA2022 conference is designed to match with on-going challenges and global trends. In this conference we have 3 keynote presentations from the representatives of World Bank, UNDP and the Office of the National Water Resources of Thailand or ONWR. There are 4 executive panel discussions on the topics of water management with climate change, SDG, water security, and sustainable groundwater management. We have 3 themes for technical presentation including water and climate change, modern technology in water or irrigation management, and sustainable water management. Two hands-on technical trainings on GCM, downscaling and water security assessment. Two side events of Science-Policy Interface Dialogue by UNDP and another side event on Water Conservation, Climate Change and Ecosystem-based Adaptation in ASEAN by the Department of Water Resources of Thailand.
5) Climate change places disastrous impacts on water crisis. For example, unusual cycle of flood and drought, sea water level rises, rapid erosion of shoreline etc. In order to slow down these impacts of climate change, Thai government committed to lead the country to achieve carbon neutral by 2015 and ambitiously to have zero emission by 2065. Water from the flood might be decreasing but we remember that the disastrous flood can come back any time in the near future. Noted that water shortage may seem to disappear but our problem in water management, growth can definitely come back any time in the future. Damages and losses on lives and properties can be redeemed, repaired or subsidized. We attempt to forget how suffering and sadness we have in abnormal cycle of floods and droughts. Those painful feelings should be forgotten and live should go on. However, please be reminded that the experience from such event should always be remembered. Most importantly, it should be learned and shared among people because only properly learning and sharing from our own experience makes humankind evolution. However only human evolution and development do not guarantee sustainability.

6) Inclusive participation from all stakeholders can cause sustainable development. Those are the main reasons why we are gathering today in the THA2022 conference. We are gathering today to share and to learn from our experiences, to transform our knowledge and experiences to make water being the most sustainable resource for all stakeholders.

7) Welcome all delegates and distinguished participants. Please allow me to mention the names of our valuable partners. We cannot hold this conference without them. The co-organizing agencies are the Thai Hydrologist Association, ONWR, the Royal Irrigation Department, the Department of Water Resources, the Department of Groundwater Resources, Kasetsart University (Kamphaeng Saen Campus), Asian Institute of Technology or AIT, Thailand Science Research and Innovation or TSRI, and National Research Council of Thailand or NRCT.

8) Our thanks are also extended to our supporting agencies including Kyoto University, National Taiwan University or NTU, Korea Water Resources Association or KWRA, Japan International Cooperation Agency or JICA and Electricity Generating Authority of Thailand or EGAT.

9) We thank World Bank, RBAP, ONWR, GIZ, IWMI, Bappenas Indonesia, DWR Vietnam, FTI, ADB, UNESCO, PELA GeoEnvironment USA., Chinese Academy of Sciences, RIHN Kyoto, Korea University and NAHRIM Malaysia for the speakers in the keynote and executive panel discussion sessions.

10) Kasetsart University, Chulalongkorn University, AIT, NTU, Kyoto University and other universities in our network are acknowledged for their contributions on providing the chairs, readers and commentators to the conference.

11) Most importantly, the conference cannot be held without generosity and support from our sponsors including EGAT, CKPower, Metropolitan Waterworks Authority or MWA, AEON Thailand Foundation, Team Consulting Engineering and Management Public Company Limited and Siam Steel International. Very long list of support we received.

12) Finally, I hope that discussions generated from this event can be the great steppingstone to make our world better and most sustainable, not only for us but for the next generations. Thank you again to everyone for being here and welcome to the THA2022.

Opening Speech

THA 2022 International Conference on Moving Towards Sustainable Water and Climate Management After COVID-19 (January 26, 2022, Online via Zoom)

Given by H.E. Air Chief Marshal Chalit Pukbhasuk, Privy Councillor of Thailand

1) Good morning Ladies and Gentlemen, Dear Distinguished delegates, in my capacity as Privy Councillor, whereby I am responsible for Royal Initiative projects to promote the well-being of Thai people. This also support the implementation of global Sustainable Development Goals, or SDG. I would like to convey to all of you participating in the THA 2022 conference my heartfelt welcome.

2) The past two years are certainly the years that none of us will ever forget. The world has faced a critical moment in history. There are a number of global threats including growing crises in natural disaster, climate change, biodiversity, and environmental degradation—as well as COVID-19.

3) The THA 2022 International Conference is therefore set under the theme of Moving Towards Sustainable Water and Climate Management After COVID-19. The THA 2022 is organized by Chulalongkorn University, in association with 9 national partners, 4 international collaborative agencies and 1 supportive agency. It is high time that such an event took place to address critical issues regarding water, climate change and sustainability especially after COVID-19 that changes the way we live.

4) The growing consequences of climate change have been all too visible across the world this year with extreme temperature, severe storms, floods and droughts. The latest assessment of the science by the Intergovernmental Panel on Climate Change or IPCC, published in August 2021, concluded that there is a clear link between rising greenhouse gas concentrations in the atmosphere and increases in the frequency and intensity of extreme weather events. It states: "Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes." The people in developing and least developed countries are often most exposed and vulnerable to the effects of climate change, even though they are the least involved actor driving the causes.

5) Countries must set ambitious national climate commitments if they are to live sustainably and recover from the COVID-19 pandemic which has impacted almost every corner of our life, causing sluggish growth of global economies, changing the way we work and interact. The COVID-19 pandemic has stimulated the need to catalyse positive change to meet the Sustainable Development Goals (SDGs) and fulfil the environmental agenda. This message was also amplified at the recent United Nations Climate Change Conference or COP26.

6) Despite the challenges, we also have an enormous opportunity in research and collaboration to transform the global economy and drive greater well-being and prosperity. To address water management issues, knowledge exchange, technology transfer and innovations are much needed. We all can help to move our community towards sustainability by focusing our research efforts around the 2030 Agenda for Sustainable Development Goals and attempting to explore better solutions for water-related problems specifically the impacts of climate change, disaster and other pressing challenges.

7) The THA2022 provides a valuable opportunity for scientists, researchers, policy planners and decision-makers to discuss and share knowledge and experiences to seek for cutting-edge solutions for water management and climate change challenge for our region and our world. I would like to thank both local and international participants attending this conference. I wish the THA2022 great success and I hope you have a fruitful discussion and rewarding experience in the THA2022. The THA conference series is expected to continue playing an important role in facilitating technical knowledge dissemination and networking in the future.

8) Now it is time to declare the THA2022 International Conference on Moving Towards Sustainable Water and Climate Management After COVID-19 officially. I hope the conference will proceed towards fostering sustainable, resilient, and inclusive development and shaping the future for us all in terms of wellbeing and its sustainability. A return to 'normal' way of living is what we are hoping. I wish all of you being healthy and safe and hope we can see each other in person in the next THA conference.

Programme of THA 2022 International Conference, Day 1 (Wednesday – 26 January 2022)

Time	Wednesday – 26 January 2022 (Morning)
08.45-09.00	Registration
09.00-09.45	Opening Ceremony I. Introduction Speech by MC II. Congratulation Speech by Assoc. Prof. Dr. Supot Teachavorasinskun, Chulalongkorn University III. Opening Speech by Air Chief Marshal Chalit Pukbhasuk, Privy Councillor, Thailand
	Group Photo
	Keynote speech
10.00-10.30	I. Dr. Benoit Bosquet, Regional Director for Sustainable Development, East Asia and Pacific, World Bank Topic: Water Disaster Management towards SDG and post Covid
10.30-11.00	II. Mr. Christophe Bahuet, Deputy Assistant Administrator and Deputy Director of the UNDP Regional Bureau for Asia and the Pacific (RBAP) Topic: Water management under Climate Change
11.00-11.30	III. Dr. Surasri Kidtimonton, Secretary-General of the Office of the National Water Resources (ONWR) Topic: Water management in Thailand and towards SDG
	Break (Clip VDO)

Time	Wednesday – 26 January 2022 (Afternoon)						
	Executive Panel Session -1 **ROOM A 1: Water Disaster Management and Climate Change**	**Technical Presentation Session** **ROOM B 1**			**Technical Presentation Session** **ROOM C 1**		
MC	Asst. Prof. Dr. Anurak Sriariyawat	**Chair**	Prof.Ming-Daw Su		**Chair**	Prof. Dr. Jui-Pin Tsai	
13.00-13.15	**Prof. Yasuto TACHIKAWA** **Kyoto University**	**13.00-13.30**	**Invited Speaker Topic A1** **Super Drought Hotspots over East Asia and Southeast Asia in the Last Decade** **:Prof. Chen Wen, Chinese Academy of Science, China**		**13.00-13.30**	**Invited Speaker Topic B1** **The Responses of Agricultural Water Resource Management to Climate Change** **:Dr.Min-Der Hung , COA and Dr. Chih-Hung Tan, AEC**	
13.15-13.30	**Mr. Yusuke Taishi** **Regional Technical Advisor for Climate Change Adaptation, UNDP**	**13.30-13.50**	**TA-103L**	INVESTIGATION OF HYDROLOGICAL INTERACTIONS IN THE CHAO PHRAYA RIVER SYSTEM IN BANGKOK USING STABLE ISOTOPIC COMPOSITIONS AND HYDROCHEMICAL FACIES :jeerapong laonamsai	**13.30-13.50**	**TC-310**	DEVELOPMENT OF FRAMEWORK TO EVALUATE CURRENT STATE OF GROUNDWATER GOVERNANCE UNDER URBANIZATION AND CLIMATE CHANGE : Saurav KC
13.30-13.45	**Dr. Giriraj Amarnath** **International Water Management Institute**	**13.50-14.10**	**TA-105S**	SENSITIVITY ANALYSIS OF THE RUNOFF IN THE LAND SURFACE MODELS FORCED BY THE OUTPUT OF MRI-AGCM 3.2 CLIMATE MODEL :Aulia Febianda Anwar Tinumbang	**13.50-14.10**	**TC-319**	SUSTAINABLE GROUNDWATER DEVELOPMENT IN CAN THO CITY, MEKONG DELTA VIETNAM UNDER CLIMATE CHANGE :Tuan Pham Van
13.45-14.00	**Mr. Abdul Malik Sadat Idris, Bappenas Indonesia/** **Prof.Kusuma**	**14.10-14.30**	**TA-116L**	ASSESSING CLIMTE CHANGE IMPACT ON FLOOD PEAK DISCHARGES OF ALL THE CLASS-A RIVERS IN JAPAN :Tomohiro Tanaka			
14.00-14.30	**General Discussion**						
				Break (Clip VDO)			
	Executive Panel Session -2 **ROOM A 2: Water Management and Climate Change**	**Technical Presentation Session** **ROOM B 2**			**Technical Presentation Session** **ROOM C 2**		
MC	Asst. Prof. Dr. Pongsak Suttinon	**Chair**	Prof. Dr. Changhyun Jun		**Chair**	Prof. Dr. TANAKA Shigenobu	
15.00-15.15	**Prof. Tainan Oki** **Special Advisor to the President, and a Professor at The University of Tokyo**	**15.00-15.20**	**TA-118L**	PROJECTED CHANGE IN SEASONAL MONSOON PRECIPITATION OVER SOUTHEAST ASIA UNDER CMIP6 CLIMATE MODEL : Sawitree Rojpratak	**15.00-15.20**	**TC-317**	Spatio-temporal distribution of groundwater recharge under climate change in the Namngum++ River Basin :Santosh Dhungana
15.15-15.30	**Dr. Klaus Schmitt** **Director of a GIZ Project on Ecosystem-based Adaptation**	**15.20-15.40**	**TA-112S**	RELATIONSHIP BETWEEN SOIL MOISTURE AND SALINITY DEGREE IN THE SALT-AFFECTED SOIL AREA IN KHON KAEN, NORTHEAST THAILAND : SUPRANEE SRITUMBOON	**15.20-15.40**	**TC-318**	Evaluation of gridded rainfall products in the selected basins of Lower Mekong :Santosh Dhungana
15.30-15.45	**Prof. Sangam Shrestha** **Asian Institute of Technolog**	**15.40-16.00**	**TA-119L**	EXPLORING BIAS CORRECTIONS OF RIVER DISCHARGE UNDER DAM OPERATION USING d4PDF IN THE CHAO PHRAYA RIVER BASIN, THAILAND: Aakanchya Budhathoki	**15.40-16.00**	**TB-201S**	SINTEX-F seasonal prediction system and its application :Takeshi Doi
15.45-16.15	**Ir. Mohd Zaki b. Mat Amin,** **Malaysia**	**16.00-16.20**	**TA-120L**	ANALYSIS OF FUTURE PRECIPITATION CHANGES IN TAIWAN USING ENSEMBLE CLIMATE CHANGE SCENERIO DATABASE, D4PDF.:Chang, JuiChe	**16.00-16.20**	**TB-205L**	WEEKLY GROUNDWATER PUMPAGE ESTIMATION IN UPPER CENTRAL PLAIN THAILAND VIA ARTIFICIAL NEURAL TECHNIQUE :Tran Thanh Long
16.15-16.45	**General Discussion**						
				Clip VDO			

Programme of THA 2022 International Conference, Day 2 (Thursday – 27 January 2022)

Thursday – 27 January 2022 (Morning)							
Executive Panel Session -3 ROOM A 3: Sustainable Groundwater Management towards SDGs		**Technical Presentation Session ROOM B 3**			**AIT-SEI Special Session on Groundwater Management ROOM C 3**		
MC	Asst. Prof. Dr. Aksara Putthividhya	**Chair**	Prof. Dr. Shu-Yuan Pan		**Chair**	Prof. Dr.Ashim Das Gupta	
09.00-09.15	**Prof. Dr. Makoto Taniguchi Research Institute for Humanity and Nature (RIHN), Japan**	**09.00-09.30**	**Invited Speaker Topic A2 A novel spatial downscaling approach for climate change assessment in regions with sparse ground data networks. :Professor Hyunhan Kwon, Sejong University**		**09.00-09.30**	**Invited Speaker Topic C1 INNOVATIONS FOR GROUNDWATER MANAGEMENT TOWARDS SDGS IN THAILAND :Surin Worakijthamrong, PhD., Director of Groundwater Development Bureau,Department of Groundwater Resources, Thailand**	
09.15-09.30	**Dr. James W. Lamoreaux Chairman at PELA GeoEnvironment, USA**	**09.30-09.50**	**TA-115S**	Flood simulation of the 2021 Thailand flood in the upstream area of Chi River basin :kwanchai pakoksung	**09.30-09.50**	**TC-312S**	Towards Sustainable Groundwater Management of Transboundary Aquifers in the Lower Mekong Region :Ashim Das Gupta
09.30-09.45	**Prof. Yonghui Yang, Center for Agricultural Resources Research, IGDB Chinese Academy of Sciences, China**	**09.50-10.10**	**TA-136L**	Aquatic weed removal with a rake to optimize water delivery :Jirawat Phuphanutada	**09.50-10.10**	**TC-314S**	MAPPING GROUNDWATER RESILIENCE TO CLIMATE CHANGE AND HUMAN DEVELOPMENT IN BANGKOK AND ITS VICINITY, THAILAND :Sanjiv Neupane
09.45-10.00	**Dr. Hans Thulstrup Senior Programme Specialist, UNESCO Jakarta**	**10.10-10.30**	**TA-127L**	Development of ultra-high resolution distributed rainfall runoff model to forecast flash flood in ungauged urban catchments :Yasuto TACHIKAWA, Feng Shi	**10.10-10.30**	**TC-316S**	Roles of multi-stakeholders in sustainable groundwater management towards SDG6. Case of Khon Kaen, Thailand :Preeyaporn Muenratch
10.00-10.30	**General Discussion**						
Break (Clip VDO)							
Executive Panel Session - 4 ROOM A 4: Water Management under Water security/SDGs		**Technical Presentation Session ROOM B 4**			**AIT-SEI Special Session on Groundwater Management ROOM C 4**		
MC	Asst. Prof. Dr. Piyatida Ruangrassamee	**Chair**	Prof. Dr.Kyuhyun Byun		**Chair**	Dr. Thanapon Piman	
10.45-11.00	**Mr. Thomas Panella, Chair the Water Sector Committee/Group for ADB**	**10.45-11.05**	**TA-132L**	HISTORICAL FLOOD SIMULATION AND EVALUATION THE PERFORMANCE OF GRIDDED PRECIPITATION DATASET IN PREK THNOT RIVER BASIN :Oudomsatia Huong	**10.45-11.05**	**TC-302S**	Nature Based Solutions (NBS) for Sustainable Urban Storm Water Management in Global South: A Short Review :Ho Huu Loc
11.00-11.15	**Professor Seungho Lee, Korea University, Korea**	**11.05-11.25**	**TA-133L**	ASSESSING FLOOD RISK USING ANALYTICAL HIERARCHY PROCESS (AHP) AND GEOGRAPHICAL INFORMATION SYSTEM (GIS): APPLICATION IN PREK THNOT RIVER BASIN :Chanponleourothana Samrith	**11.05-11.25**	**TC-327L**	A ROBUST APPLICATION OF GOOGLE EARTH ENGINE FOR ESTIMATING SURFACE SUSPENDED SEDIMENT CONCENTRATION (SSSC) DYNAMICS IN MEKONG DELTA :Punwath Prum
11.15-11.30	**Mr. Nguyen Minh Khuyen, Deputy Director General - Department of Water Resources Management, MONRE**	**11.25-11.45**	**TA-135L**	Model of water leakage beneath reservoir and above diversion water tunnel; Mae Prachum reservoir area, Mae Taeng, Chiang Mai Province :Noppadol Poomvises	**11.25-11.45**	**TA-129L**	Development of the landslide-integrated SWAT model :Lu, Chih-Mei
11.30-11.45	**Mr. Somchai Wangwatanaphanich, The Federation of Thai Industries, Thailand**	**11.45-12.05**	**TA-126L**	POTENTIAL OF ENSEMBLE OPTIMAL INTERPOLATION IN TACKLING PARAMETER BIAS :Manoj Khaniya			
11.45-12.15	**General Discussion**						
Break (Clip VDO)							

Thursday – 27 January 2022 (Afternoon)

Technical Presentation Session ROOM A 5			Technical Presentation Session ROOM B 5			Technical Presentation session ROOM C 5		
Chair	Prof. Yo-Jin Shiau		Chair	Prof. Dr. Li-Chi Chiang		Chair	Prof. Dr. Ming-Che Hu	
13.00-13.20	TA-102S	MANAGING FLASH FLOOD AND DROUGHT IN RAINFED AGRICULTURE – THE CONTEXT OF WATER CRISIS MANAGEMENT IN THAILAND :Supapap Patsinghasanee	13.00-13.30		**Invited Speaker Topic B2 Participatory Water Diversion Project in Bang Rakam Flood-prone Field :Dr. Chakaphon Singto, RID, Thailand**	13.00-13.20	TB-215L	Improving flood management through future reservoir development and operation in the Tonle Sap largest tributary :Davin Tes
13.20-13.40	TA-109S	Improving Accuracy of Groundwater Storage in Thailand Using GRACE Data Assimilation Technique :Natthachet Tangdamrongsub				13.20-13.40	TB-207L	A DEVELOPMENT OF SOIL MOISTURE MONITORING SYSTEM FOR INCREASING IRRIGATION SUPPLY EFFICIENCY APPLIED IN THORTHONGDAENG OPERATION AND MAINTANANCE PROJECT, KAMPHANGPHET, THAILAND.:Panuwat Pinthong
13.40-14.00	TA-138L	PREDICTING THE RESERVOIR INFLOW OF BHUMIBOL DAM USING XGBOOST MACHINE LEARNING ALGORITHM :Pheeranat Dornpunya	13.30-13.50	TB-203S	Reducing Irrigation Water Requirement of the Chao Chet - Bang Yihon Operation and Maintenance Project by Defining New Cropping Calendar based on Time Series NDVI. :Manatchanok Pannak	13.40-14.00	TB-220L	ESTIMATION OF CROP WATER REQUIREMENT AND IRRIGATION EFFICIENCY USING CLOUD–BASED IRRISAT APPLICATION IN THE LOWER PING RIVER BASIN, THAILAND :Paphanin Phutonglom
14.00-14.20	TA-124L	ASSESSING FLOOD INUNDATION IN THE LOWER PREK THNOT RIVER BASIN UNDER CLIMATE CHANGE USING RRI MODEL COUPLED WITH SWAT :Sophea Rom Phy	13.50-14.10	TB-209L	REAL-TIME RESERVOIR OPTIMIZATION FOR LONG-TERM OPERATION CONSIDERING SEASONAL ENSEMBLE PRECIPITATION FORECAST: A CASE STUDY OF THE SIRIKIT DAM IN 2019 :Thatkiat Meema	14.00-14.20	TB-213L	THE OPTIMAL IRRIGATION SCHEDULING FOR SMART FARM VIA REAL-TIME SENSOR :Sak Sakulthai
14.20-14.40	TA-338L	HYDRAULIC TOMOGRAPHY USING FIBER BRAGG GRATING MULTILEVEL WELL :Jui-Pin Tsai	14.10-14.30	TB-214L	Visualization of the Dynamic of Soil Moisture in Terraced Paddy Fields by Using Geoelectrical Resistivity Tomography :Shao-Yiu Hsu	14.20-14.40	TB-216L	HYBRID NEURO FUZZY-BASED RESERVOIR RE-OPERATION MODEL: CASE STUDY OF BHUMIBOL DAM IN THAILAND : Khin Muyar Kyaw
Break (Clip VDO)								
Technical Presentation Session ROOM A 6			Technical Presentation Session ROOM B 6			Technical Presentation session ROOM C 6		
Chair	Prof. Dr. K.S. Cheng		Chair	Prof. Dr. Anongrit Kangrang		Chair	Prof. Dr. Kiguchi Masashi	
15.00-15.20	TA-123L	FUTURE CHANGES OF FLOOD CONTROL EFFECTS OF DAMS IN CLASS-A RIVERS IN JAPAN USING d4PDF :Keiichiro Kitaguchi	15.00-15.20	TB-217L	Telemetry System for Irrigation : Chettana Chaiyasit	15.00-15.20	TC-342L	Applying Flood-prone Fields for Flood Management in Chao Praya River Basin :Surachat Malasri
15.20-15.40	TA-125L	IMPACTS OF CLIMATE CHANGE AND DAM CONSTRUCTION ON AGRICULTURAL FLOOD DAMAGES IN THE CAMBODIAN FLOODPLAIN OF THE MEKONG RIVER BASIN :Sophal Try	15.20-15.40	TB-218L	The Calibration Curve for Irrigation Reservoirs by Survey Tool Innovation : Porntipa Pinthong	15.20-15.40	TC-343L	THAICID Academic Network and their Supporting Roles on Irrigation and Drainage toward Sustainable Water Management :Noppadon Kowsuvon
15.40-16.00	TA-139S	TACKLING THE 2021 TROPICAL STORM DIANMU FLOOD IN THE GREATER CHAO PHRAYA RIVER BASIN, THAILAND: THE PERSPECTIVE VIEWS THROUGH CO-RUN EXERCISE UNDER THE SPEARHEAD RESEARCH PROGRAM :Areeya Rittima	15.40-16.00	TB-219S	An Implementation of Automatic Flap Gate Weir Type III-A & III-B toward Structural Irrigation Water Management Best : Chaiya Phoungphotisop	15.40-16.00	TC-303S	Greenhouse Gas Emission Analysis from Palm Oil Industry in Thailand : JunJun Ma
16.00-16.20	TA-121L	REAL-TIME FLOOD FORECASTING USING ECMWF ENSEMBLE PRECIPITATION FORECAST IN THE UPPER NAN RIVER BASIN, THAILAND :Thatkiat Meema	16.00-16.20	TB-206L	AN EXTENDED-RANGE WEATHER FORCAST OVER TWO WEEKS USING A COUPLED WRF-ROMS MODEL: A CASE STUDY OF CHAO PHRAYA RIVER BASIN :Kritanai Torsri	16.00-16.20	TB-211L	MULTI-OBJECTIVE BIOMONITORING APPROACHES USING BIOLOGICAL COMMUNITIES TO ASSESS THE WASTEWATER TREATMENT EFFICIENCY AND ECOSYSTEM SERVICES OF SUBTROPICAL CONSTRUCTED WETLANDS :Rita Sau Wai Yam
Clip VDO								

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more materials of Executive Panel Discussion can be downloaded from

http://project-wre.eng.chula.ac.th/aseanacademicnetwork/files/THA2022/THA2022_Booklet_Final%20180422.pdf

(Draft) Programme of THA 2019 International Conference, Day 3 (Friday – 28 January 2022)

Friday – 28 January 2022 (Morning)

Workshop A: Training courses for hydrologic analysis using GCM climate projection outputs ROOM A 7		Technical Presentation Session ROOM B 7: Department of Groundwater Resources Presentation			Technical Presentation Session ROOM C 7		
Purpose of the training: you will learn about climate change downscaled data for Southeast Asia and water resource impact assessment using it. In addition, you will learn how to use climate change data through exercises.		**Chair**	Prof. Dr. Chawalit Ratanatamskul		**Chair**	Prof.Dr.Dongkyun Kim	
09:00-09:20	**1. Dynamical downscaling of climate data for Southeast Asia at Meteorological Research Institute in Japan** **Dr. Akihiko MURATA**, Meteorological Research Institute, Japan	**09.00-09.30**		**Invited Speaker Topic C2** **Integrating Groundwater and Resiliency Frameworks: Informing Transboundary GroundwaterManagement in the Lower Mekong River Basin, Cambodia and Vietnam** **: Haider Saira M., Powlen, Kathryn, and Davis Kyle W., USGS**	**09.00-09.20**	**TC-341S**	Indicators of Water User Association for Sustainability Transition: A Preliminary Model :Jitraporn Somyanontanakul
					09.20-09.40	**TC-344L**	INWEPF-THAI Innovative Rice Cultivation to Sustain Green Approaches for food security and alleviate poverty under Global Warming Challenges : Rasu Suepsahakarn
09:20-09:40	**2. Evaluation of MRI-AGCM and 150-year continuous simulation in Southeast Asia** **Dr. Toshiyuki NAKAEGAWA**, Meteorological Research Institute, Japan	**09.30-09.45**	**TC-325L**	An Agent-based Approach for Managing Food-Energy-Water Systems Under Future Climate Scenarios Using FEWCalc and DSSAT: Opportunities and Challenges for Local Decision-makers in Thailand :Jirapat Phetheet	**09.40-10.00**	**TC-345S**	Community based water resources management criteria towards SDGs : Piyatida Ruangrassamee
09:40-10:00	**3. Impact assessment of climate change on water resources in Japan Southeast Asia using d4PDF** **Prof. Yasuto Tachikawa**, Graduate School of Engineering, Kyoto University, Japan	**09-45-10.00**	**TC-328L**	GIS ANALYSIS FOR GROUNDWATER EXPLORATION IN HARD ROCK TERRAINS: HUAI KRACHAO, KANCHANABURI, THAILAND :Jurarud Yanawongsa	**10.00-10.20**	**TC-301S**	The New National Water Law for Improving Water Management Problems in Thailand :Araya Yotmongkol
10:00-10:30	**3.1 Introduction of the exercise (uncertainty assessment of reservoir operation using d4PDF), How to access d4PDF and data format** **Dr. Thatkiat Meema**, Graduate School of Engineering, Kyoto University, Japan	**10.00-10.15**	**TC-331L**	MANAGED AQUIFER RECHARGE : THE EXPLORATION OF POTENTIAL AREAS, NAM KAM RIVER BASIN, SAKON NAKHON AND NAKHON PHANOM PROVINCES, THAILAND : Jirateep Yotmaw			
		10.15-10.30	**TC-332L**	APPLICATION OF NANOFILTRATION MEMBRANE FOR REMOVAL OF VOCS AND HEAVY METALS IN GROUNDWATER, RATCHABURI, THAILAND :Chadaporn Busarakum			
Break (Clip VDO)							
Workshop A: Training courses for hydrologic analysis using GCM climate projection outputs ROOM A 8		Technical Presentation Session ROOM B 8: Department of Groundwater Resources Presentation			Technical Presentation session ROOM C 8		
Purpose of the training: you will learn about climate change downscaled data for Southeast Asia and water resource impact assessment using it. In addition, you will learn how to use climate change data through exercises.		**Chair**	Dr Praphawadee Otarawanna		**Chair**	Prof. Dr. Chawalit Ratanatamskul	
10:40-11:30	**3.2 Hand-on the exercise (precipitation analysis using d4PDF)** **Dr. Thatkiat Meema**, Graduate School of Engineering, Kyoto University, Japan	**10.40-10.55**	**TC-334L**	HYDROLOGICAL FORENSIC INVESTIGATION COMBINING HIERARCHICAL CLUSTER ANALYSIS: A CASE STUDY OF 16TH LUM NAM JONE RESERVOIR, CHACHOENGSAO, THAILAND :Manussawee Hengsuwan	**10.40-11.00**	**TC-322S**	ASSESSMENT OF WATER QUALITY OF INLE LAKE AND FOUR MAIN STREAMS FLOWING INTO INLE LAKE, IN MYANMAR :Ei Wai Phyo
		10.55-11.10	**TC-336L**	GROUNDWATER MONITORING NETWORK IN THAILAND :Thanyarat Srikamma	**11.00-11.20**	**TC-340L**	Water use efficiency improvement at local level via training process - Case study in the Thor Tong Daeng (TTD) Irrigation Project area, Kamphaengphet Province Thailand :Chitsanuwat Maneesrikum
		11.10-11.25	**TC-337L**	CHARACTERIZATION OF CONTAMINATED GROUNDWATER USING MEMBRANE INTERFACE PROBE AND HYDRAULIC PROFILING TOOL (MiHPT) IN RATCHABURI, THAILAND :Phanumat Kullaboot	**11.20-11.40**	**TC-326L**	OPINIONS AND PERSPECTIVES IN CHAO PHRAYA DELTA'S 2040 DEVELOPMENT :Thapthai Chaithong
11:30-12:00	**Q&A**	**11.25-11.40**	**TC-330L**	Groundwater Resources Planning and Development in Eastern Economic Corridor (EEC) with an Integrated Spatial Plan and Public Participation : Vijitsri Sanguanwongse	**11.40-12.00**	**TB-208L**	Discussion on the Suitability of SWAT Model Applied to Hydrological Simulation of Paddy Field in Taiwan :Li-Chi Chiang
		11.40-11.55	**TC-335L**	COST AND BENEFIT ANALYSIS FROM USING AUTOMATIC METERING READING FOR GROUNDWATER REVENUE MANAGEMENT : CASE STUDY FROM THAILAND GROUNWATER CRISIS AREA : Supanee Harnphattananusorn / Vijitsri Sanguanwongse			
Break (Clip VDO)							

Friday – 28 January 2022 (Afternoon)

Workshop B: Training courses for water security index ROOM A 9		Workshop C: Science-Policy Interface Dialogue on Water and Climate Change ROOM B 9	
In this training workshop, you will learn about water security status data and calculation method in case of Thailand. In addition, you will learn how to use water security index data through exercises. The example of application and implementation of water security index in Thailand is illustrated. The strength and weakness of Thailand water management status were discussed.		Objectives: 1.Familiarize participants with the concept of Science-Policy Interface 2.Explore challenges and opportunities for Science-Policy Interface 3.Network and build community of action for continuing activities towards achieving SDGs	
13.00-13.20	**1. Introduction of Water security index** **Asst. Prof. Piyatida Ruangrassamee** Faculty of Engineering, Chulalongkorn University, Thailand	**13.00-13.15**	**Warm-up** *:Menti*
13.20-13.40	**2. Example of mainstreaming water security index in national water resources management in Thailand** Office of the National Water Resources, Thailand	**13.15-13.30**	**Introduction to Science-Policy Platform** *:Presentation*
13.40-14.00	**3. Linkage of water security index and water operation in Thailand: framework and system** **Asst. Prof. Pongsak Suttinon** Faculty of Engineering, Chulalongkorn University, Thailand	**13.30-13.45**	**Getting to know each other & Locating where we are** *: Round of Self-Introduction*
14.00-14.30	**4.1 Introductions of exercise** **Asst. Prof. Piyatida Ruangrassamee** **Asst. Prof. Pongsak Suttinon** Faculty of Engineering, Chulalongkorn University, Thailand	**13.45-14.05**	**Inputting to the Quadrant and Identify 3 key functions** *: Small breakout groups of 3-4 people and fill the output into the consolidated sheet of 9 quadrant*
Break (Clip VDO)			
14.40-15.30	**4.2 Hand-on the exercise** **Asst. Prof. Piyatida Ruangrassamee** **Asst. Prof. Pongsak Suttinon** Faculty of Engineering, Chulalongkorn University, Thailand	**14.20-15.20**	**Open Discussion on Challenges and Solutions** *: Group of max 5. Sharing & Mapping Exercise on Challenges and Solutions through 5 topics (Free to choose topic(s) of interest)* *1. Financing* *2. Capacity Building* *3. Data* *4. Innovation* *5. Governance*
15.30-16.00	**Q&A**	**15.20-15.50**	**Next Step** *: Suggestions for next step & Allocate working groups for taking consultation to action*
		15.50-16.00	**Summary and Reflection** *: Menti & Photo*
Clip VDO			

EXECUTIVE PANEL DISCUSSIONS

more materials of Executive Panel Discussion can be downloaded from

http://project-wre.eng.chula.ac.th/aseanacademicnetwork/files/THA2022/THA2022_Booklet_Final%20180422.pdf

SESSION A1 :
WATER DISASTER MANAGEMENT AND CLIMATE CHANGE

Session A1: Water Disaster Management and Climate Change

Objective to provide the recent information on research and new ideas/concept to cope with issues under climate change and move towards SDGs.

1. Key Speaker: Prof. Dr. Yasuto Tachikawa
(Department of Civil and Earth Resources Engineering, Graduate School of Engineering, Kyoto University)

On the topic of Projection of Hydrologic Extreme Using Large Ensembled Climate Simulation and Japan's New Policy on Water-related Disaster Risk Reduction.

The extreme events that happen in Japan such as the heavy rainfall in July 2018 and Typhoon Hagibis in October 2019 are the events that make people lose a lot of life and cause great damage to the economy. Therefore, the issue to mention is "Impact assessment of climate change on hydrologic extremes and adaptation strategy planning by policymakers" and will be separated into these four main topics.

1) Future climate projection data
- "d4PDF" was extensively used for impact assessment studies. The scenario case will be plus 2 degrees for the scenario case data plus 4 degrees for the extreme case data with very long time-series data.

2) Flood and inundation modeling and flood projections
- A distributed rainfall-runoff model for all basins in Japan and a detailed inundation simulation model for the three major metropolitan areas were successfully developed.

3) Impact assessment of climate change on flood risk
- Non-parametric estimations and largest-scale flood and inundation predictions were successfully achieved.
- Probabilistic flood risk curve estimation was realized.

4) Adaptation strategy planning by policymakers

The Government of Japan has decided to incorporate climate change scenarios data into flood control planning and has begun to review the plans.

<u>New Policy for Japan on Water-related Disaster Risk Reduction</u>

The name of the policy is "River Basin Disaster Resilience and Sustainability by All"

1. Transition to River Basin Disaster Resilience and Sustainability by All
   - Measures to be implemented with the cooperation of all stakeholders in any kind of place around basins.
   - Accelerate preventive disaster risk reduction.
2. Revise Plans for Flood Control
   - Upgrade flood control plans considering the impacts of climate change.

2. Key Speaker: Mr. Yusuke Taishi
(Regional Technical Advisor for Climate Change Adaptation, UNDP)

On the topic of Water Management in a changing climate.

The presentation will introduce more findings on evidence about climate change and the impact of climate change on water disasters.

<u>A summary of projected climate parameters</u>
- Overall rainfall is expected to increase across Asia
- However, it is still uncertain whether this means lower risks of hydrological and agricultural droughts.

- Extreme weathers are more likely (heavy rain, heat waves, dry days) which are expected to give rise to various disaster events.
- It is still possible that some parts of Asia experience agricultural droughts while receiving higher annual rainfall.
- One thing that we can say about future climate change is climate change will definitely hold serious challenges in the distribution of water across geographic locations and different time periods.

<u>The example of water management with UNDP supports</u>

- Philippines: Provision of crop insurance to support farmers against rainfall variability (Mindanao), Using ecosystem-based coastal management to raise resilience to typhoons in the eastern provinces (new project).
- Sri Lanka: Rehabilitation of ancient water cascades in the central dry zone of the country, The introduction of climate-resilient agriculture (training and water-saving technic).
- Vietnam: Extension of "last-mile" irrigation connections to vulnerable and ethnic minority farmers, Upgrading communal ponds for rainfed farmers.
- Myanmar: Integrated rural water management (Rehabilitation of degraded watersheds, Construction of community irrigation channels and ponds, Introduction of climate-resilient agriculture).

<u>Lessons learned from UNDP's experience</u>

- There is no "one size fits all" solution.
- There are multiple channels of support: Central ministry's planning and expenditure, Local administration's planning and expenditure, through supporting NGOs, CSOs, and other community groups.
- Resilience cannot be built if communities are not empowered, communities cannot be empowered if they are not engaged, and communities cannot be engaged if they are not informed.

3. Key Speaker: Dr. Giriraj Amarnath
(International Water Management Institute)

On the topic of Bundled solutions for climate risk management

<u>Understanding risk and investing in resilience</u>

- Trends in disaster impact in Asia and the Pacific: Decreasing in mortality and increasing in economic losses.

<u>Water risk knowledge products and tools</u>

- Multi-hazard Economic Exposure Map = Multi-hazard data + Population Exposure, Gender Risk + Gross Domestic Product(GDP) + Historical loss and event database.
- Hydromet optimization tool (v1): Guide the process of impactful investments in hydromet and early warning services, Digital data solutions can help in optimizing the hydromet operations to strengthen hydrological simulations to manage disaster risks.

<u>Climate risk insurance</u>

- How insurance can improve adaptation and increase resilience.
- When insurance is the right instrument for adaptation.
- Method to make the agricultural sector more resilient to climate risks.

<u>The issues</u>

- Weather risk remains a major challenge to farming in South Asia.
- A large fraction of rural households in South Asia were affected by drought and floods.
- Rainfed agriculture exposes farmers to huge risks in the lack of bundled solutions.

- Climate shocks had a significant impact on the short and long-term welfare of households (lower adoption of agricultural inputs, lower affordable credit access, lower technology adoption, and lower risk-bearing and income generation capacity).

Bundling insurance with other services

- Weather-based insurance with seed inputs, weather forecast, agriculture advisory services, grain procurement, and credit link.

4. Key Speaker: Mr. Abdul Malik Sadat Idris
(Director of Water Resources and Irrigation, Bappenas Indonesia)

On the topic of National Plan for Water Disaster Management in Indonesia.

General Information on Indonesian Disasters

- Flood is the highest frequency and losses of natural disaster in Indonesia (at 62%, 785 million/yr.).
- The total number of disaster events in the year 2021 in 3,504 cases, Flood reaches the highest number at 984 cases more than landslide (905 cases) and Tornado (682 cases) respectively.
- Due to the uncontrollable of water extraction in the North Coast of Java, the rate of land subsidence has increase up to 5-20 cm/year in highly dense city. This has also increased coastal flood hazards up to 5-200 cm.
- 5 Agglomeration Areas will experience a raw water deficit of around 163 m^3/s in 2024.
- The plan to add 13 industrial estates (covering 38.377 hectares) requires a water supply of around 67 m^3/s without relying on groundwater as raw water.

Impact of Climate Change

- Indonesia is projected to have a shorter rainy season and a longer dry season, while precipitation tends to increase more than 50 mm/day during the rainy season.
- Indonesia is projected to have an increase in temperature ranging from 1.5 °C to 3.5 °C (RCP 4.5 to RCP 8.5) by the end of the 21st century.

Indonesia National Resilient Infrastructure

The target is to enhance the disaster resilience of 20 high-disaster-risk provinces through 3 main strategies (Disaster Risk Reduction in 50 Cities, Coastal Protection in 5 cities of North Java Coast, Restoration of 4 Critical Watershed)

1. Disaster Risk Reduction in 50 Cities: through “integrated flood risk management strategy” that conducted by National and Local Budget and Investment from Development Partner.
2. Coastal Protection in 5 cities of North Java Coast: Strategies for a structural component are an installation of Land Subsidence monitoring equipment, 100 stations for water quality monitoring, construction of domestic wastewater treatment plant, construction of sea dike, and coastal protection structure and Toll Road Semarang-Demak. And strategies for a non-structural component are the formulation of integrated coastal development plans and the enforcement of groundwater uptake regulations.
3. Restoration of 4 Critical Watershed: Conservation in watershed area, Improving the water quality, Water management

Strategic Planning for Water Disaster

1. Green Infrastructures
2. Integrated Water Resource Management
3. Enhancing Community Preparedness
4. Strengthen the Country’s Investment Capacity Through Creative Financing

Blended Financing – Investing in Disaster Resilient Infrastructure Midterm Foreign Loan Plan 2020-2024

1. National Urban Flood Resilience Program(NUFReP): 400 Million USD
2. Flood Management and Coastal Protection in North Java: 500 Million USD
3. Comprehensive Disaster Reduction and Management Improvement of Jeneberang River Basin: 288 Million USD
4. Integrated Urban Flood Management Project in JABODETABEK
5. Urgent Disaster Reduction of Mt.Semeru, Mt.Kelud, Mt.Agung, and Other Erupted Volcanoes in Indonesia: 174 Million USD

Q&A form audiences

1. The trend of higher rainfall various irrigation infrastructures whether it is a reservoir, irrigation channel, or embankment that have been used for a long time, we habitation these infrastructures to accommodate the increasing rainfall would require a huge investment by the presentation of the project example, it seems to be considered on a small or middle project. If considered for a large-scale project with a large irrigation area and more water user groups. What factors should be considered for sustainable success?

Answer: Mr. Yusuke Taishi

A small or medium scale of the example project is unnecessary. For example, in Sri Lanka where we support the community with the water castigate, this project can benefit more than half a million people. And for the second question, it was true that this will use a lot of money, so I suggest combining various incremental steps. For example, by training or giving specific skills to the farmer. This will cost less investment and the farmer can continue to practice on their own.

2. It seems that Japan is advocating using the river basin at the appropriate geographical scale for managing water resources and building resilience. We shared this view at the global water practice at the world bank. Can you tell us what is the time frame or timeline for Japan to make this shift to river basin disaster resilience and sustainability by all? And how they factor the flexibility since there is still some uncertainty about localized climate impact.

Answer: Dr. Yasuto Tachikawa

In the past of the Japan Government, the very important way to reduce flood disasters is the development of the dam's research work and draining the water in the river. Also, many research using future climate change scenarios, it's reviewed that future rainfall intensity will increase without drought. So from our result to draining the floodwater on the river is difficult. So that is why a much more intemperate way is important, not only river maybe how to do a well organize or some regulation or other way.

3. Referring to flood risk curve development shows the relation of exceedance probability and economic damage. Please elaborate more on the criteria of economic damages and the economic damages would be the main decisions factor to be used in New Policy improvement or not?

Answer: Dr. Yasuto Tachikawa

The relationship between flood damage and return period. And in Japan, we can estimate that relationship for example in a sticky area we can estimate the water depth and for each depth, we can estimate the database based on statistical data. But, at least the government has the manual about the relationship between damage and depth for each elaborate used. Hopefully, I think that kind of information will be established in Asia. And now I think that government recognizes that to establish and develop such kind of relationship between flood damage and occurrence probability. But now not this is still not established in the policy yet.

4. In terms of policymaker, I would like to ask how can I implement the insurance with the local people and make them accept this concept. So Can you share some experience about implementing the insurance with the local people?

<u>Answer: Dr. Giriraj Amarnath</u>

The road of climate insurance has been significantly important, that is increasingly important for data collection to bring more the digital. Because in the past we have damaged data collection and this takes a lot of time to deal with. And the available data is very poor. Insurance companies rarely want to invest a lot of money. According to this matter, if you want to deliver a risk control product, it will be very expensive for the private sector. So the challenge is the trust of who is going to look at the model development data collection and who will be guaranteed the quality of data. I think today we see that insurance is getting better and better into the water risk management program. Now, countries are installing more automatic water stations. It's mean that the insurance companies have better data collection. I think now we are changing for the better form. And if we want to access our credit insurance needs to be taken care of us immediately. So I think this is the greatest road for the private sector to play here and also the insurance companies need to step in more to invest in data collection and make them more transparent.

5. Would like to ask you to share about how to encourage people from the community up for the policy. And, How we can do in practical terms to bottom-up the community?

<u>Answer: Mr. Yusuke Taishi</u>

It's important to understand why the bottom-up is important. Cause in reality it was difficult to know what will happen in the future 2030-2050. You cannot make an approach prediction alone because your future perception may be wrong. Then, when the future is uncertain, the local people need to be resilient and be able to ask what kind of future is true. That is why the bottom-up approach is really important. And the national hydro associate agency can not predict a perfect future. So, every single individual people needs to be able to react and change the behavior based on different futures that can be presented.

And to encourage the local community, we need to change the perception. The local water system, local water resource, water ecosystem, and others need to be engaged and informed as a partner in building a resilient society. So The mindset of sharing information and making an effective engagement is really important.

THA 2022 Panel Session 1: Water Disaster Management and Climate Change, January 26, 2022

Projection of Hydrologic Extremes Using Large Ensemble Climate Simulations and Japan's New Policy on Water-related Disaster Risk Reduction

Yasuto Tachikawa

Department of Civil and Earth Resources Engineering,
Graduate School of Engineering, Kyoto University

京都大学

Impact assessment of climate change on hydrologic extremes and adaptation strategy planning by policymakers

2

Future climate projection data

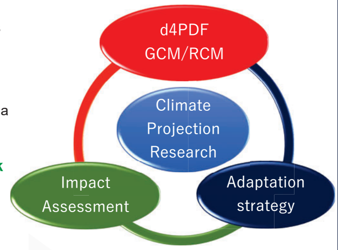
Large ensemble climate change projection data, d4PDF was extensively used for the impact assessment studies.

Flood and inundation modeling and flood projections

A distributed rainfall-runoff model for all basins in Japan and a detailed inundation simulation model for the three major metropolitan areas were successfully developed.

Impact assessment of climate change on flood risk

- Non-parametric estimations and largest-scale flood and inundation predictions were successfully achieved.
- Probabilistic flood risk curve estimation was realized.

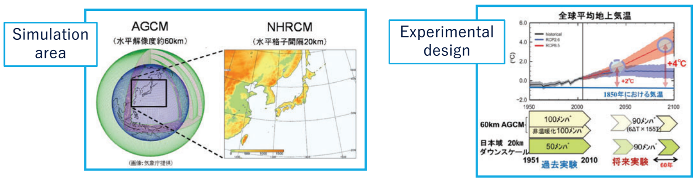


Adaptation strategy planning by policymakers

The Government of Japan has decided to incorporate climate change scenarios data into flood control planning and have begun to review the plans.

A new opportunity for extreme hydrologic prediction research using the database for Policy Decision making for Future climate change (d4PDF)

3



The database consists of atmospheric simulations for the globe using 60km resolution MRI-AGCM 3.2H (Mizuta et al. 2012) and dynamically downscaled simulations using 20km resolution NHRCM (Sasaki et al. 2011).

The entire globe experiment (60km resolution)

- Historical experiment for 60 years (1951-2011) × 100 ensemble members (6,000 years time series data)
- 4 degree increase experiment for 60 years (2051-2111) × 90 ensemble members (5,400 years time series data, 60 years × 15ensemble members × 6 SSTs)

Downscaled local experiment (20 km resolution)

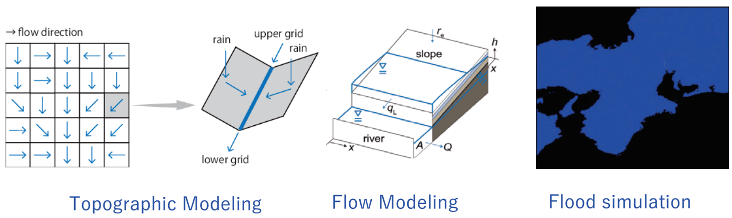
- Historical experiment for 60years (1951-2011) × 50 ensemble members (3,000 years time series data)
- 4 degree increase experiment for 60 years (2051-2111) × 90 ensemble members (5,400 years time series data, 60 years × 15ensemble members × 6 SSTs)

4

Flood and Inundation Modeling and Flood Projections

Runoff generation and flow routing model

5

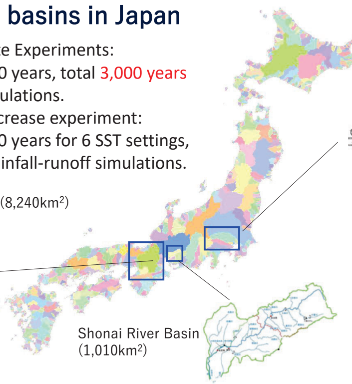


A flow direction map with 1 km spatial resolution is developed. Then, generated runoff is routed according to the flow direction map using one dimensional kinematic wave flow model .

Climate change impact assessment on flood extremes for all 1st class river basins in Japan

6

- Historical Climate Experiments: 50 ensembles of 60 years, total 3,000 years Rainfall-runoff simulations.
- The 4-degree increase experiment: 15 ensembles of 60 years for 6 SST settings, total 5,400years rainfall-runoff simulations.



Ara River Basin (2,940km^2)

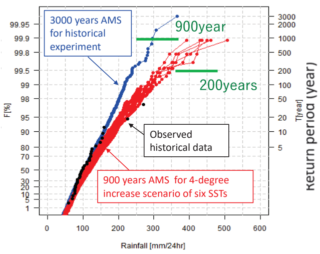
Yodo River Basin (8,240km^2)

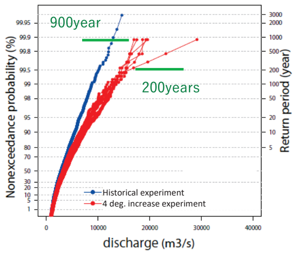
Shonai River Basin (1,010km^2)

Probability plot for annual maximum 24hours basin rainfall for the Yodo River basin (8,240km^2)

7

Tachikawa et al. (2017)





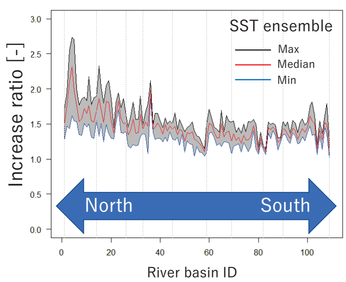
Tachikawa, Y., Miyawaki, K., Tanaka, T., Yorozu, K., Kato, M., Ichikawa, Y., Kim, S. (2017). Future change analysis of extreme floods using large ensemble climate simulation data. *Journal of Japan Society of Civil Engineers, Ser. B1 (Hydraulic Engineering)*, 73(3), 77-90.

Changes of extreme river discharge for all 1st class river basins in Japan under 4-degree increase scenario

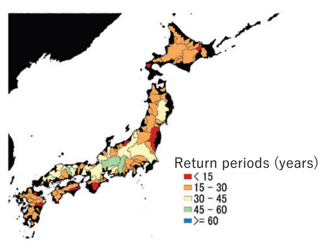
8

Kobayashi et al. (2020)

Peak discharge increase ratios for all Japanese basins



Design level (100 to 200 years in Japan) will decrease to 15 to 60 years in the 4 degree rise climate

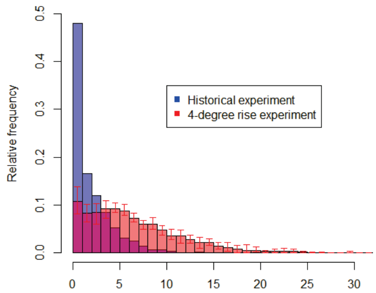


Kobayashi, K., Tanaka, T., Shinohara, M., & Tachikawa, Y. (2020). Analyzing Future Changes of Extreme River Discharge in Japan Using d4PDF. *Journal of Japan Society of Civil Engineers, Ser. B1 (Hydraulic Engineering)*, 76(1), 140-152.

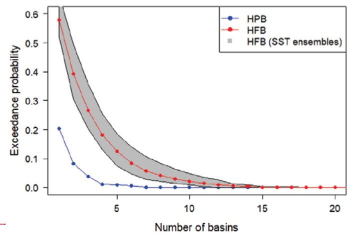
9

Increase of simultaneous flood probability under 4-degree scenario

Tanaka et al. (2021)



Number of rivers exceeding design level in the same year estimated by using d4PDF



Exceedance probability of the number of river basin exceeding design level in the same year for the 41 basins in the western Japan

Tanaka, T., Kobayashi, K., & Tachikawa, Y. (2021). Simultaneous flood risk analysis and its future change among all the 109 class-A river basins in Japan using a large ensemble climate simulation database d4PDF. *Environmental Research Letters, 16*(7), 074059.

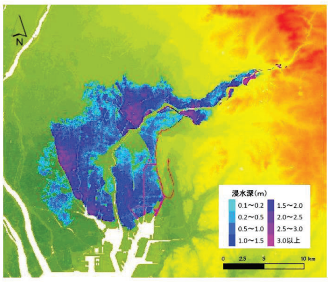
10

Impact assessment of climate change on flood risk

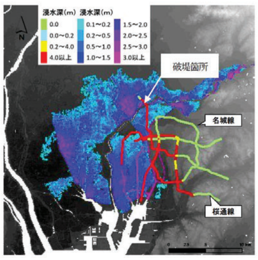
11

Largest-class urban inundation projections under the 4-degree increase scenario in the Nagoya City area

Takeda et al. (2021)



Inundation depth for the largest-class flood under the 4-degree increase scenario.



Inundation depth for the subway in the Nagoya City for the flood scenario.

Takeda, M., Ohmizo, K., Kawaike, K., Tachikawa, Y., Tanaka, T. (2021). Examination of assumed inundation due to large scale floods in future forecasts. *Journal of Japan Society of Civil Engineers, Ser. B1 (Hydraulic Engineering)*, 77(2), accepted.

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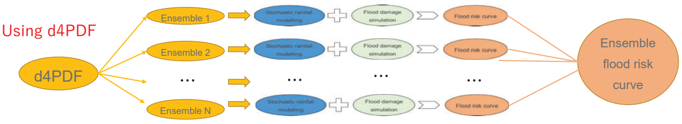
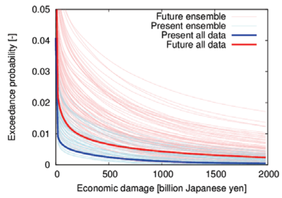
Flood risk curve development

Tanaka et al. (2018)

Using d4PDF



Simulation results of Typhoon 18, 2013 with extended rainfall (600 mm)



Tanaka, T., Tachikawa, Y., Ichikawa, Y., Yorozu, K. : Flood risk curve development with probabilistic rainfall modelling and large ensemble climate simulation data: a case study for the Yodo River basin, Hydrological Research Letters, Vol. 12, No. 4, pp. 28-33, 2018, https://doi.org/10.3178/hrl.12.28

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Achievements of climate change impact studies on flood disasters in the TOUGOU Program

Extreme flood prediction under climate change scenario	• Ensemble climate scenario dataset, d4PDF with spatial resolution of 60km (global), 20km, and 5km (East Asia) developed by the Meteorological Research Institute and others were extensively used. • Nonparametric probability evaluation of extreme flood were successfully conducted.
Largest-class flood and risk estimation	• Largest-scale flood and inundation predictions were successfully achieved. • Probabilistic flood risk curve estimation was realized.
Collaborative research for developing foundations on adaptations in Asian and the Pacific	• Impact studies were expanded to corroborative researches in the Asia and the Pacific region. • Flood projection research using climate scenario data including d4PDF and NHRCM data are conducted in Vietnam, Thailand, Indonesia, Taiwan, and Pacific Islands.

14

MLIT Ministry of Land, Infrastructure, Transport and Tourism

River Basin Disaster Resilience and Sustainability by All

Japan's New Policy on Water-related Disaster Risk Reduction

Japan's new policy, River Basin Disaster Resilience and Sustainability by All, considers river basins as spaces that include the watershed and flood plain areas, and this policy takes comprehensive and multilayered actions as follows: 1) flood prevention, 2) exposure reduction, and 3) disaster resilience. The policy calls for all stakeholders in river basins, including the national government, prefectures, municipalities, private enterprises, residents and water users, to take actions for disaster resilience and sustainability. In 2020, after experiencing tragic water disasters in recent years, Japan's Ministry of Land, Infrastructure, Transport and Tourism greatly shifted its flood management policy to the new policy, River Basin Disaster Resilience and Sustainability by All.

https://www.mlit.go.jp/river/kokusai/pdf/pdf21.pdf

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MLIT Ministry of Land, Infrastructure, Transport and Tourism, Japan

Background

Impacts of Climate Change

Water disasters will continue to intensify. It is necessary to enhance the methods of measures to improve safety quickly.

Typhoon Hagibis (2019)

Floods in Japan (2018)

Social Trends

With Japan facing a declining and aging population, it is necessary to achieve safe and secure Compact Plus Network urban planning to maintain regional vitality.

Technological Innovation

Remarkable progress is being made in technologies such as 5G, AI, Big Data, and IT . It is necessary to utilize these technologies in disaster risk reduction, including evacuation.

https://www.mlit.go.jp/river/kokusai/pdf/pdf21.pdf

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MLIT Ministry of Land, Infrastructure, Transport and Tourism, Japan

New Policy for Japan

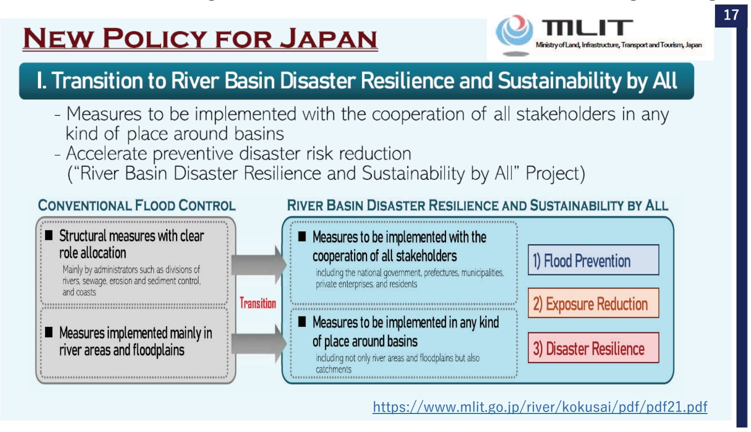
I. Transition to River Basin Disaster Resilience and Sustainability by All

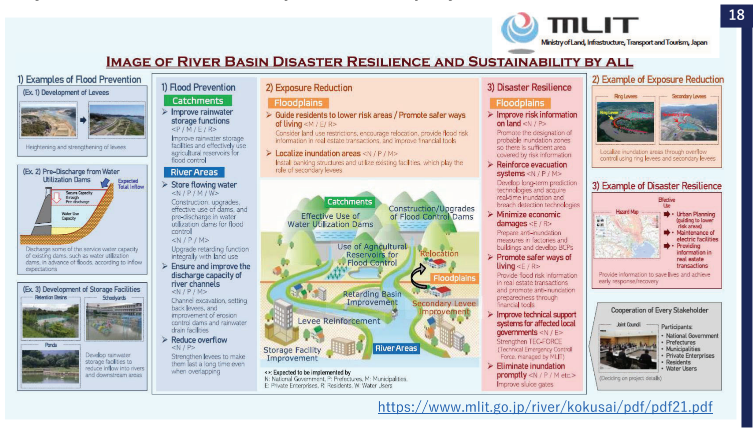
- Measures to be implemented with the cooperation of all stakeholders in any kind of place around basins
- Accelerate preventive disaster risk reduction ("River Basin Disaster Resilience and Sustainability by All" Project)

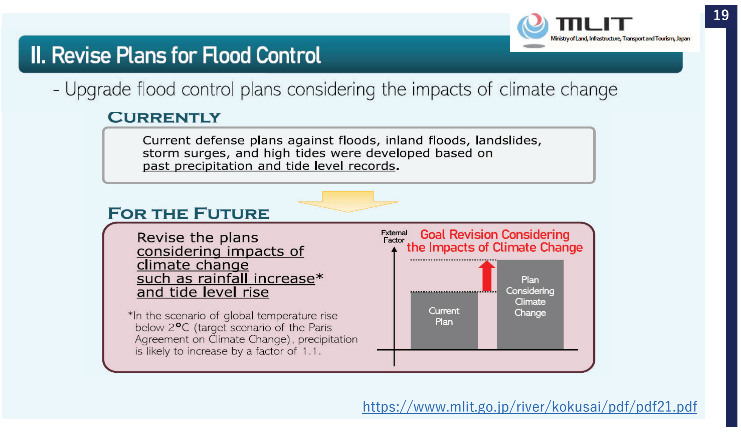
II. Revise Plans for Flood Control

- Upgrade flood control plans considering the impacts of climate change

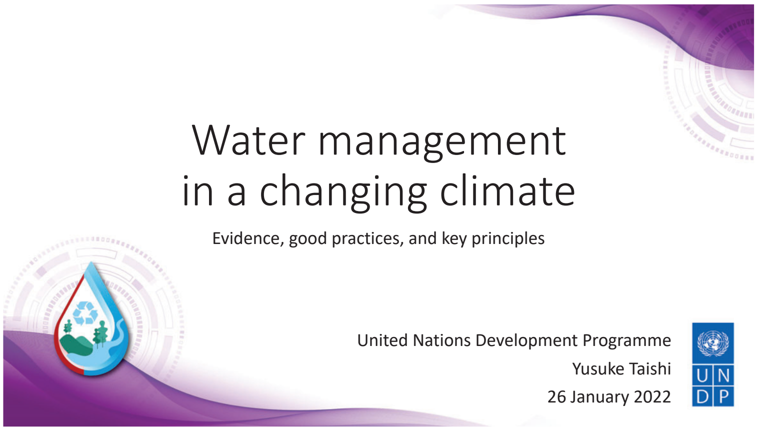
https://www.mlit.go.jp/river/kokusai/pdf/pdf21.pdf

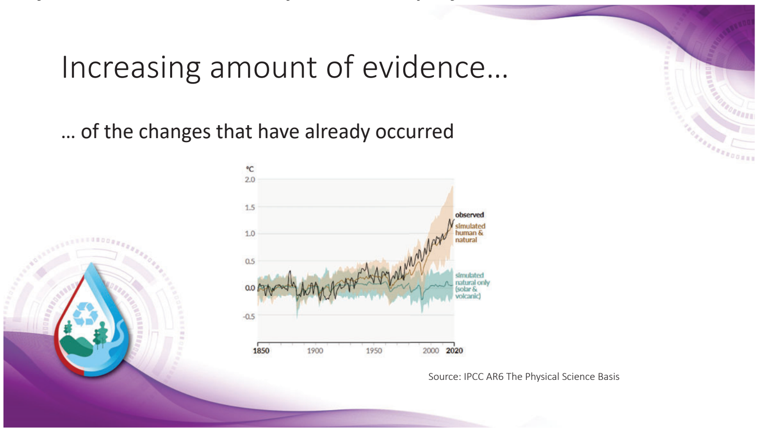

17
New Policy for Japan
MLIT
Ministry of Land, Infrastructure, Transport and Tourism, Japan
I. Transition to River Basin Disaster Resilience and Sustainability by All
- Measures to be implemented with the cooperation of all stakeholders in any kind of place around basins
- Accelerate preventive disaster risk reduction (“River Basin Disaster Resilience and Sustainability by All” Project)
Conventional Flood Control
River Basin Disaster Resilience and Sustainability by All
Structural measures with clear role allocation
Mainly by administrators such as divisions of rivers, sewage, erosion and sediment control, and coasts
Measures implemented mainly in river areas and floodplains
Transition
Measures to be implemented with the cooperation of all stakeholders
including the national government, prefectures, municipalities, private enterprises and residents
Measures to be implemented in any kind of place around basins
including not only river areas and floodplains but also catchments
1) Flood Prevention
2) Exposure Reduction
3) Disaster Resilience
https://www.mlit.go.jp/river/kokusai/pdf/pdf21.pdf

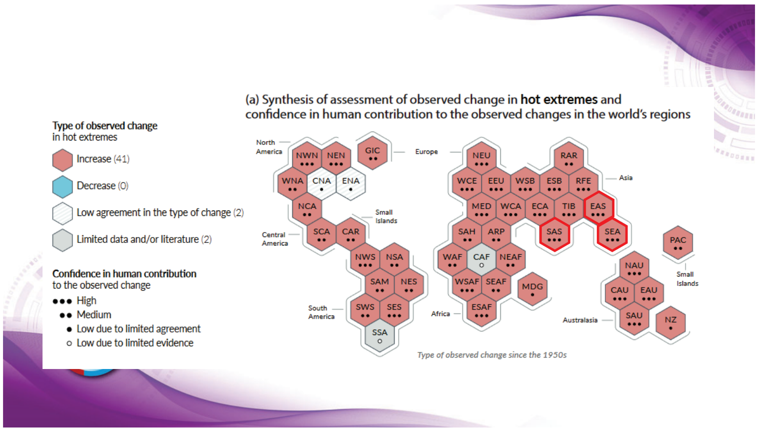

18
MLIT
Ministry of Land, Infrastructure, Transport and Tourism, Japan
Image of River Basin Disaster Resilience and Sustainability by All
1) Examples of Flood Prevention
1) Flood Prevention
Catchments
River Areas
2) Exposure Reduction
Floodplains
3) Disaster Resilience
Floodplains
2) Example of Exposure Reduction
3) Example of Disaster Resilience
Catchments
Effective Use of Water Utilization Dams
Construction/Upgrades of Flood Control Dams
Use of Agricultural Reservoirs for Flood Control
Relocation
Floodplains
Retarding Basin Improvement
Secondary Levee Improvement
Levee Reinforcement
Storage Facility Improvement
River Areas
Cooperation of Every Stakeholder
https://www.mlit.go.jp/river/kokusai/pdf/pdf21.pdf

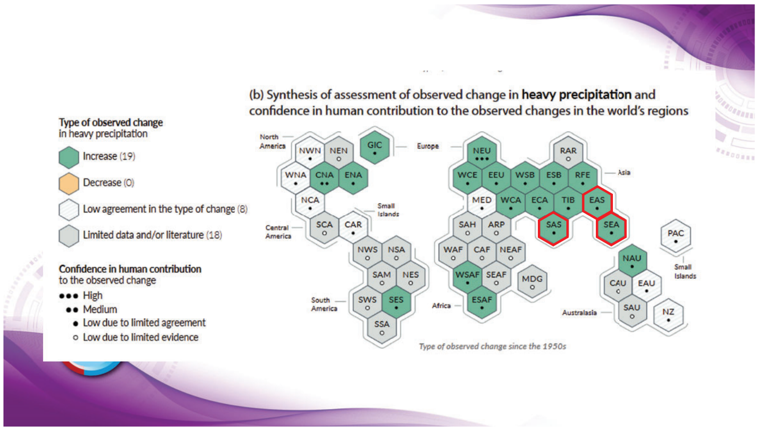

19
MLIT
Ministry of Land, Infrastructure, Transport and Tourism, Japan
II. Revise Plans for Flood Control
- Upgrade flood control plans considering the impacts of climate change
Currently
Current defense plans against floods, inland floods, landslides, storm surges, and high tides were developed based on past precipitation and tide level records.
For the Future
Revise the plans considering impacts of climate change such as rainfall increase* and tide level rise
*In the scenario of global temperature rise below 2°C (target scenario of the Paris Agreement on Climate Change), precipitation is likely to increase by a factor of 1.1.
External Factor
Goal Revision Considering the Impacts of Climate Change
Current Plan
Plan Considering Climate Change
https://www.mlit.go.jp/river/kokusai/pdf/pdf21.pdf

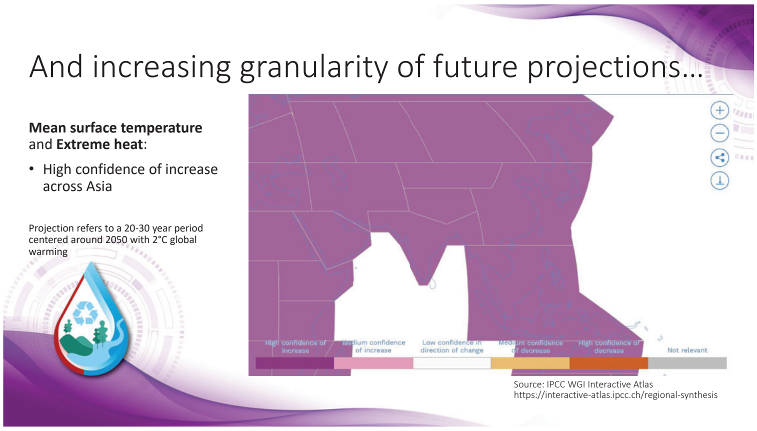

THA 2022 Panel Session 1: Water Disaster Management and Climate Change), January 26, 2022
Thank you very much
京都大学

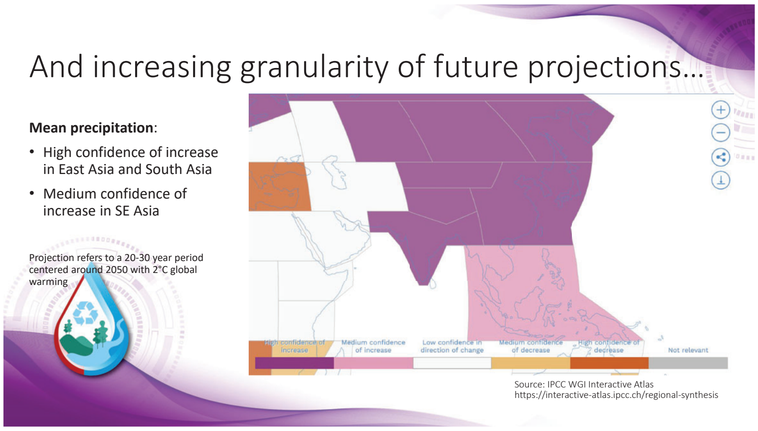

Water management
in a changing climate
Evidence, good practices, and key principles
United Nations Development Programme
Yusuke Taishi
26 January 2022
U N
D P

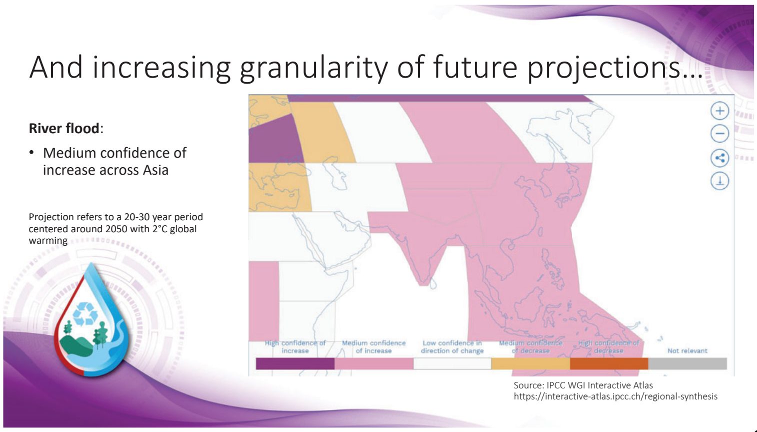

Increasing amount of evidence…
… of the changes that have already occurred
°C
observed
simulated human & natural
simulated natural only (solar & volcanic)
1850
1900
1950
2000
2020
Source: IPCC AR6 The Physical Science Basis

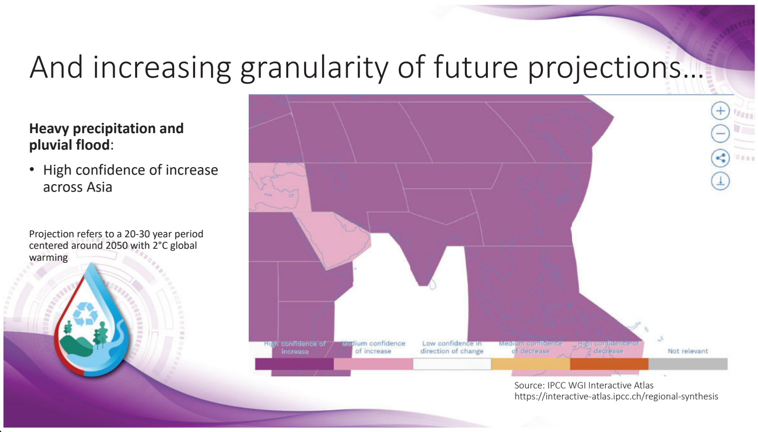

(a) Synthesis of assessment of observed change in hot extremes and confidence in human contribution to the observed changes in the world's regions
Type of observed change in hot extremes
Increase (41)
Decrease (0)
Low agreement in the type of change (2)
Limited data and/or literature (2)
Confidence in human contribution to the observed change
●●● High
●● Medium
● Low due to limited agreement
○ Low due to limited evidence
Type of observed change since the 1950s


(b) Synthesis of assessment of observed change in heavy precipitation and confidence in human contribution to the observed changes in the world's regions
Type of observed change in heavy precipitation
Increase (19)
Decrease (0)
Low agreement in the type of change (8)
Limited data and/or literature (18)
Confidence in human contribution to the observed change
●●● High
●● Medium
● Low due to limited agreement
○ Low due to limited evidence
Type of observed change since the 1950s


And increasing granularity of future projections…
Mean surface temperature and Extreme heat:
• High confidence of increase across Asia
Projection refers to a 20-30 year period centered around 2050 with 2°C global warming
Source: IPCC WGI Interactive Atlas
https://interactive-atlas.ipcc.ch/regional-synthesis


And increasing granularity of future projections…
Mean precipitation:
• High confidence of increase in East Asia and South Asia
• Medium confidence of increase in SE Asia
Projection refers to a 20-30 year period centered around 2050 with 2°C global warming
Source: IPCC WGI Interactive Atlas
https://interactive-atlas.ipcc.ch/regional-synthesis


And increasing granularity of future projections…
River flood:
• Medium confidence of increase across Asia
Projection refers to a 20-30 year period centered around 2050 with 2°C global warming
Source: IPCC WGI Interactive Atlas
https://interactive-atlas.ipcc.ch/regional-synthesis

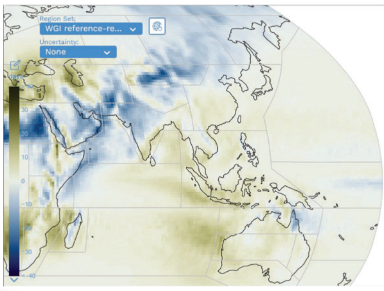

And increasing granularity of future projections…
Heavy precipitation and pluvial flood:
• High confidence of increase across Asia
Projection refers to a 20-30 year period centered around 2050 with 2°C global warming
Source: IPCC WGI Interactive Atlas
https://interactive-atlas.ipcc.ch/regional-synthesis

And increasing granularity of future projections…

Consecutive dry days (change):

- Increase across many parts of Asia

Projection refers to the 2041-2060 period under the RPC 8.5 scenario

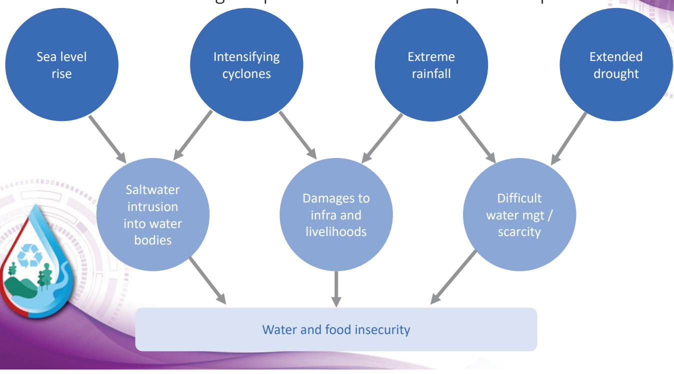


Source: IPCC WGI Interactive Atlas
https://interactive-atlas.ipcc.ch/regional-synthesis

A summary of projected climate parameters

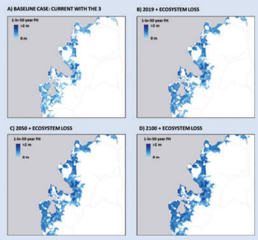
- Overall rainfall is expected to increase across Asia
- However, it is still uncertain whether this means lower risks of hydrological and agricultural droughts
- Extreme weathers are more likely (heavy rain, heat waves, dry days) which are expected to give rise to various disaster events
- It is still possible that some parts of Asia experience agricultural droughts while receiving higher annual rainfall

Transmission of climate change impact to human development impact

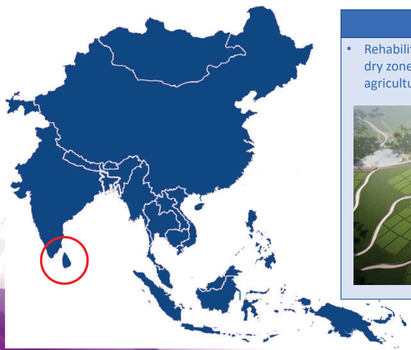


Philippines

- Provision of **crop insurance** to support farmers against rainfall variability (Mindanao)
- Using **ecosystem-based coastal management** to raise resilience to typhoons in the eastern provinces



Flood height with and without coastal ecosystems (in a 1-in-50 flood)

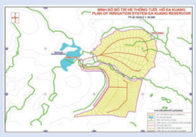


Sri Lanka

- Rehabilitation of ancient water cascades in the central dry zone of the country + introduction of climate resilient agriculture

Viet Nam

- Extension of "last-mile" irrigation connections to vulnerable and ethnic minority farmers + upgrading communal ponds for rainfed farmers



Myanmar

- Integrated rural water management:
  - Rehabilitation of degraded watersheds
  - Construction of community irrigation channels and ponds
  - Climate resilient agriculture

Lessons learned from UNDP's experience

- There is no "one size fits all" solution
- There are multiple channels of support:
  - Central ministry's planning and expenditure
  - Local administration's planning and expenditure
  - Through supporting NGOs, CSOs and other community groups
- Resilience cannot be built if communities are not empowered; communities cannot be empowered if they are not engaged; communities cannot be engaged if they are not informed

Recommendations for private sector entities

- Different actions depending on the readiness of the company and the sector that it is operating in.
- First – Raise awareness about your company's operation
  - What is the environmental footprint of the company's operations?
  - What are negative externalities that can be internalized?
  - Who are engaged in its supply chains and are they made vulnerable because of climate change?
  - Where, along the supply chain, can you reduce emissions or build resilience?

Recommendations – Cont'd

- Second – Know what others are doing
  - Glasgow Financial Alliance for Net Zero (GFANZ) (www.gfanzero.com)
  - ESG information disclosure (e.g. WBCSD ESG Disclosure Handbook)
  - UN Guiding Principles on Business and Human Rights (www.business-humanrights.org)
- Lastly, read the Agenda 2030 (it's only 35 pages!)

International Water Management Institute

THA 2022 International Conference

Bundled solutions for climate risk management

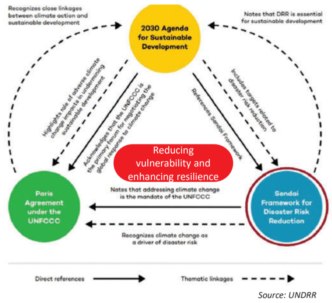
26 Jan 2022

Giriraj Amarnath, Ph.D.
Research Group Leader: Water Risks to Development and Resilience

Presentation outline

- Understanding risk and investing in resilience
- Water risk knowledge products and tools
- Climate risk insurance

Integrating adaptation into sustainable development and Sendai framework for Disaster Risk Reduction

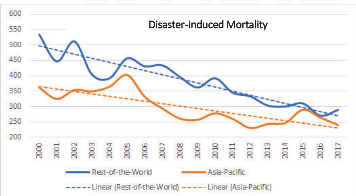


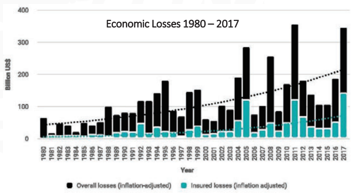
Source: UNDRR

Trends in disaster impact in Asia and the Pacific

Decreasing mortality; increasing economic losses

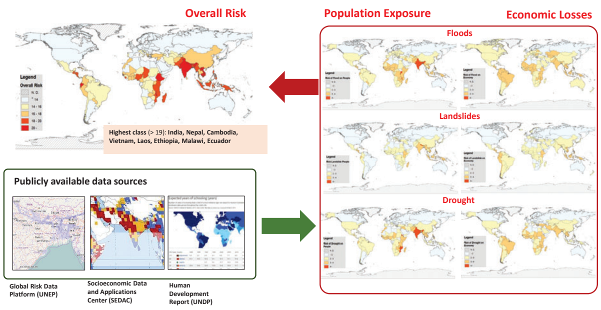
- Decrease in mortality
- Disaster losses are outpacing the region's economic growth
- Annual economic losses stand at US$675 billion, or 2.4% of the region's GDP (including drought impact)





Source: UNDRR, ESCAP, EMDAT

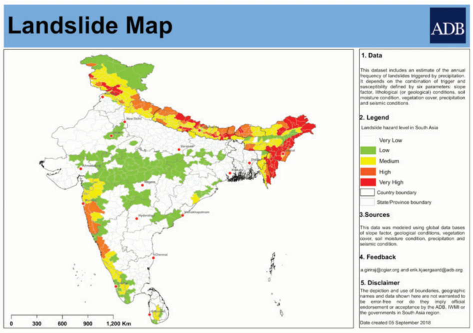
Mapping global water-related disaster risk



Amarnath G, Yoshimoto S, Goto K, Fujihara M, Smakhtin V, Aggarwal P, Ravan S. 2016. Global trends in water-related disasters using publicly available database for hazard and risk assessment, Congress of JRCSA 2016, held in Kyoto, Japan.

Amarnath, G.; Alahacoon, N.; Smakhtin, V.; Aggarwal, P. 2017. Mapping multiple climate-related hazards in South Asia. IWMI Research Report 170, 41p. doi: 10.5337/2017.207

Climate Screening products for investing in disaster resilience

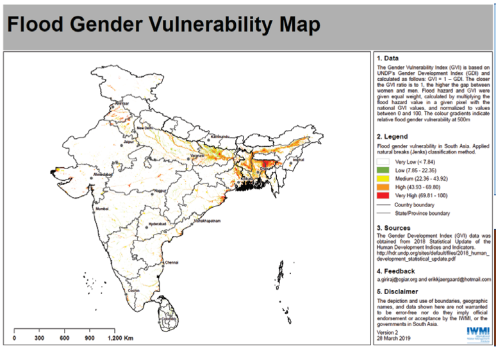


Digital atlas will be published in 2021

Source: IWMI

- Mapping individual hazards (Flood, Drought, Landslides, Coastal inundation, Cyclone, Forest fires, Earthquake, Extreme rainfall, Heatwaves and Sea level rise);
- Multi-hazard Risk filters to support in developing DRM policies and financial investment portfolio for building resilience

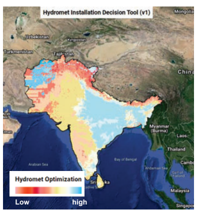
Climate Screening products for investing in disaster resilience

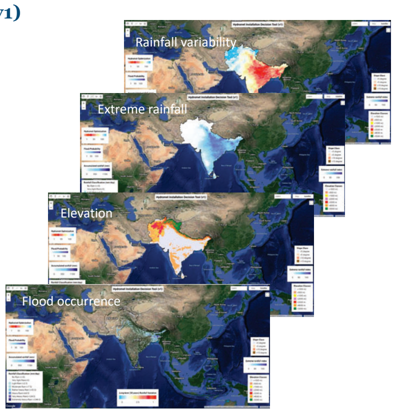


Geospatial Intelligence Analysis

Multi-hazard Data
+
Population Exposure, Gender Risk
+
Gross Domestic Product (GDP)
+
Historical loss and event database
=
Multi-hazard Economic Exposure and gender-risk maps can guide DRM policy and Sustainable climate Finance

Hydromet optimization tool (v1)





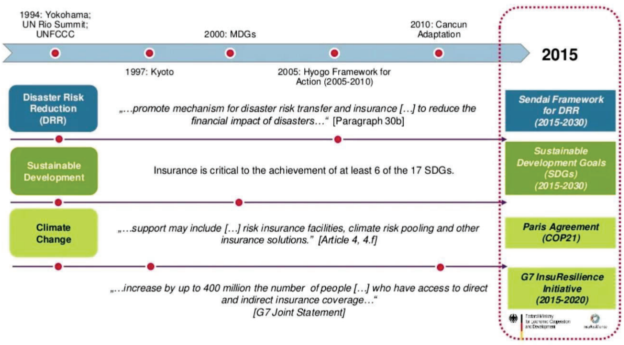
- Guide the process of impactful investments in hydromet and early warning services;
- Digital data solutions can help in optimizing the hydromet operations to strengthen hydrological simulations to manage disaster risks;

https://wrd_iwmi.users.earthengine.app/view/hydromet

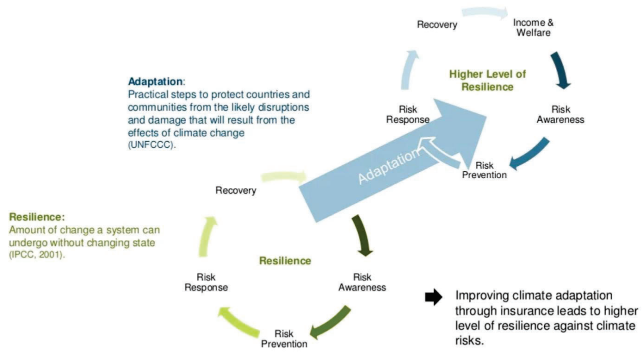
The Role of Insurance in Climate Adaptation

- How can insurance improve adaptation and increase resilience?
- When is insurance the right instrument for adaptation?
- How to make the agricultural sector more resilient to climate risks?

Growing importance of insurance



How can insurance improve adaptation and increase resilience?



How to make the agricultural sector more resilient to climate risks?

Who bears climate risks?	What kind of risks?	Insurance solutions
Governments	› human losses › costs for disaster response › damages of public infra-structure and buildings › development setbacks	Macro-level insurance: › index-based climate risk insurance (e.g. ARC) › Cat-bonds etc.
Agricultural service providers	› loss of income and profits › damage of assets › credit failures › bankruptcy	Meso-level insurance: › bundled insurance products › index-based insurance, etc.
Farmers / pastoralists	› income losses and reduced consumption › asset losses › persistent poverty	Micro-level insurance: › harvest/livestock insurance › index-based/indemnity-based insurance etc.

➡ Insurance solutions at all levels are crucial to increase resilience of the agricultural sector.

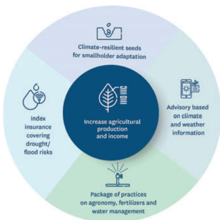
The Issues

- Weather risk remains a major challenge to farming in the South Asia;
- A large fraction of rural households in South Asia were affected by drought and floods;
- Rainfed agriculture exposes farmers to huge risks in the lack of bundled solutions
- Climate shocks had a significant impact on the short and long-term welfare of households:
  - lower adoption of agricultural inputs that would help increase productivity
  - lower affordable credit access
  - lower technology adoption
  - lower risk bearing and or income generation capacity

Inter-cropping on the flood plains of river Bagmati, in Muzaffarpur, Bihar, India

Bundling insurance with other services

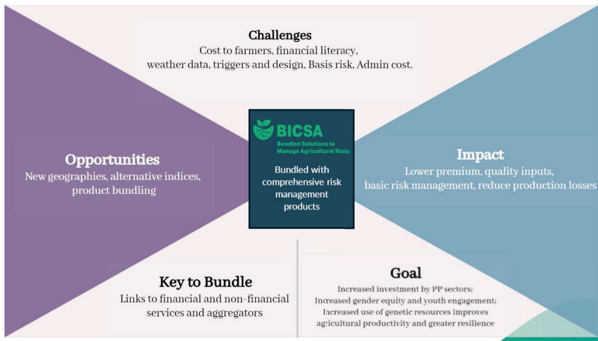
- IWMI and its partners offers
  - Weather based weather insurance with
    - Seed inputs
    - Weather forecast and
    - agriculture advisory services provided to insured farmers
    - Grain procurement
    - Credit link (sooner)



Source: IWMI

BICSA
Bundled Solutions to Manage Agricultural Risks

How it works



Source: IWMI

BICSA at a glance

*An **integrated one-stop-shop service delivery model** for smallholder farmers in Sri Lanka*

*Provides **climate smart solutions** for raining access to agricultural inputs, weather data and agronomic advisory services*

***Digitally enabled** through the use of satellite technology and mobile services*

*Provide insurance to farmers and includes them in the **agricultural value chain** from the provision of seeds to gaining access to markets*

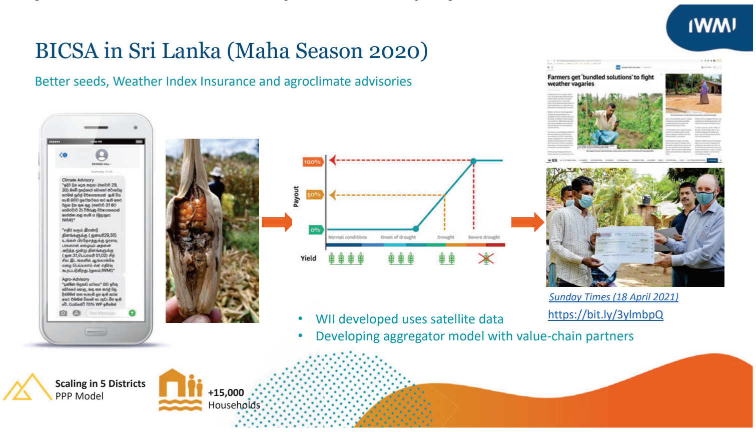
***Overcome challenges** such as access to finance, low purchasing power, low incomes, price instability and access to market.*

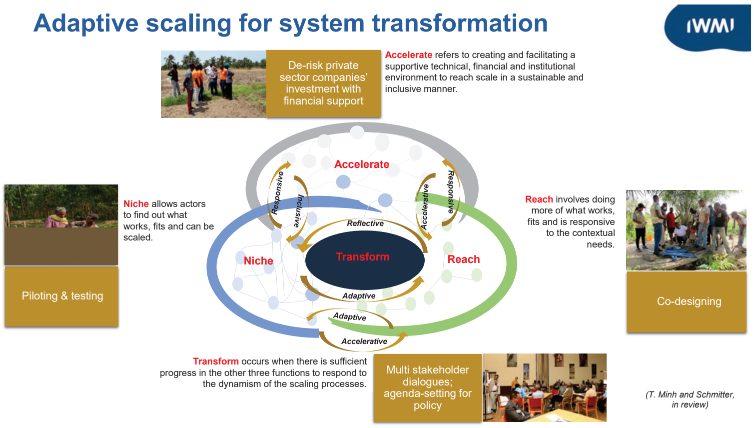
*Additionally, the model provides a **commercially sustainable and scalable solution** for government, development and private actors.*

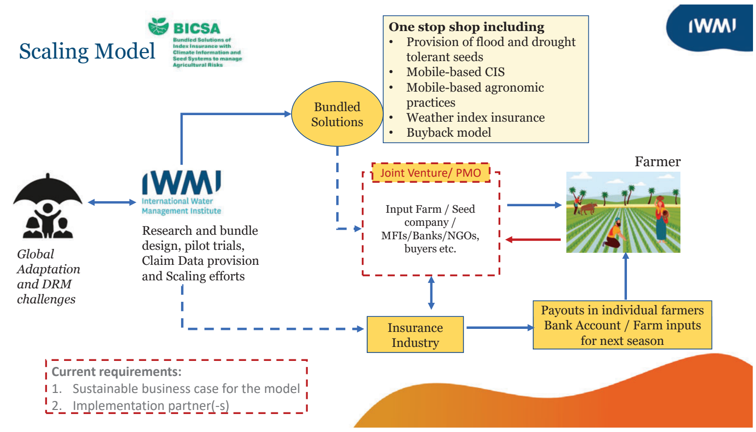
BICSA Implementation

- ✓ 9 steps guiding principles
- ✓ Innovative approaches such as using new technologies or satellite-based indices
- ✓ Improve weather data infrastructure and data systems
- ✓ Support development of sound national rural risk management strategies
- ✓ Educate farmers on the role of insurance
- ✓ Support regular monitoring, evaluation and impact studies


BICSA in India
Better seeds, Weather Index Insurance and agroclimate advisories
https://www.iwmi.cgiar.org/2019/09/solutions-for-those-managing-risk-in-climate-disasters/
First integrated solutions to climate and production risks
Scaling up and Scaling down in agriculture value chain
Scaling in 3 States
PPP Model
+15,000
Households


BICSA in Sri Lanka (Maha Season 2020)
Better seeds, Weather Index Insurance and agroclimate advisories
Farmers get 'bundled solutions' to fight weather vagaries
Payout
Yield
Sunday Times (18 April 2021)
https://bit.ly/3ylmbpQ
WII developed uses satellite data
Developing aggregator model with value-chain partners
Scaling in 5 Districts
PPP Model
+15,000
Households

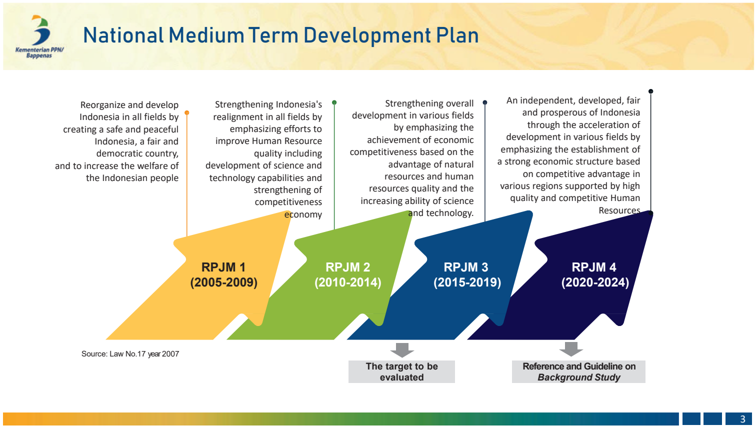

Adaptive scaling for system transformation
De-risk private sector companies' investment with financial support
Accelerate refers to creating and facilitating a supportive technical, financial and institutional environment to reach scale in a sustainable and inclusive manner.
Niche allows actors to find out what works, fits and can be scaled.
Piloting & testing
Accelerate
Responsive
Inclusive
Reflective
Transform
Niche
Reach
Adaptive
Accelerative
Reach involves doing more of what works, fits and is responsive to the contextual needs.
Co-designing
Transform occurs when there is sufficient progress in the other three functions to respond to the dynamism of the scaling processes.
Multi stakeholder dialogues; agenda-setting for policy
(T. Minh and Schmitter, in review)

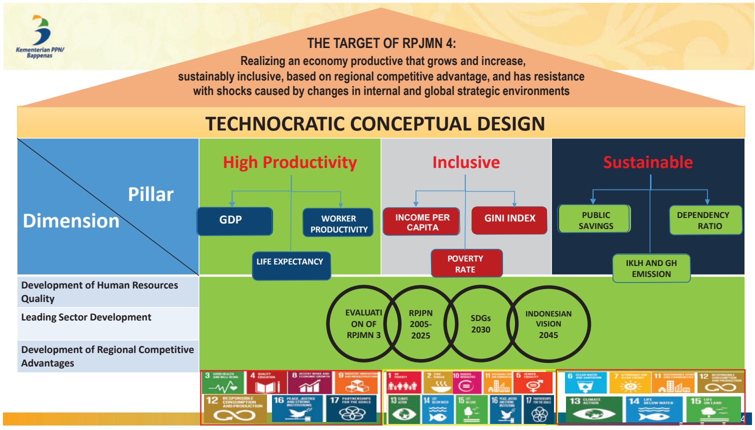

Scaling Model
BICSA
Bundled Solutions of Index Insurance with Climate Information and Seed Systems to manage Agricultural Risks
One stop shop including
Provision of flood and drought tolerant seeds
Mobile-based CIS
Mobile-based agronomic practices
Weather index insurance
Buyback model
Bundled Solutions
IWMI
International Water Management Institute
Research and bundle design, pilot trials, Claim Data provision and Scaling efforts
Global Adaptation and DRM challenges
Joint Venture/ PMO
Input Farm / Seed company / MFIs/Banks/NGOs, buyers etc.
Farmer
Insurance Industry
Payouts in individual farmers Bank Account / Farm inputs for next season
Current requirements:
1. Sustainable business case for the model
2. Implementation partner(-s)


International Water Management Institute
Thank you
Giriraj Amarnath
Email: a.giriraj@cgiar.org
Climate Change, Agriculture and Food Security
CCAFS
RESEARCH PROGRAM ON Water, Land and Ecosystems
CGIAR

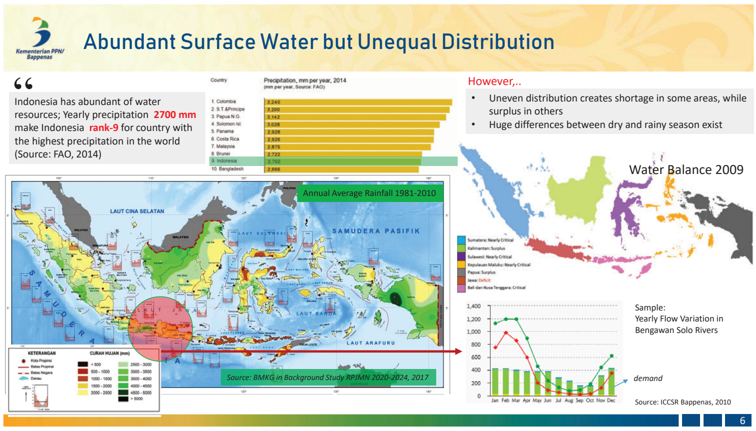

Kementerian PPN/ Bappenas
WATER MANAGEMENT IN INDONESIA
In
ASEAN Workshop on Water Management and Climate Change towards Asia's Water-Energy-Food Nexus and SDGs
Bangkok, January 23rd, 2019
Abdul Malik Sadat Idris, ST., M.Eng
Director of Irrigation and Water Resources
Ministry of National Development Planning / BAPPENAS

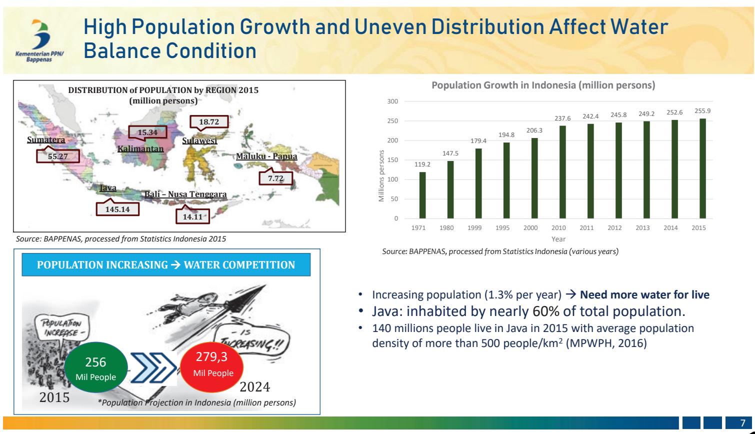

Outline
Introduction: National Medium Term Development Plan and Technocratic Process
Status and Challenges
7
Seven Quick Win for Integrated Water Resource Management
2

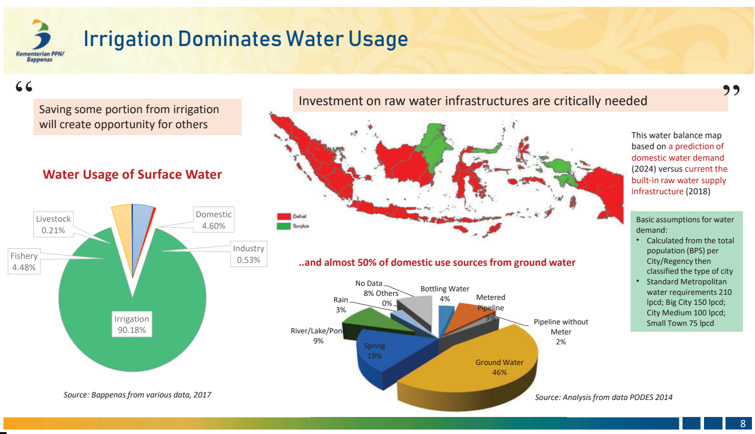

National Medium Term Development Plan
Reorganize and develop Indonesia in all fields by creating a safe and peaceful Indonesia, a fair and democratic country, and to increase the welfare of the Indonesian people
Strengthening Indonesia's realignment in all fields by emphasizing efforts to improve Human Resource quality including development of science and technology capabilities and strengthening of competitiveness economy
Strengthening overall development in various fields by emphasizing the achievement of economic competitiveness based on the advantage of natural resources and human resources quality and the increasing ability of science and technology.
An independent, developed, fair and prosperous of Indonesia through the acceleration of development in various fields by emphasizing the establishment of a strong economic structure based on competitive advantage in various regions supported by high quality and competitive Human Resources
RPJM 1 (2005-2009)
RPJM 2 (2010-2014)
RPJM 3 (2015-2019)
RPJM 4 (2020-2024)
Source: Law No.17 year 2007
The target to be evaluated
Reference and Guideline on Background Study
3

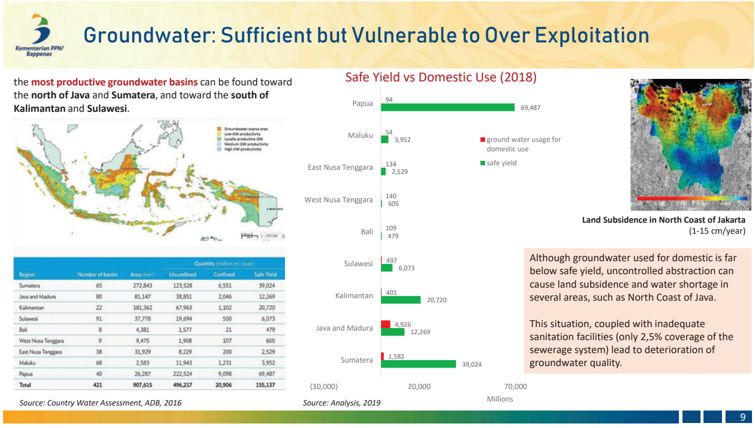

THE TARGET OF RPJMN 4:
Realizing an economy productive that grows and increase, sustainably inclusive, based on regional competitive advantage, and has resistance with shocks caused by changes in internal and global strategic environments
TECHNOCRATIC CONCEPTUAL DESIGN
Pillar
Dimension
High Productivity
Inclusive
Sustainable
GDP
WORKER PRODUCTIVITY
LIFE EXPECTANCY
INCOME PER CAPITA
GINI INDEX
POVERTY RATE
PUBLIC SAVINGS
DEPENDENCY RATIO
IKLH AND GH EMISSION
Development of Human Resources Quality
Leading Sector Development
Development of Regional Competitive Advantages
EVALUATION OF RPJMN 3
RPJPN 2005-2025
SDGs 2030
INDONESIAN VISION 2045


STATUS AND CHALLENGES OF WATER MANAGEMENT IN INDONESIA
5

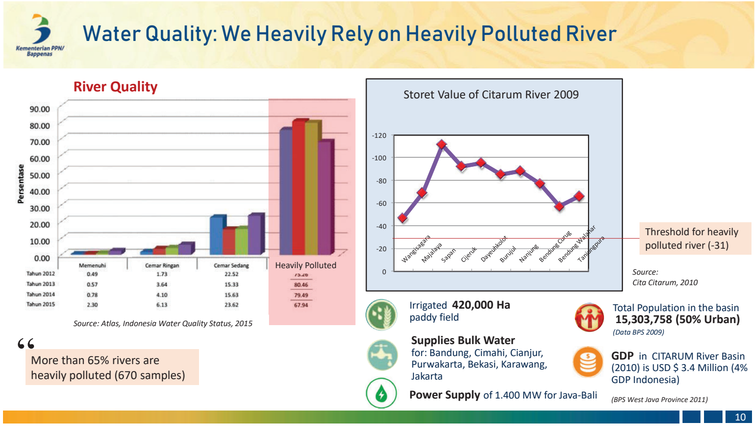

Abundant Surface Water but Unequal Distribution
Indonesia has abundant of water resources; Yearly precipitation 2700 mm make Indonesia rank-9 for country with the highest precipitation in the world (Source: FAO, 2014)
However,..
Uneven distribution creates shortage in some areas, while surplus in others
Huge differences between dry and rainy season exist
Water Balance 2009
Annual Average Rainfall 1981-2010
Source: BMKG in Background Study RPJMN 2020-2024, 2017
Sample: Yearly Flow Variation in Bengawan Solo Rivers
demand
Source: ICCSR Bappenas, 2010
6

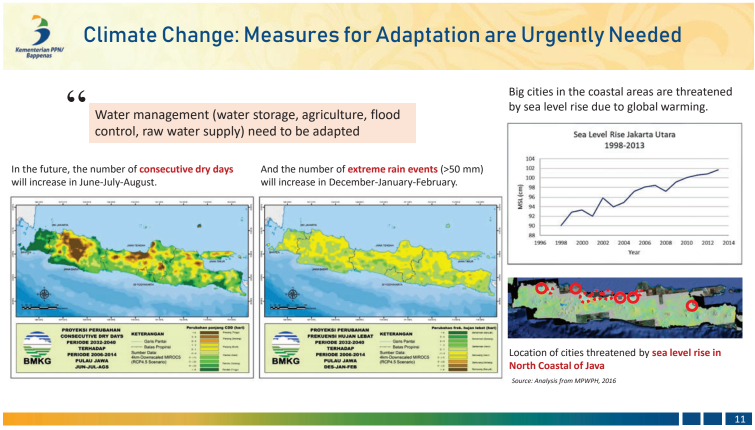

High Population Growth and Uneven Distribution Affect Water Balance Condition
DISTRIBUTION of POPULATION by REGION 2015 (million persons)
Sumatera 55.27
Kalimantan 15.34
Sulawesi 18.72
Maluku - Papua 7.72
Jawa 145.14
Bali - Nusa Tenggara 14.11
Source: BAPPENAS, processed from Statistics Indonesia 2015
Population Growth in Indonesia (million persons)
119.2
147.5
179.4
194.8
206.3
237.6
242.4
245.8
249.2
252.6
255.9
1971 1980 1990 1995 2000 2010 2011 2012 2013 2014 2015
Year
Source: BAPPENAS, processed from Statistics Indonesia (various years)
POPULATION INCREASING → WATER COMPETITION
256 Mil People
2015
279,3 Mil People
2024
*Population Projection in Indonesia (million persons)
Increasing population (1.3% per year) → Need more water for live
Java: inhabited by nearly 60% of total population.
140 millions people live in Java in 2015 with average population density of more than 500 people/km² (MPWPH, 2016)
7

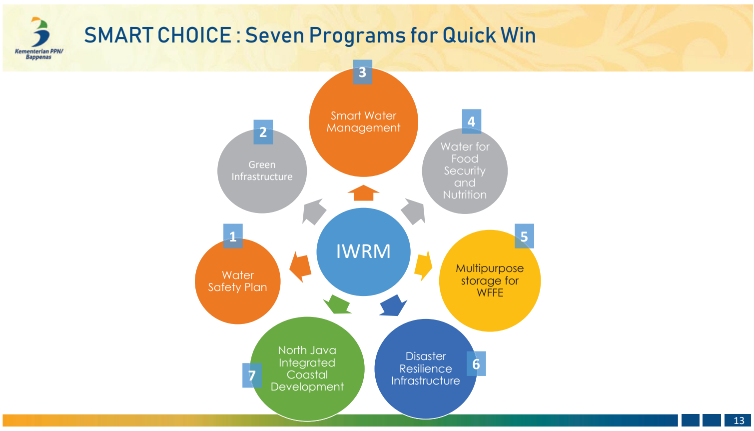

Irrigation Dominates Water Usage
Saving some portion from irrigation will create opportunity for others
Investment on raw water infrastructures are critically needed
Water Usage of Surface Water
Livestock 0.21%
Domestic 4.60%
Industry 0.53%
Fishery 4.48%
Irrigation 90.18%
Source: Bappenas from various data, 2017
This water balance map based on a prediction of domestic water demand (2024) versus current the built-in raw water supply infrastructure (2018)
..and almost 50% of domestic use sources from ground water
No Data 0%
Bottling Water 4%
Others 8%
Rain 3%
Metered Pipeline
River/Lake/Pond 9%
Spring 19%
Pipeline without Meter 2%
Ground Water 46%
Source: Analysis from data PODES 2014
8

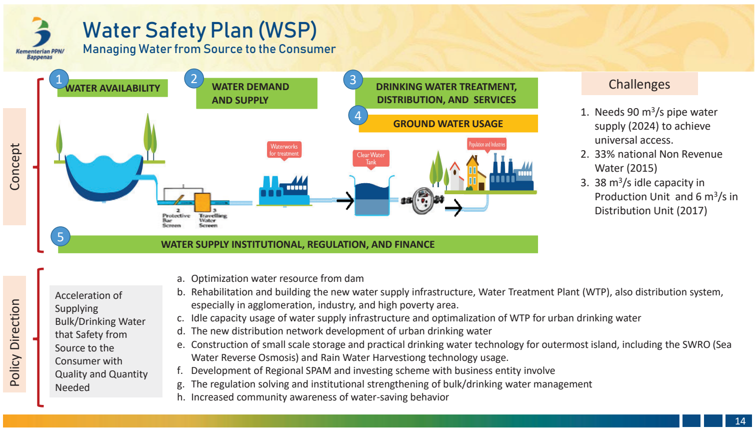


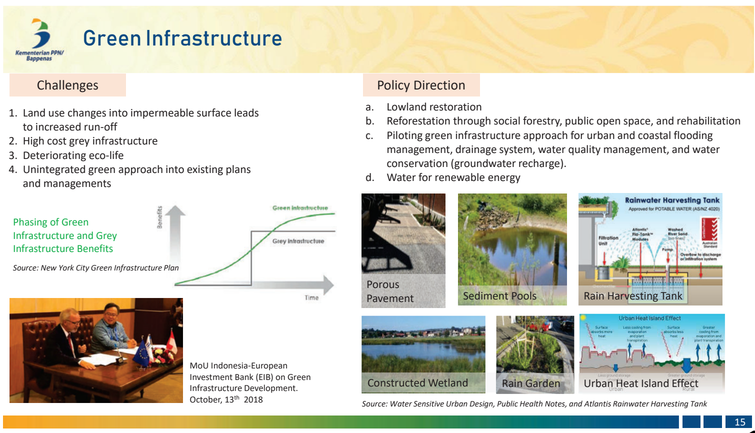
Region	Number of basins	Area (km²)	Quantity (million m³/year) Unconfined	Confined	Safe Yield
Sumatera	65	272,843	123,528	6,551	39,024
Java and Madura	80	81,147	38,851	2,046	12,269
Kalimantan	22	181,362	67,963	1,102	20,720
Sulawesi	91	37,778	19,694	550	6,073
Bali	8	4,381	1,577	21	479
West Nusa Tenggara	9	9,475	1,908	107	605
East Nusa Tenggara	38	31,929	8,229	200	2,529
Maluku	68	2,583	11,943	1,231	3,952
Papua	40	26,287	222,524	9,098	69,487
Total	**421**	**907,615**	**496,217**	**20,906**	**155,137**

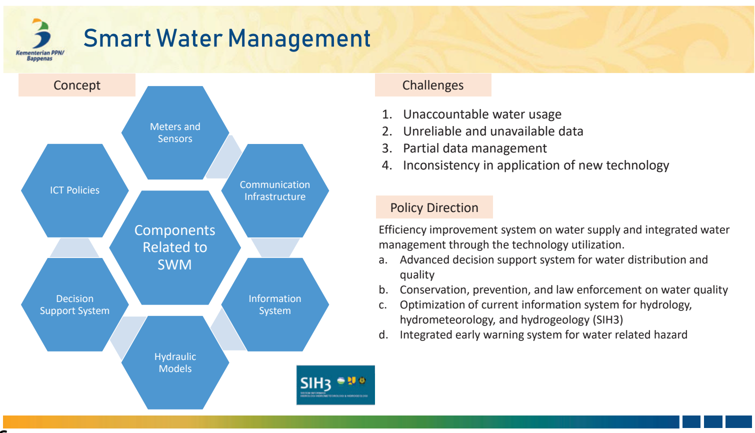


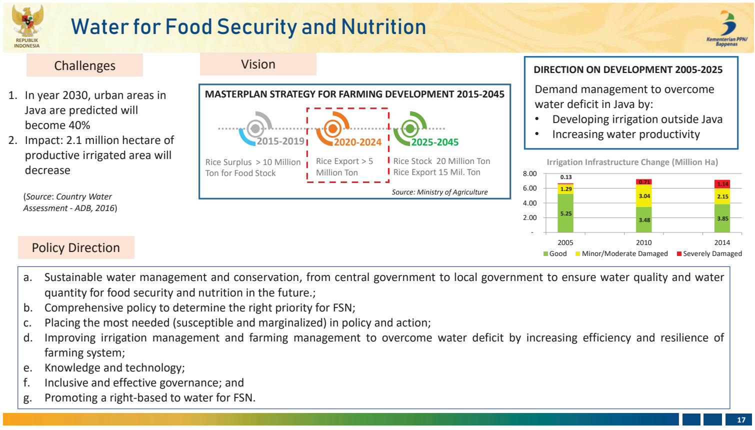


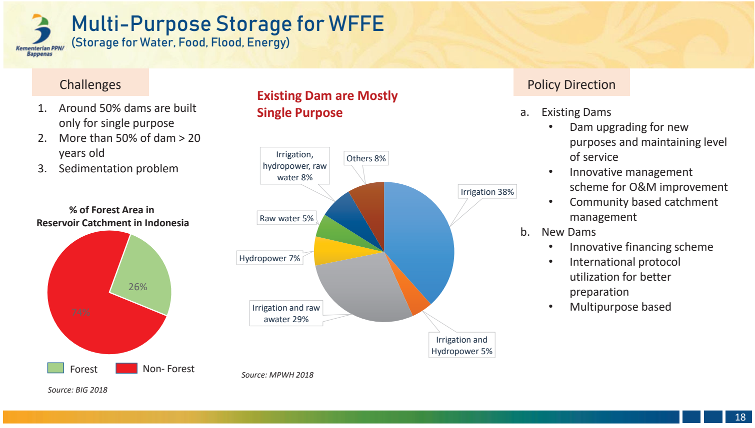


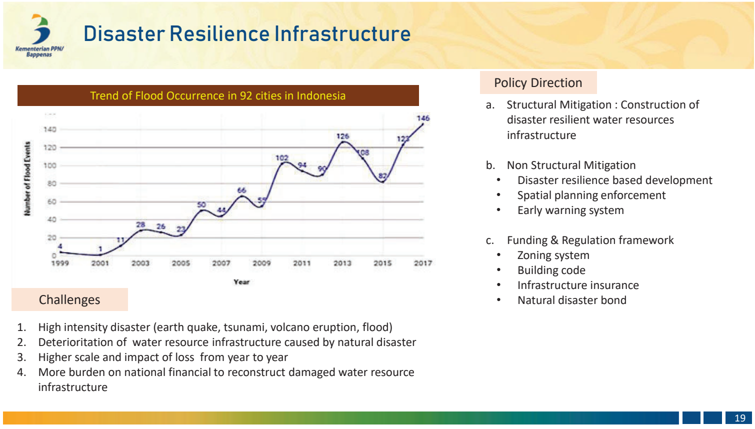


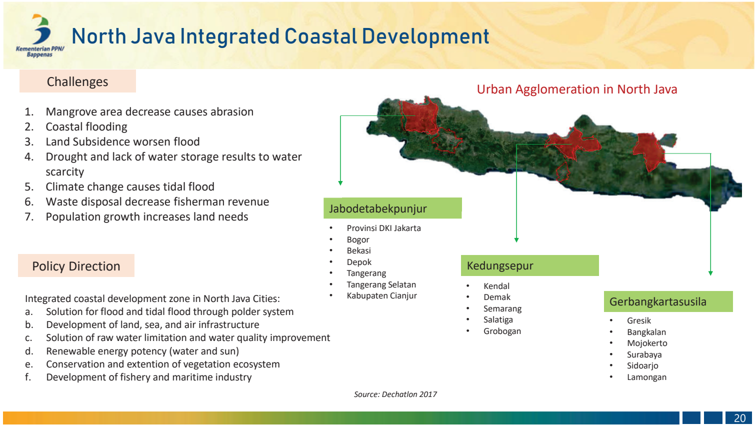


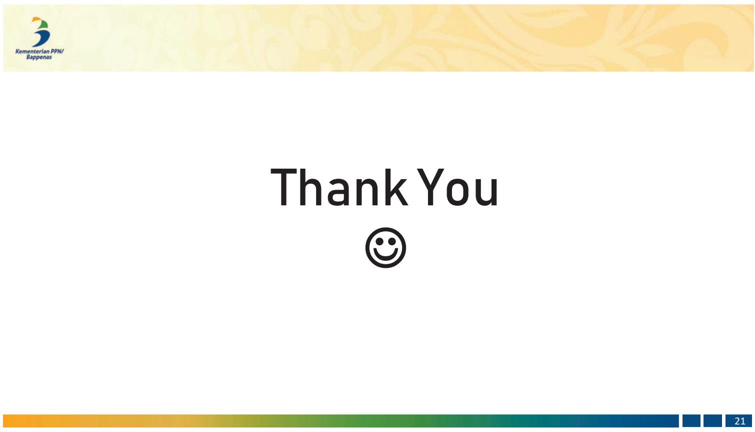



Water for Food Security and Nutrition
Challenges
1. In year 2030, urban areas in Java are predicted will become 40%
2. Impact: 2.1 million hectare of productive irrigated area will decrease
(Source: Country Water Assessment - ADB, 2016)
Vision
MASTERPLAN STRATEGY FOR FARMING DEVELOPMENT 2015-2045
2015-2019
2020-2024
2025-2045
Rice Surplus > 10 Million Ton for Food Stock
Rice Export > 5 Million Ton
Rice Stock 20 Million Ton
Rice Export 15 Mil. Ton
Source: Ministry of Agriculture
DIRECTION ON DEVELOPMENT 2005-2025
Demand management to overcome water deficit in Java by:
• Developing irrigation outside Java
• Increasing water productivity
Irrigation Infrastructure Change (Million Ha)
Good
Minor/Moderate Damaged
Severely Damaged
Policy Direction
a. Sustainable water management and conservation, from central government to local government to ensure water quality and water quantity for food security and nutrition in the future.;
b. Comprehensive policy to determine the right priority for FSN;
c. Placing the most needed (susceptible and marginalized) in policy and action;
d. Improving irrigation management and farming management to overcome water deficit by increasing efficiency and resilience of farming system;
e. Knowledge and technology;
f. Inclusive and effective governance; and
g. Promoting a right-based to water for FSN.
17


Multi-Purpose Storage for WFFE
(Storage for Water, Food, Flood, Energy)
Challenges
1. Around 50% dams are built only for single purpose
2. More than 50% of dam > 20 years old
3. Sedimentation problem
% of Forest Area in Reservoir Catchment in Indonesia
26%
Forest
Non- Forest
Source: BIG 2018
Existing Dam are Mostly Single Purpose
Irrigation, hydropower, raw water 8%
Others 8%
Irrigation 38%
Raw water 5%
Hydropower 7%
Irrigation and raw awater 29%
Irrigation and Hydropower 5%
Source: MPWH 2018
Policy Direction
a. Existing Dams
• Dam upgrading for new purposes and maintaining level of service
• Innovative management scheme for O&M improvement
• Community based catchment management
b. New Dams
• Innovative financing scheme
• International protocol utilization for better preparation
• Multipurpose based
18


Disaster Resilience Infrastructure
Trend of Flood Occurrence in 92 cities in Indonesia
Number of Flood Events
Year
Challenges
1. High intensity disaster (earth quake, tsunami, volcano eruption, flood)
2. Deterioritation of water resource infrastructure caused by natural disaster
3. Higher scale and impact of loss from year to year
4. More burden on national financial to reconstruct damaged water resource infrastructure
Policy Direction
a. Structural Mitigation : Construction of disaster resilient water resources infrastructure
b. Non Structural Mitigation
• Disaster resilience based development
• Spatial planning enforcement
• Early warning system
c. Funding & Regulation framework
• Zoning system
• Building code
• Infrastructure insurance
• Natural disaster bond
19


North Java Integrated Coastal Development
Challenges
1. Mangrove area decrease causes abrasion
2. Coastal flooding
3. Land Subsidence worsen flood
4. Drought and lack of water storage results to water scarcity
5. Climate change causes tidal flood
6. Waste disposal decrease fisherman revenue
7. Population growth increases land needs
Policy Direction
Integrated coastal development zone in North Java Cities:
a. Solution for flood and tidal flood through polder system
b. Development of land, sea, and air infrastructure
c. Solution of raw water limitation and water quality improvement
d. Renewable energy potency (water and sun)
e. Conservation and extention of vegetation ecosystem
f. Development of fishery and maritime industry
Urban Agglomeration in North Java
Jabodetabekpunjur
• Provinsi DKI Jakarta
• Bogor
• Bekasi
• Depok
• Tangerang
• Tangerang Selatan
• Kabupaten Cianjur
Kedungsepur
• Kendal
• Demak
• Semarang
• Salatiga
• Grobogan
Gerbangkartasusila
• Gresik
• Bangkalan
• Mojokerto
• Surabaya
• Sidoarjo
• Lamongan
Source: Dechatlon 2017
20


Thank You
☺
21

SESSION A2 :
WATER MANAGEMENT AND CLIMATE CHANGE

Session A2: Water Management and Climate Change

1. Prof. Dr. Tainan Oki, University of Tokyo

Dr. Oki started the session by introducing himself and give introductory of his background. He continued by explaining about his project ADAP-T (03:23). ADAP-T is a research framework about impact assessment and adaptation to climate change. It focuses in 4 major sectors : Freshwater, Coastal, Sediment, and Rural. The adaptation measure is aimed to work together with the Thailand side and the stakeholder/policy maker in government and citizens in targeted areas, and this project aims to show the cost & benefit of the adaptation on those major sectors.

The project also comes up with the methodology for well balanced adaptation portfolio that do a Meta-analysis considering financial and other metrics related to the sectors. And the activity should support the Co-design for the good practice. Which support policy making for national master plans, integrated with adaptation by various stakeholders. And have a good practice/prototyping of the adaptation to climate change that will further be refined and disseminated in neighboring states.

The study area of the ADAP-T distributes in a few regions. For Sediment area is located in Chiang rai, for Freshwater and Forest in Nan, For Rural area in Khon Khaen, for Urban area in Bangkok, and Coastal area in Narathiwat.

The speaker furthermore talked that there are currently 19 research groups under JICA: ADAP-T program mainly focuses in Adaptation options, and Risk Maps. One of the examples of the research that is presented is about: Shallow Ground Water Mapping for Agricultural use (07:19) by Dr. Dessel Suanburi (Kasetsart Univ.) & Dr Koshi Yoshida (UTokyo). In the scenario of severe drought, shallow ground water (SGW) is the only source of water for upland farmers. The supplemental use of SGW (not main source of irrigation) is recommended to avoid the risk of over pumping. The research also shows that effective use of SGW can contribute to more benefit for farmers.

Drought Monitoring Platform (08:33) is the next research that is talked about by Dr. Mingkol Raksapatcharawong (Kasetsart Univ.) and Dr. Kazuo Oki (UTokyo). Unfortunately, the systems are not working now but the evaluation of the drought (wet) conditions using satellite images and the estimation of rice yield by a simulation model is combined to produce a drought risk evaluated by indices (SPI, SDT, DSI) in semi-real time. This will provide people with the information of upcoming drought and let them prepare in the coming few weeks.

The next research is by Dr. Sutissak Soralump (Kasetsart Univ.) and Dr. So Kazama (Tohoku Univ.) titled Adaptation to landslide risk (08:54). It is about risk-based design level and adaptation approaches for mitigation impacts from landslide/slope failure/sedimentation. This research also develops and install community-based landslide warning system and tools and had intense workshop or the community to make sure the community are aware of the climate change impact to landslide and also how to adapt for it and that disaster risk reduction should be the key to adaptation of climate change.

Next, a research entitled by "Impact of Climate and land use changes on flood discharge" (09:57) by Dr. Koichiro Kuraji (UTokyo) and Dr. Wanchai Arunpraparut (Kasetsart Univ.) was introduced. This research assesses the quantitative prediction of impacts of climate and land use changes on flood discharge in forest area. This research developed a scenario of which area could transfer between forest or farming land (or other related area in the research). It is estimated due to the economic demands, the change of the landscape will occur where the farmland would increase and replacing the forest. The research also showed the prediction model of the 10 years flood runoff based on this scenario and what would happen for the flood discharge based on the levels of the land use forest cover ratio.

Adaptation to sea level rise in coastal zone (11:46) is the next research that is talked about. This research is done by Dr. Sompratana Rithphring (Kasetsart Univ.) and Dr. Keiko Udo (Tohoku Univ.) This research observes the current beach conditions at 133 locations, and observe coastal erosion and examine counter measures and how much volume of sand for beach nourishment and the cost of it. Not just in the academic side of the surveillance and research, this team also interviewed 48 villagers living in the coastal zone about climate change, coastal disaster, and erosion problems. And they also held workshop for capacity development targeting the stakeholders.

Dr. Hiroaki Shirakawa (Nagoya Univ.) and Dr. Weerakaset Suanpaga (Kasetsart Univ.) developed a web application (12:46), which resulted in interactive tool for evidence-based policy making. It's showed the map with cost & benefit of adaptation in major sectors for supporting making decision well-balanced adaptation portfolio. All these research and activities are now compiled into 1 comprehensive results of ADAP-T that are delivered to NAP. And it will be approved by cabinet in 2022.

Summary (14:06), it is important to gather and share the adaptation counter measures and its related information to develop good practice. And collaboration between stakeholders is important, localizing activities are also important on the targeted area. The involvement of the young generation is the key to success for the future.

2. Dr. Klaus Schmitt, Ecosystem-based Adaptation, a Nature based Solution for Flood Protection and Water Provision in River Basins

Destruction of forest and wetlands & conversions to other forms of land-use are a major contribution to flooding in the low-lying areas of river basins. This is worsened by the impacts of climate change, and to address this, Nature-based solutions (NbS) offer cost effective adaptation options and co-benefits including biodiversity conservation and human wellbeing. If these solutions focus on human adaptation and assure livelihood benefits are implemented as part of a climate adaptation strategy, they are called Ecosystem-based-Adaptation (EbA) . This required the participation of the local people in an integrated approach for adapatation strategies to avoid path dependencies and maladaptation's.

The unsustainable use of natural resources & development in the coastal zone are threatening the protection function of the mangrove forest belt. The resulting erosion and destruction of the mangrove belt leads to dyke failure, overtopping and flooding. This is why the Flood Protection in this case in the muddy coast with Mangroves (18:05) are crucial. The whole tidal flats and mangrove are an "energy conversion system" that is very effective nature-based system for coastal protection. The speaker shown an illustrated figure to emphasize this problem.

Restoration of floodplains/tidal flats is a precondition for mangrove rehabilitation in sites where erosion has destroyed the mangroves and eroded the foreshore. The best solution for this problem is T-Shaped, permeable bamboo fences. This will minimize the erosion and effective on reducing it, stimulate sedimentation therefore restore floodplains and recreates conditions for mangrove regeneration. The design, technical specifications and placement of T-Fences required a sound understanding of site-specific coastal processes (wind, waves, currents), sediment transport, morphodynamics, hydrology and coastal dynamic. Th specific conditions that are mentioned are then tested in the laboratory to try to recreate the closest environment to see the effectiveness of the T-Fences, then design option was tested and implemented based on certain scenarios.

EbA and Integrated Water Resources Management (IWRM) .

Water availability in adequate quality is highly dependent on healthy ecosystems and their provisioning functions and services; Healthy ecosystems also reduced water related risk. IWRM should put more emphasis on promoting the ability and strengths if healthy ecosystems to reduce vulnerabilities to climate change in watersheds/river basins. Integrating the concepts and approaches of EbA and IWRM could support the mainstreaming of climate change adaptation and risk management into IWRM. EbA measures should be a part of (forest and comprehensive) land-use planning and integrated into river basin wide plans as participatory approaches to conservation and developments.

The speaker ends the session by listing the conclusion of the presentation in forms of summaries (29:30), similar to the summaries written here.

3. Prof. Dr. Sangam Shrestha, AIT
Research priority of SDG 6 under climate change scenario

SDG 6 (33:43) is an initiative for sustainable development goals to ensure clean water and sanitation for all by 2030 that consist of 6 targets. On 2021 the UN released a report on the progress of this project, and the worlds is not on track on the target (34:36) shown by 26% of the worlds population still lacked safely managed drinking water on 2020. There are also 2.3 billion people live in water-stressed countries of which 733 million live in high and critically water-stressed countries most of which located in Asia pacific region and African region. The Integrated Water Management system also needs to be doubled in terms of the current rate of progress globally. The report from UN also shows that only 24 countries reported that all rivers, lakes, and aquifers that they share with their neighbors are covered by operational arrangements for cooperation.

Climate Change & water : Facing the Facts

The speaker talks about how Climate change impact on water affects the Socio-economic vulnerability. And this affected major economic related area such as Energy, Agriculture, Water, and wealth. Furthermore the impact can be divided into two which is Primary Impact and Secondary Impact. It is shown in the illustration on the presentation of the speaker and which sub-sector affected by climate change impact. Then the speaker shows the global demographic of climate change impact on water & socioeconomic vulnerability based on the region. As an example in Brazil, Groundwater recharge decreases by more than 70% by the 2050s, Electricity production potential at existing hydropower stations decreases by more than 25% by the 2070s in Europe.

One of the focuses on the research area is related to Monitoring and Prediction of climate change (42:40). These can be done through the research area : Use of ICTs, AI & Big Data, GCMs/RCMs. But there are still a lot of uncertainties in the climate change impact and assessment. This come from various sources an example would be the data that is used come from Global Climate Models (GCMs) in the global scale, and it will be down scaled into appropriate methods based on the needs before scaled down again for regional & local scale variables. Therefore the research priorities should focus on the what are the sources of uncertainties, how to quantify the source of uncertainties, and how to reduce the uncertainties in impact assessment and adaptation. Another research area is the importance of Climate change to Water-Energy-Food Nexus.

Adaptation to Climate Change. Adaption pathways is a planning approach that addresses the uncertainties and also the challenges on climate changes decision making. It takes inti account multiple outcomes of the future and also the action-relative cost that is appropriate for each pathways.

As the closing remark, the speaker emphasize on the climate change is the major stressor to SDG 6, the research priorities should focus on multiscale nature of impact and adaptation, Accelerating adaptation is urgent to reduce water insecurity.

4. Ir. Mohd. Zaki b. Mat Amin
Enhancing Water Management Towards Future Climate in Malaysia-

Climate variability and Climate Change can result in excessive water or water scarcity. The impacts to the environment can be seen in the form of increased flood, erosion, frequency of droughts, etc. The speaker then shows the floods in Peninsular Malaysia on December 2021 as an example of the disaster resulted from climate change. There are 5 components (55:45) that need~~s~~ to be improved on the water sector, the first sector is the Governance, 2nd is the People, 3rd is improvement on Infrastructure, 4th is on the Information sector and 5th is on the Finance sector.

To enhance the water sector in Malaysia, there are 2 problem statements.. There are either too much water or too little water, and the 2nd problem is that Malaysia is rich in water resources yet it is not capitalized as compared to energy sector. In the future, the water sector will be recognized and made more visible as a significant contributor to national growth, economically, socially and environmentally through the National Agenda on water sector transformation.

For this water sector transformation, there are Twin objectives, which are: Water security & sustainability, and Water as an economic opportunity. For the context of microplanning of the water sector, they are divided into ~~2~~ : (1) Planning for water resources & Services Management, (2) Planning for infrastructure Safety and Risk Reduction (resilience). This is in line with the 12th Malaysia Dev. Plan (2021-2025) (59:10). On Chapter 8, the goal is to increase the resilience against climate change and on chapter 9, it focuses on transforming the water sector by accelerating the implementation of IWRM to achieve sustainable development goals.

Global Approach Managing Water

IWRM requires a cross-sectoral, multi-level approach as shown on the presentation on which important sectors are needed to cooperate in managing the water sector. There are 4 phases of water sector transformation (1:00:27) from 2020-2040 that have been formulated by the Malaysian government. A roadmap will be developed to outline strategies, initiatives and programs for each phase to ensure the success of the transformation. For the transformation of the water sector, there are 5 strategies (1:01:08), which are Empowering people, Strengthening Governance at All Levels, Enhancing Capability in Data-Driven Decision-Making, Ensuring Sustainable Financing, and Developing Sustainable Infrastructure with Cost-Effective Technology.

Based on the 5 sectors(1:02:04) that were mentioned in the beginning to improve the water sector, a dedicated task force will be established under the National Water Council to guide, coordinate, monitor, and report progress. Based on the 12th Malaysia Dev Plan (2021-2025) (1:02:17) there are 10 pillars under the water sector transformation, but the speaker wants to highlight on the Technology Adoption Pillars and the RDIC Pillars. For the Tech. Adoption, the Application of the 10-10 MySTIE Framework is proposed to the water sector, where there are 10 technologies application that will be connected to water supply lines using AI and IoT sensors for predictive maintenance, as well as Drought and flood forecasting for reservoir management and early disaster mitigation, and also AI & deep learning algorithms to monitor quality and predict future availability of transboundary water resources. For RDIC, the speaker shows the National Water Innovation Roadmap (2021-2040) (1:03:32), and there are 5 components which are: Clean River, Reserve Margin, Smart Water, Disaster Risk Reduction, and Water Finance.

Improving Climate Resilience

The speaker briefly explained the content of Paris Agreement : Updated Nationally Determined Contribution (NDC,2021). In terms of implementing a low carbon, clean & resilient development, the Malaysian Government had 4 strategies which is Moving towards a Low-Carbon Nation, Accelerating Transition to the Circular Economy, Sharing Responsibility in Pollution Prevention, and Increasing Resilience against Climate Change and Disasters. The Malaysian government also has the National

Adaptation Plan (NAP) that they hope to complete by 2025. The NAP 2025 is tailored to the NDC 2021, to overcome the barrier & to formulate, implement and monitor the NAP process in Malaysia. There are 4 outcomes that are expected from the NAP 2025 as shown in the presentation.

The climate change adaptation framework (1:06:20) aims to facilitate the formulation of sound policies and best practices that support sustainable water management. The framework also intended to serve as a resource for decision makers, and as a guide to develop NAP in sectors. There are 3 issues (1:06:45) identified in the Framework : 1. Water Resources, 2. Water Utilization, 3. Water related disasters. The speaker then elaborates there are strategies across the water sectors for these issues. There are 18 strategies for Water Resources, 20 for water utilization, and 11 for water related disaster.

The speaker further elaborates this example for the water resource and elaborates the scenario presented on his presentation regarding water resource management in the river. There are potential issues and impact, and how to handle the problem, the solution is elaborated in the slide. The speaker explains that in order to access the information for an appropriate plan, they can access a portal that have access to data such as Water Stress Index, Water Surplus-deficit, Water Yield, etc. (1:08:20).

Key Messages

There are 8 initiatives from the Malaysian government roadmap to transform the Water sectors as shown in the presentation. Overall, Malaysia is planning & implementing water management through IWRM towards future Climate change impact. Additionally, these sessions also mention about planning, improving & implementing water infrastructure safety & risk reduction for climate resilience, as well as Mainstreaming & Implementing Climate Change Adaptation initiatives through National Adaptation Plan (NAP & Malaysia Development Plan). Finally, water sector transformation implementation in Malaysia Development Plan has been mentioned.

THA 2022 International Conference on climate change
Moving Towards Sustainable Water and Climate Change Management After COVID-19, 26-28 January 2022, Online platform

Good practices of adaptation to climate change in six sectors in Thailand

Taikan Oki[1],
Masashi Kiguchi[1], & Taichi Tebakari[2]
[1]The University of Tokyo, [2]Chuo University

"Water Management and Climate Change", THA 2022 International Conference on Moving Towards a Sustainable Water and Climate Change Management After COVID-19, Online, January 26, 2022

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ADAP-T's Research framework

- Impact assessment and adaptation to Climate Change
  - CC projections and impact/damage assessment
    - in major four sectors: freshwater, coastal, sediment, and rural
  - Options of adaptation
    - early warning system based on seasonal forecast (for reservoir operation)
    - Infrastructure, such as Sabo (sediment management) dam
    - land use planning (e.g., forest management, retention area), …
  - Cost & benefit (B/C) of adaptation in major sectors
- Methodology for well-balanced adaptation portfolio
  - Meta analysis considering financial and other metrics
- Co-design for the good practice
  - Support policy making for national master plans, integrated with adaptation by various stakeholders, such as central & local governments, citizens, researchers, …
  - ➔Good practice/prototyping of adaptation to climate change, to be further refined and disseminated in neighboring states

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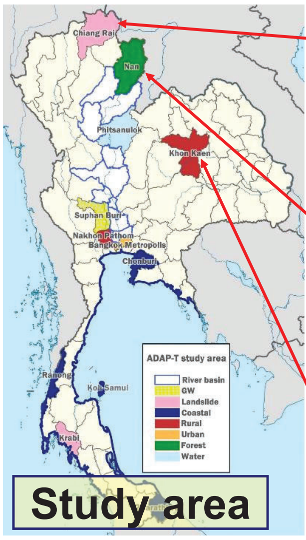

Study area

Sediment

Install landslide early warning system ➔ Hazard map based on risk assessment

Fresh Water **Forest**

Overlooking local heavy rain by low density ➔ Strengthening automatic weather station (AWS) network

Rural

Monitoring risk of salinity by satellite➔ Salt accumulation data for accuracy improvement

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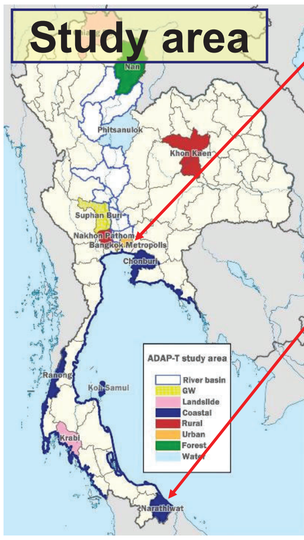
Study area



Urban

Economic damage by urban flood➔ Adaptation measures, e.g. elevated road.

Coastal

Beach erosion by sea level rise➔ Monitoring changes in past decade

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Countermeasures of climate change in Thailand

- Office of Natural Resources and Environmental Policy and Planning (ONEP) is the core agency for the adaptation to climate change in Thailand.
- Climate Change Master Plan 2015-50 formulated in 2015.
  - Mitigation and adaptation to climate change
  - Vision 2050; "Thailand becomes a Climate Change Resilient and Low-Carbon Development Society Following Sustainable Development Pathway"
- National Adaptation Plan (NAP)
  - Implementation plan of adaptation at ministries and agencies.
  - NAP will be submitted to the cabinet in 2022

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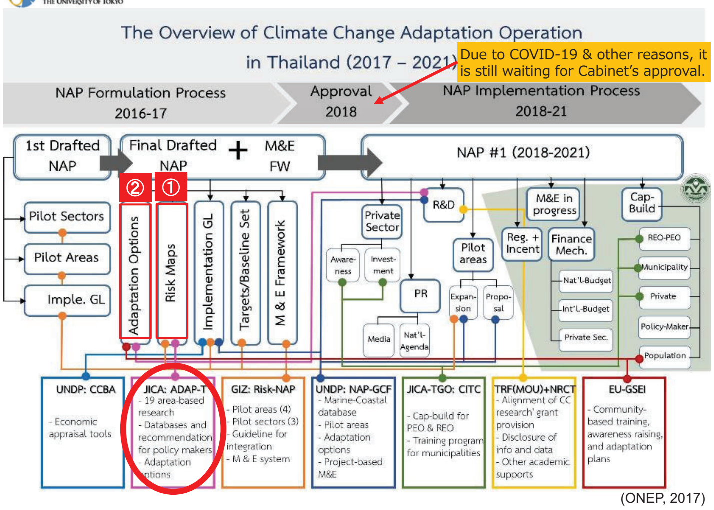

(ONEP, 2017)

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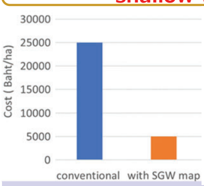
Shallow Ground Water Mapping for agricultural use ①

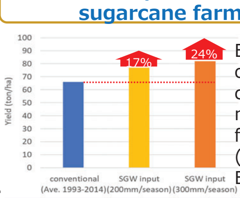
- In severe drought year (like 2015, 2018), shallow ground water (SGW) was only the source of water for upland farmers.
- Introduction of Electromagnetic Geophysical Techniques can support farmers to find the adequate location of shallow well.
- However, supplemental use of SGW (not main source of irrigation) is recommended to avoid the risk of over pumping.

Cost saving for developing the shallow well



Only 1/5 is available by digging well in random. Shallow ground water map support farmers to find good well.

Yield improvement for sugarcane farming



Effective use of SGW can contribute to more benefit for farmers. (in Suphan Buri Prov.)

Dr. Desell Suanburi (Kasetsart Univ.), Dr. Koshi Yoshida (UTokyo)

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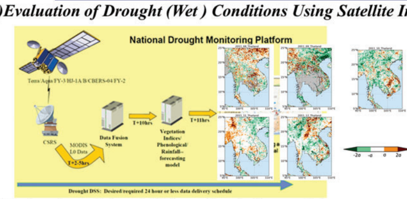
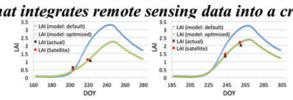
Drought monitoring platform ①

(1)Evaluation of Drought (Wet) Conditions Using Satellite Images

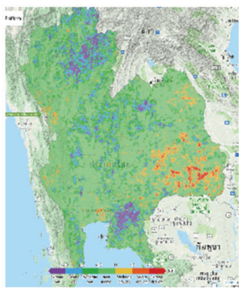


- Drought risk evaluated by indices (SPI, SDT, DSI) in semi-real time.

(2)Estimation of rice yield by a simulation model that integrates remote sensing data into a crop growth model



	Default	Optimized	Actual		Default	Optimized	Actual
Yield(g/m²)	291.22	249.21	192.34	Yield(g/m²)	290.20	258.34	229.12
Error(%)	51.40	29.56		Error(%)	26.66	12.75	



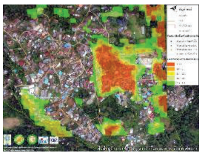
http://csrs.ku.ac.th/wegis/Product/ADAP-T

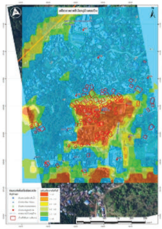
Dr. Mongkol Raksapatcharawong (Kasetsart Univ.), Dr. Kazuo Oki (UTokyo)

Adaptation to landslide risk ①

- Landslide/slope failure/sedimentation: audit/surveillance & risk assessment of existing significant infrastructures
- Risk based design level and adaptation approaches for mitigation: impacts from landslide/slope failure/ sedimentation
- Develop and install community-based Landslide warning system and tools
- Climate change impact to landslide
- Climate change adaptation


Local workshop


Factor of Safety Map at Doi Chang, Chiang Rai

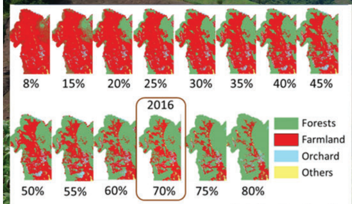

Zonation Susceptibility Landslide Map at Doi Chang, Chiang Rai

Dr. Suttisak Soralump (Kasetsart Univ.), Dr. So Kazama (Tohoku Univ.)

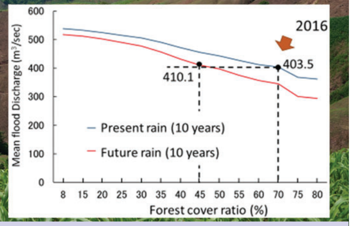
Impact of climate and land use changes on flood discharge ①

- Quantitative prediction of impacts of climate and land use changes on flood discharge in forest area.
- 8~80% of forest ratio in 2050 as land use change
- Flood with forest ratio less than 50% is larger than that of present.
- For B/C analysis of the adaptation to C.C. on flood disaster

Land use map



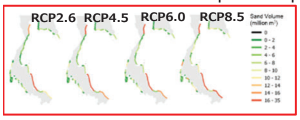
Prediction of 10 yrs flood runoff



Dr. Koichiro Kuraji (UTokyo), Dr. Wanchai Arunpraparut (Kasetsart Univ.)

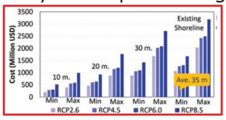
Adaptation to sea level rise in coastal zone ①

- Observe the current beach conditions at 133 locations
- Observe the coastal erosion and examine counter measures
- Assess the volume of sand for beach nourishment and the cost
- Interview 48 villagers-living in the coastal zone about climate change, coastal disaster, and erosion problem
- Hold local workshop for capacity development targeting stakeholders



Volume of sand required for each nourishment to maintain the present shoreline

Risk



Necessary cost for nourishment(Million USD)
*referenced cost of $5.5~10.5/t

Damage


Local workshop by young researcher & students

Co-design

Dr. Sompratana Ritphring (Kasetsart Univ.), Dr. Keiko Udo (Tohoku Univ.)

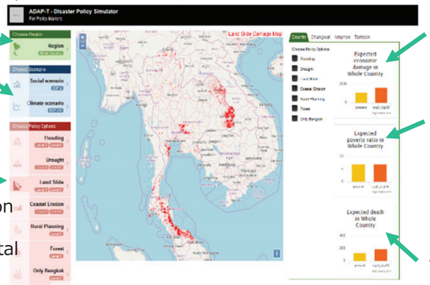
Web application ②

- Interactive tool for evidence-based policy making.
- Show the map with cost & benefit of adaptation in major sectors for supporting making decision well-balanced adaptation portfolio.

Select Region

Select Shared Socioeconomic Pathways and Climate change scenarios

Select Adaptation to each disaster (Example. Coastal erosion >nourishment)



Map of risk and economic loss

Assessment of economic loss

Assessment of impact to poverty

Assessment of human damage

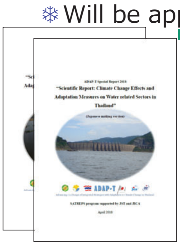
Dr. Hiroaki Shirakawa (Nagoya Univ.), Dr. Weerakaset Suanpaga (Kasetsart Univ.)

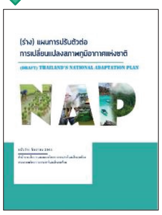
Contribution to ONEP

- National Adaptation Plan (NAP)
  - Results from ADAP-T are delivered to NAP
  - Will be approved by cabinet in 2022.

Input

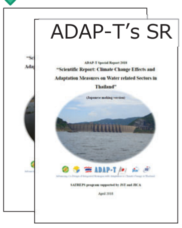
Update


Special Report (SR) on CC effects & adaptation measures on water related sectors in Thailand (Apr., 2018)
*English & Thai version



Draft of Thailand's National Adaptation Plan (Sep., 2018)

ADAP-T's SR



Summary

- It is important to gather and share the adaptation counter measures and its related information, and to develop the good practice on regional scale.
- Necessary to collaborate not only with responsible agencies related to climate change but also the operating agencies in water issues such as RID (Royal Irrigation Department), ONWR (Office of the National Water Resources), HII (Hydro-Informatics Institute), TMD (Thai Meteorological Department), and so on.
- Localizing activities are also important. We had organized the outreach activities (workshops, etc.) in remote areas with Thai collaborators.
- Involvement of young generation should be the key.

WS on the weather information utilization in Khon Kaen with TMD (May, 2018)➔

THA 2022 International Conference on
Moving Towards a Sustainable Water and Climate Change Management After COVID-19
28 - 28 January 2022 09.00 - 16.30 hrs.

Ecosystem-based Adaptation a Nature-based Solution for Flood Protection and Water Provision in River Basins

Dr Klaus Schmitt | 26.01.2022

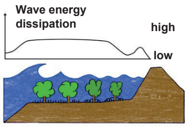
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
On behalf of Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection of the Federal Republic of Germany

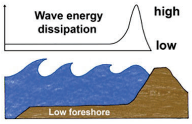
Introduction

- Destruction of forests and wetlands & conversion to other forms of land-use are a major contribution to flooding in the low-lying areas of river basins
- This is exacerbated by the impacts of climate change
- To address this, Nature-based solutions (NbS) offer cost effective adaptation options and co-benefits including biodiversity conservation and human wellbeing
- If NbS focus on human adaptation, assure livelihood benefits and are implemented as part of a climate adaptation strategy, they are called **Ecosystem-based Adaptation** (EbA)
- This requires the participatory involvement of local people in an integrated approach which must be part of a diverse suite of site-specific and appropriate adaptation strategies to avoid path dependencies and maladaptations

Flood protection: muddy coasts with Mangroves

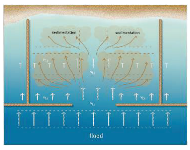
- The unsustainable use of natural resources and development in the coastal zone are threatening the protection function of the mangrove forest belt
- The resulting erosion and destruction of the mangrove belt leads to dyke failure, overtopping and flooding
- The whole of the tidal flats and mangrove forests are an "energy conversion system" and therefore a very effective **nature-based system** for coastal protection

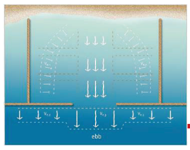




Restoration of floodplains/tidal flats

- … is a precondition for mangrove rehabilitation in sites where erosion has destroyed the mangroves and eroded the foreshore
- **T-shaped, permeable bamboo fences**, placed to minimise lee erosion are effective for reducing erosion, stimulate sedimentation and thereby restore floodplains
- Recreates conditions for mangrove regeneration
- The long-shore parts dampen the incoming wave energy, and the cross-shore parts decrease the long-shore currents, creating calm water conditions for sedimentation

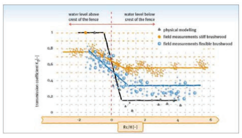


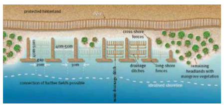


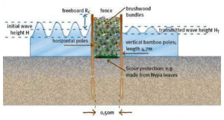
Design, technical specifications and placement of T-fences

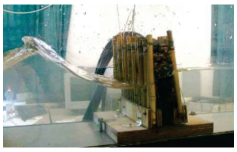
requires a sound understanding of site-specific **coastal processes** (wind, waves, currents), sediment transport, morphodynamics, hydrology and coastal dynamic

- Permeable bamboo fences filled with soft brushwood effectively dampen wave energy
- Fence **porosity** affects attenuation of both high- and low-frequency waves drastically
- **Specifications**: bamboo diameter, length and embedment depths; crest height; scour protection etc.
- **Placement** of the fences to minimise lee erosion

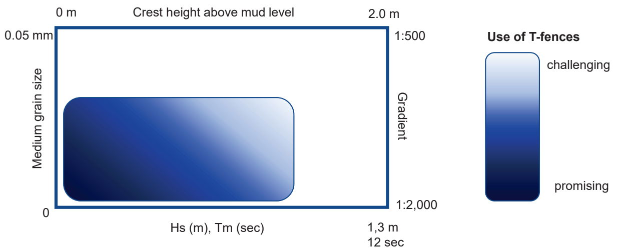






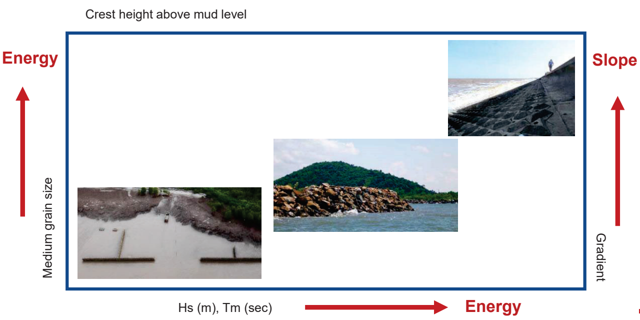


Solutions only feasible within a set of boundary conditions



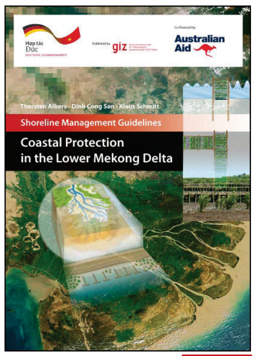
Hs: significant wave height; Tm: mean wave period

Solutions only feasible within a set of boundary conditions



Additional design considerations

- Level of erosion and presence of fine sediments: in sites with severe erosion, a top mud layer > 0.5 m is an indication that there is enough mud in the system for sedimentation
- Proximity to the shoreline and length of submergence to minimise damage by shipworms



Manual

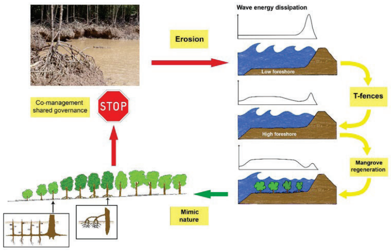
http://coastal-protection-mekongdelta.com/download/library/40.Shoreline-Management-Guidelines_EN.pdf (Albers et al., 2013)

PANORAMA Solution

https://panorama.solutions/en/solution/ecosystem-based-coastal-protection-through-floodplain-restoration

Sustainability through shared governance

- Unsustainable use of natural resources and development in the coastal zone (and catchment area) causes erosion
- Root cause must be addressed
- Involvement of local communities through shared governance (co-management) is required to address the root cause and ensure sustainability

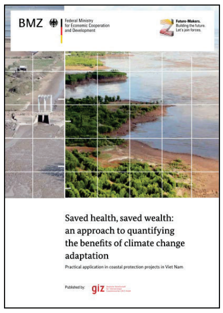


PANORAMA Solution
https://panorama.solutions/en/solution/co-management-shared-governance-natural-resources-coastal-area

Quantification of benefits & cost effectiveness

- A study from the Mekong Delta compared the values of mangrove planting with dyke upgrade based on **saved wealth** and **saved health**
  Stadelmann, M., Michaelowa, A., Butzengeiger-Geyer, S., Köhler, M. 2015. Universal metrics to compare the effectiveness of climate change adaptation projects. In: Leal Filho, W. (ed.) Handbook of Climate Change Adaptation: 2143–2160.
- The saved wealth index per USD invested for mangroves is about 19 times higher than for the dyke upgrade
- Mangroves provide health benefits of 243 Disability-Adjusted Life Years in 20 years - the dyke upgrade does not deliver any positive health impacts (report)
- Cost-benefit analysis Lami Town, Fiji
  https://www.researchgate.net/profile/James-Vause-2/publication/335790207_Developing_the_economic_case_for_EbA/links/5d7b629c92851c87c37b33fa/Developing-the-economic-case-for-EbA.pdf

Scenario	Benefit-to-cost ratio (FJD)	Assumed damage avoidance
Ecosystem-based options	$19.50	10–25%
Emphasis on ecosystem-based options	$15.00	25%
Emphasis on engineering options	$8.00	25%
Engineering options	$9.00	25–50%



https://www.adaptationcommunity.net/?wpfb_dl=139

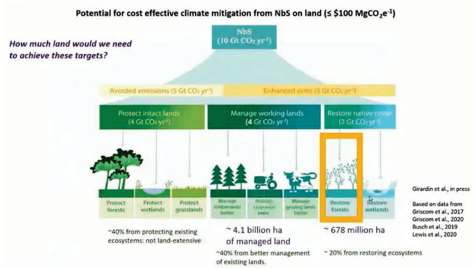
EbA measure for flood protection and water provision

- EbA measures can enhance water availability, improve water quality and reduce water-related risks, in addition, they generate livelihood, economic and environmental co-benefits
- Conservation of existing catchment forests, mangroves and wetlands are effective EbA measures and can be complemented by appropriate wetland and forest rehabilitation using native species
- Over-emphasis on tree planting (for carbon gain) may lead to adverse impacts on local communities and biodiversity; and distracts from the need to protect intact ecosystems (e.g. conversion of peatlands to tree plantations)

Example:

- Locally established protected areas (Other Effective Conservation Measures, OECM, Aichi Target 11) can further contribute to forest and wetland protection

Protect and manage is more effective than rehabilitation (restoration)



Talk on *Value and limits of working with nature to address climate change* (Oxford Martin School January 2021)
https://www.youtube.com/watch?v=Ka7Sc5d1v3k 11:25 – 14:00 min

EbA and Integrated Water Resources Management (IWRM)

- Water availability in adequate quality is highly dependent on healthy ecosystems and their provisioning functions and services; healthy ecosystems also reduce water-related risks
- IWRM should put more emphasis on promoting the ability and strengths of healthy ecosystems to reduce vulnerabilities to climate change in watersheds/river basins
- Integrating the concepts and approaches of EbA and IWRM could support the mainstreaming of climate change adaptation and risk management into Integrated Water Resources Management
- EbA measures should be part of (forest and comprehensive) land-use planning and integrated into river basin wide plans as participatory approaches to conservation and development

Conclusion

- Use of **area** (tidal flats, mangroves) **as a nature-based coastal protection system** is very effective and provides co-benefits
- Engineering is required in erosion sites and needs sound **understanding** of dynamic coastal processes
- EbA solutions [such as T-shaped, permeable and temporary bamboo fences] only work within a specific set of **boundary conditions** and must be **site-specific** and **appropriate**
- Avoid pitfalls of NbS such as green-washing and over-emphasis on tree planting (Global Standard for NbS)
- Different solutions and their costing should be part of an integrated river basin **Master Plan** which also integrates EbA and IWRM
- Such an integrated plan should include mangrove, forest and wetland protection and sustainable use/management (i.e., conservation) involving local communities - **conservation and development**

As a federally owned enterprise, GIZ supports the German Government in achieving its objectives in the field of international cooperation for sustainable development.

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Slide 4: photo R Sorgenfrei 2016; graphics from Albers et al., 2013 (link see slide 8)
Slide 5: photo T Albers 2010; graphics from Albers et al., 2013
Slide 6: graphic K. Schmitt 2020, https://panorama.solutions/en/solution/ecosystem-based-coastal-protection-through-floodplain-restoration
Slide 7: photos: T-fences Cong Ly and GE Wind, 2013; breakwater Russell; seawall Pham Thuy Duong 2012
Slide 9: modified from Albers and Schmitt, 2015 (see link on slide 9)
Slide 11: https://www.cbd.int/sp/targets/
Slide 12: see link on slide 12

THA 2022 International Conference on
Moving Towards a Sustainable Water and Climate Change Management After COVID-19

SDGs, Water and Climate Change: Research Priorities

Sangam Shrestha
Professor
Water Engineering and Management
Asian Institute of Technology

Presentation Outline

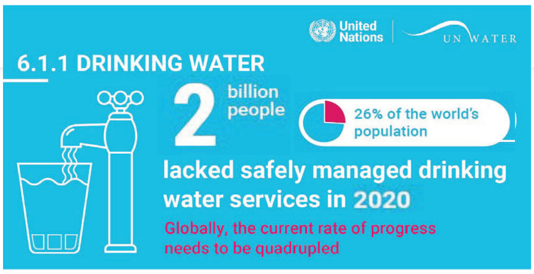
- SDG 6: Review of progress
- Stressors to SDG 6
- Climate change and water: Facing the facts
- Research priorities
- Connect Mekong (project)
- Concluding remarks

SDG6
Review of Progress

SDG 6: Ensuring clean water and sanitation for all by 2030!

4

SDG 6: Ensuring clean water and sanitation for all by 2030!

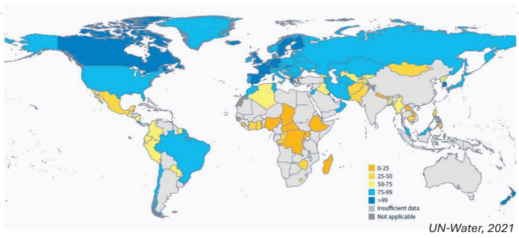


UN-Water, 2021

5

SDG 6: Ensuring clean water and sanitation for all by 2030!

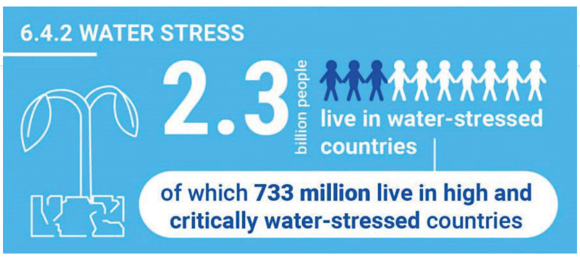
6.1.1 Proportion of population using safely managed drinking water services (2020)



UN-Water, 2021

6

SDG 6: Ensuring clean water and sanitation for all by 2030!

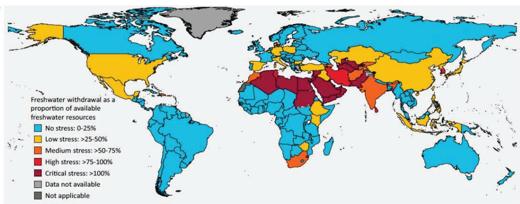


UN-Water, 2021

7

SDG 6: Ensuring clean water and sanitation for all by 2030!

6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources (2018)



UN-Water, 2021

8

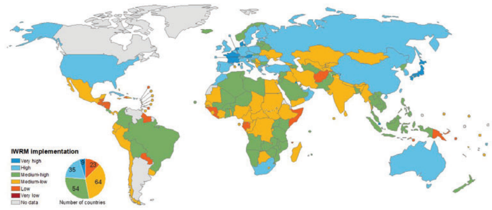
SDG 6: Ensuring clean water and sanitation for all by 2030!

UN-Water, 2021

9

SDG 6: Ensuring clean water and sanitation for all by 2030!

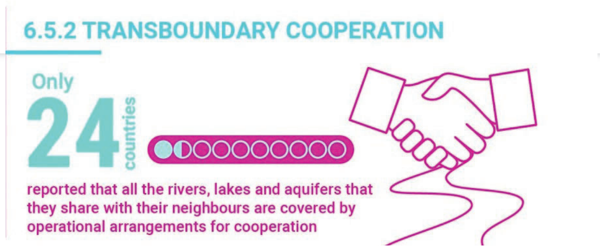
6.5.1 Degree of integrated water resources management implementation (0–100) (2020)



UN-Water, 2021

10

SDG 6: Ensuring clean water and sanitation for all by 2030!

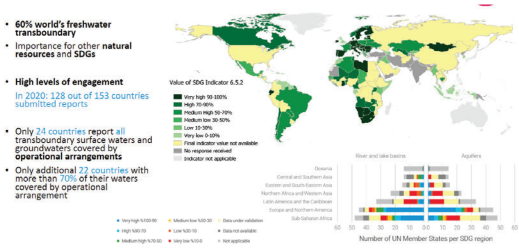


UN-Water, 2021

11

SDG 6: Ensuring clean water and sanitation for all by 2030!

6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation

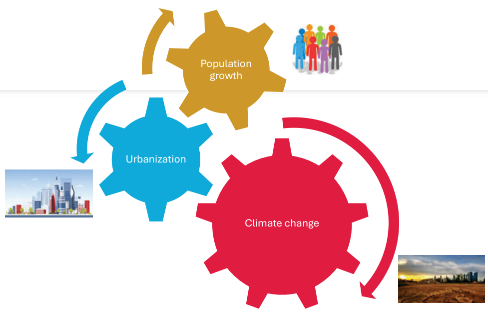


UN-Water, 2021

12

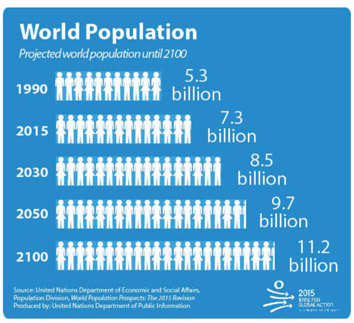
Stressors to SDG 6

Stressors to SDG 6



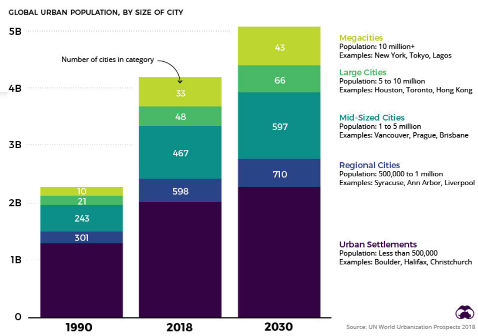
14

Population Growth



15

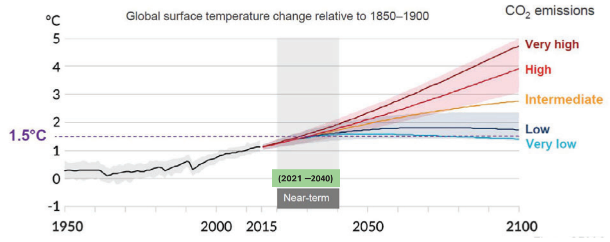
Urbanization



16

Climate change

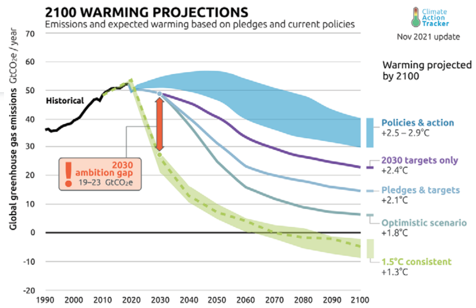
Global warming of 1.5°C and 2°C will be exceeded unless deep reductions in CO_2 and other greenhouse gas emissions occur in the coming decades



(IPCC AR 6)

17

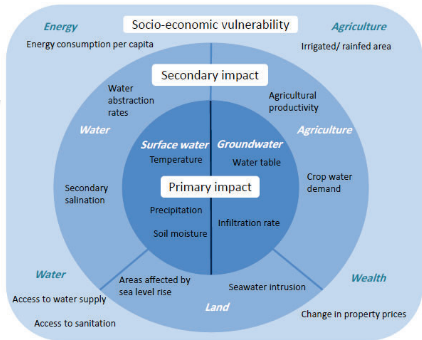
Climate change



18

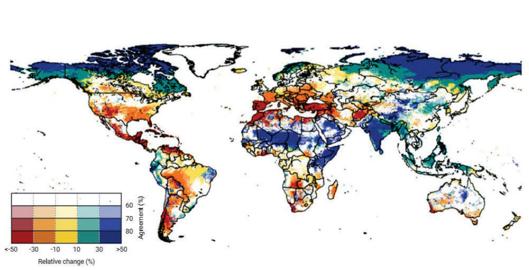
Climate change & water: Facing the facts

Climate change impact on water



20

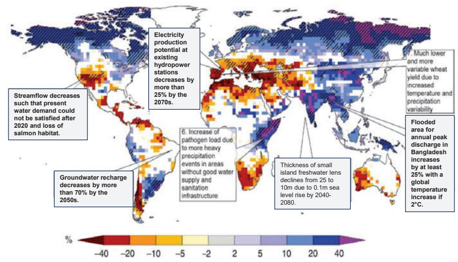
Climate change impact on water & socioeconomic vulnerability



Relative change in annual discharge at 2°C temperature increase compared with present day under RCP 4.5 (WWDR 2020)

21

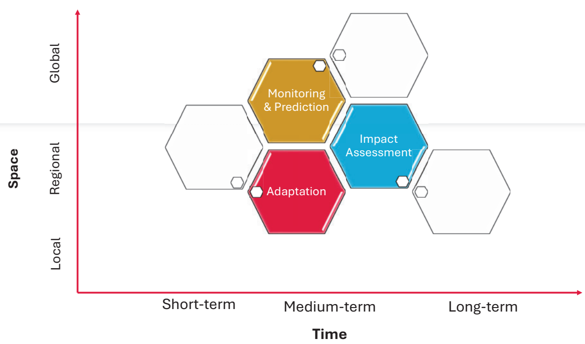
Climate change impact on water & socioeconomic vulnerability



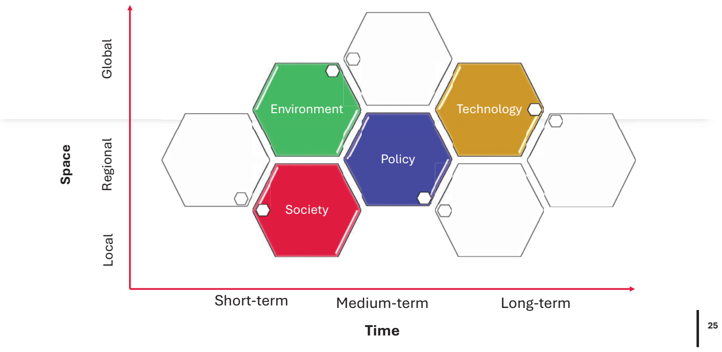
Future climate change impacts related to freshwater which threaten the sustainable development of the affected regions (IPCC AR5)

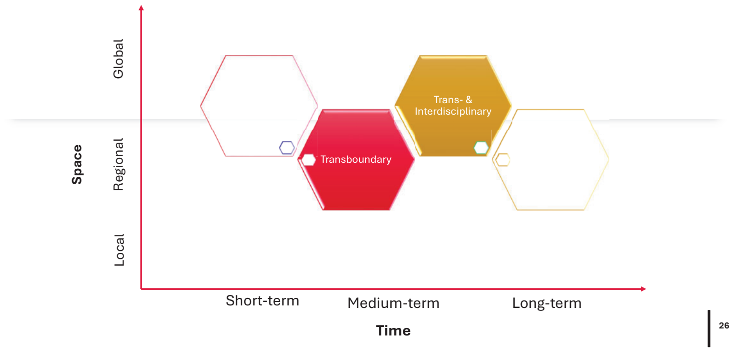
22

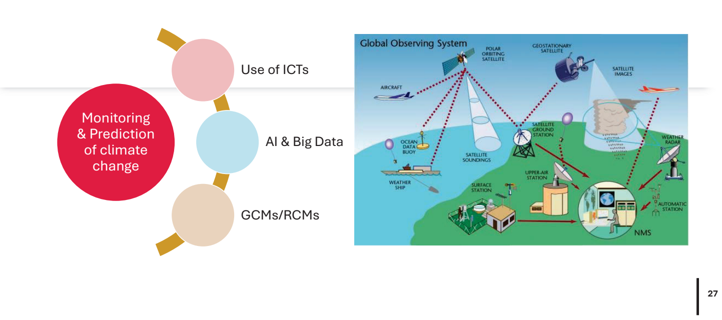
Research Priorities

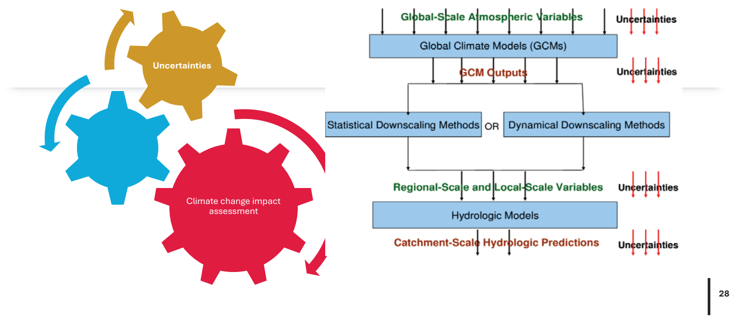


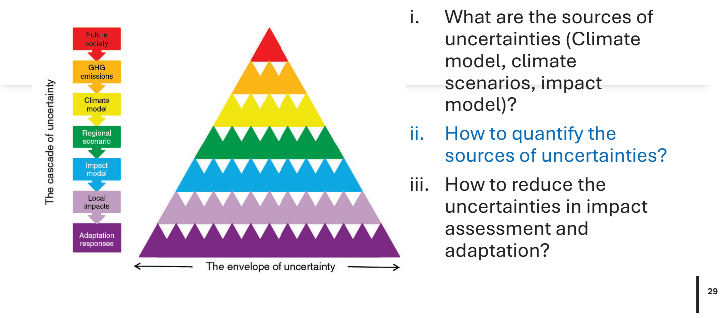
24

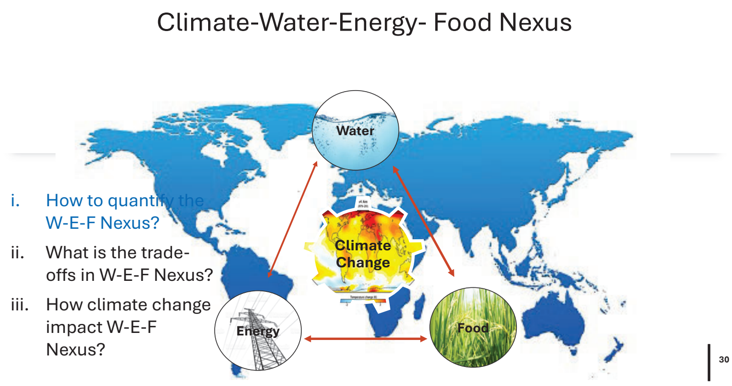

Global
Regional
Local
Space
Environment
Technology
Policy
Society
Short-term
Medium-term
Long-term
Time
25

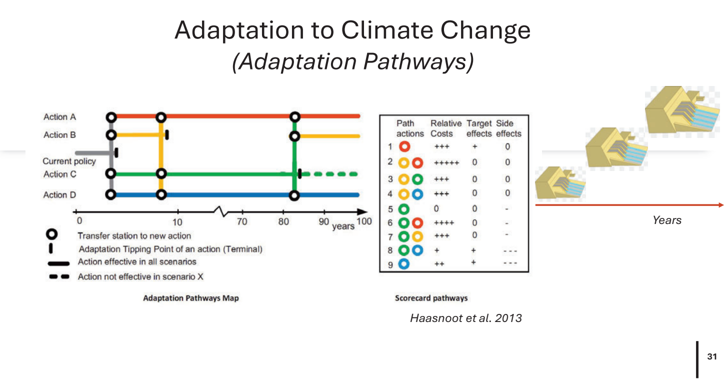

Global
Regional
Local
Space
Trans- & Interdisciplinary
Transboundary
Short-term
Medium-term
Long-term
Time
26

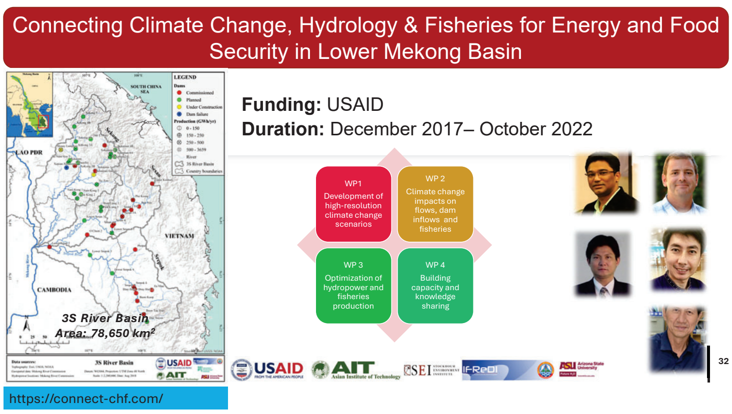

Monitoring & Prediction of climate change
Use of ICTs
AI & Big Data
GCMs/RCMs
Global Observing System
27


Uncertainties
Climate change impact assessment
Global-Scale Atmospheric Variables
Uncertainties
Global Climate Models (GCMs)
GCM Outputs
Uncertainties
Statistical Downscaling Methods
OR
Dynamical Downscaling Methods
Regional-Scale and Local-Scale Variables
Uncertainties
Hydrologic Models
Catchment-Scale Hydrologic Predictions
Uncertainties
28

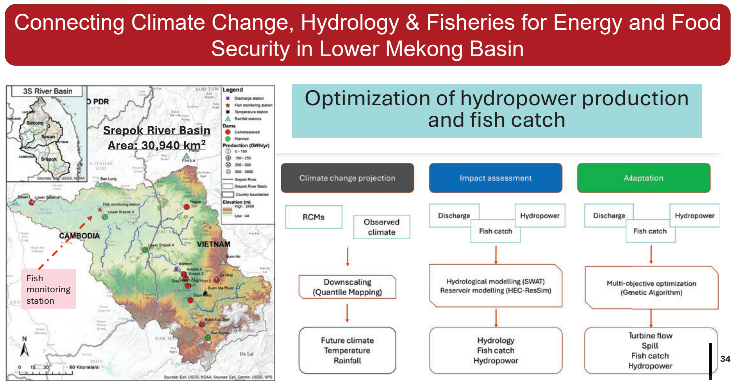

Future society
GHG emissions
Climate model
Regional scenario
Impact model
Local impacts
Adaptation responses
The cascade of uncertainty
The envelope of uncertainty
i. What are the sources of uncertainties (Climate model, climate scenarios, impact model)?
ii. How to quantify the sources of uncertainties?
iii. How to reduce the uncertainties in impact assessment and adaptation?
29

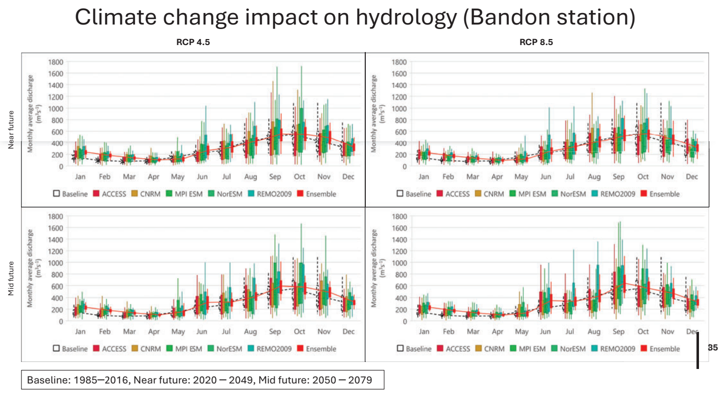

Climate-Water-Energy- Food Nexus
Water
Climate Change
Energy
Food
i. How to quantify the W-E-F Nexus?
ii. What is the trade-offs in W-E-F Nexus?
iii. How climate change impact W-E-F Nexus?
30

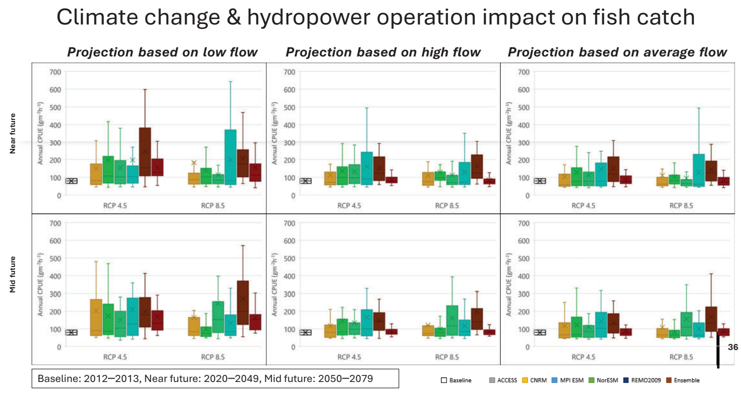

Adaptation to Climate Change
(Adaptation Pathways)
Action A
Action B
Current policy
Action C
Action D
years
Transfer station to new action
Adaptation Tipping Point of an action (Terminal)
Action effective in all scenarios
Action not effective in scenario X
Adaptation Pathways Map
Path actions
Relative Costs
Target effects
Side effects
Scorecard pathways
Years
Haasnoot et al. 2013
31

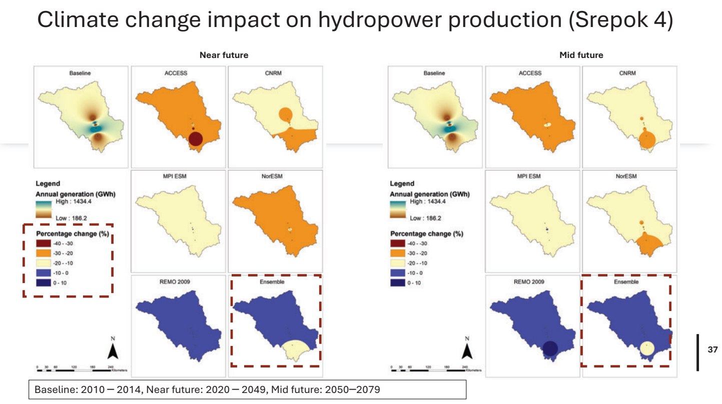

Connecting Climate Change, Hydrology & Fisheries for Energy and Food Security in Lower Mekong Basin
Funding: USAID
Duration: December 2017– October 2022
WP1 Development of high-resolution climate change scenarios
WP 2 Climate change impacts on flows, dam inflows and fisheries
WP 3 Optimization of hydropower and fisheries production
WP 4 Building capacity and knowledge sharing
3S River Basin
Area: 78,650 km²
LAO PDR
CAMBODIA
VIETNAM
USAID
AIT
https://connect-chf.com/
32

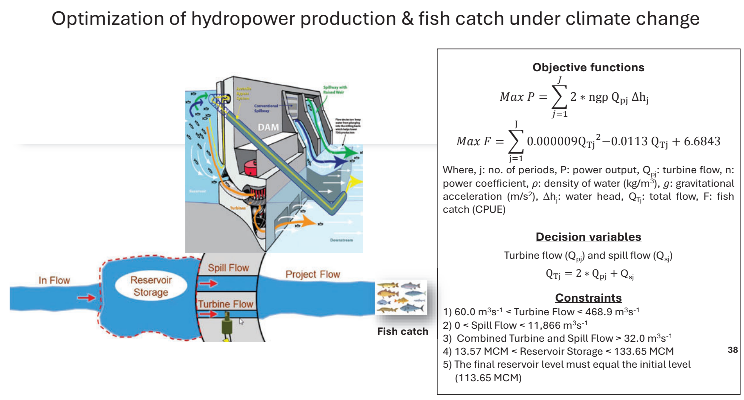

Asian Institute of Technology
ABOUT CONNECT MEKONG
https://connect-chf.com/

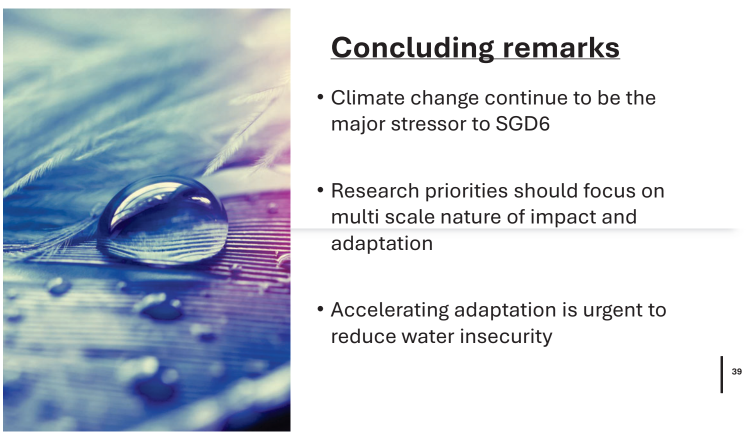

Connecting Climate Change, Hydrology & Fisheries for Energy and Food Security in Lower Mekong Basin
3S River Basin
Srepok River Basin
Area: 30,940 km²
CAMBODIA
VIETNAM
Fish monitoring station
Optimization of hydropower production and fish catch
Climate change projection
Impact assessment
Adaptation
RCMs
Observed climate
Downscaling (Quantile Mapping)
Future climate Temperature Rainfall
Discharge
Hydropower
Fish catch
Hydrological modelling (SWAT) Reservoir modelling (HEC-ResSim)
Hydrology Fish catch Hydropower
Multi-objective optimization (Genetic Algorithm)
Turbine flow Spill Fish catch Hydropower
34


Climate change impact on hydrology (Bandon station)
RCP 4.5
RCP 8.5
Near future
Mid future
Monthly average discharge (m³/s)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Baseline ACCESS CNRM MPI ESM NorESM REMO2009 Ensemble
35
Baseline: 1985–2016, Near future: 2020 – 2049, Mid future: 2050 – 2079

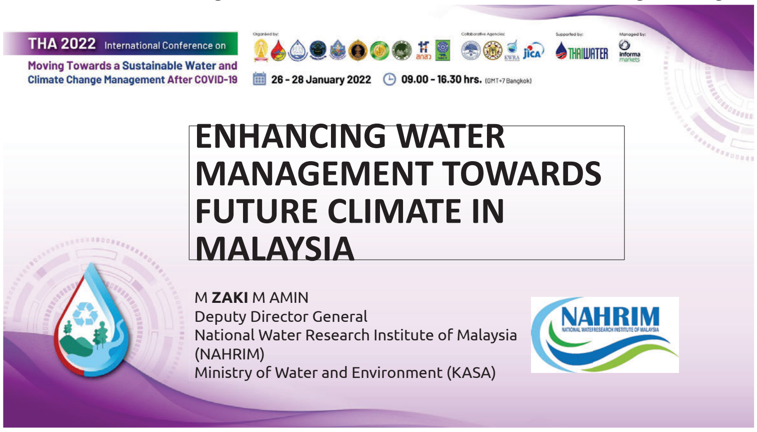

Climate change & hydropower operation impact on fish catch
Projection based on low flow
Projection based on high flow
Projection based on average flow
Near future
Mid future
Annual CPUE (gm/h·m²)
RCP 4.5
RCP 8.5
36
Baseline: 2012–2013, Near future: 2020–2049, Mid future: 2050–2079
Baseline ACCESS CNRM MPI ESM NorESM REMO2009 Ensemble


Climate change impact on hydropower production (Srepok 4)
Near future
Mid future
Baseline
ACCESS
CNRM
MPI ESM
NorESM
REMO 2009
Ensemble
Legend
Annual generation (GWh)
High : 1434.4
Low : 186.2
Percentage change (%)
-40 - -30
-30 - -20
-20 - -10
-10 - 0
0 - 10
37
Baseline: 2010 – 2014, Near future: 2020 – 2049, Mid future: 2050–2079

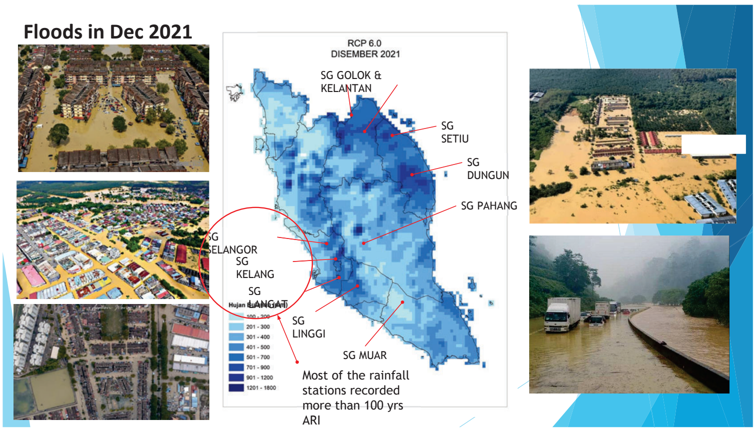

Optimization of hydropower production & fish catch under climate change
DAM
In Flow
Reservoir Storage
Spill Flow
Turbine Flow
Project Flow
Fish catch
Objective functions
$Max\ P = \sum_{j=1}^{J} 2 * \eta g \rho\ Q_{pj}\ \Delta h_j$
$Max\ F = \sum_{j=1}^{J} 0.000009 Q_{Tj}^{2} - 0.0113\ Q_{Tj} + 6.6843$
Where, j: no. of periods, P: power output, Q_{pj}: turbine flow, η: power coefficient, ρ: density of water (kg/m³), g: gravitational acceleration (m/s²), Δh_j: water head, Q_{Tj}: total flow, F: fish catch (CPUE)
Decision variables
Turbine flow (Q_{pj}) and spill flow (Q_{sj})
$Q_{Tj} = 2 * Q_{pj} + Q_{sj}$
Constraints
1) 60.0 m³s⁻¹ < Turbine Flow < 468.9 m³s⁻¹
2) 0 < Spill Flow < 11,866 m³s⁻¹
3) Combined Turbine and Spill Flow > 32.0 m³s⁻¹
4) 13.57 MCM < Reservoir Storage < 133.65 MCM
5) The final reservoir level must equal the initial level (113.65 MCM)
38

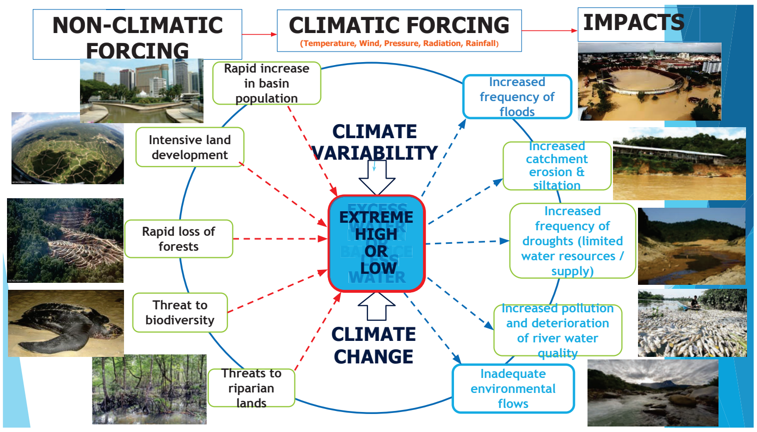

Concluding remarks
• Climate change continue to be the major stressor to SGD6
• Research priorities should focus on multi scale nature of impact and adaptation
• Accelerating adaptation is urgent to reduce water insecurity
39

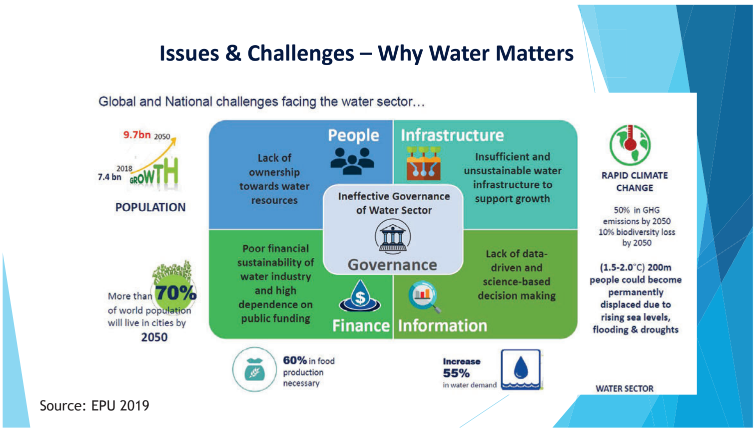

6 CLEAN WATER AND SANITATION
THA 2022 International Conference on
Moving Towards a Sustainable Water and Climate Change Management After COVID-19
Thank you very much
sangam@ait.asia
Sangam Shrestha
Professor
Water Engineering and Management
Asian Institute of Technology

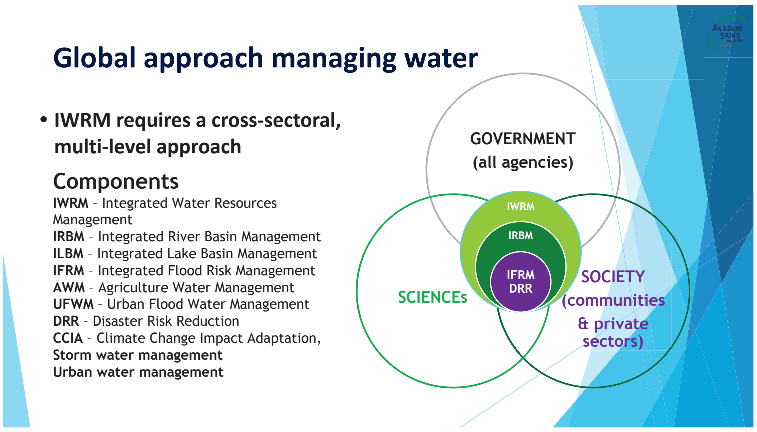

THA 2022 International Conference on
Moving Towards a Sustainable Water and Climate Change Management After COVID-19
28 - 28 January 2022
09.00 - 16.30 hrs.
ENHANCING WATER MANAGEMENT TOWARDS FUTURE CLIMATE IN MALAYSIA
M ZAKI M AMIN
Deputy Director General
National Water Research Institute of Malaysia (NAHRIM)
Ministry of Water and Environment (KASA)
NAHRIM


ENHANCING WATER MANAGEMENT – TRANSFORMING THE WATER SECTOR
IMPROVING CLIMATE RESILIENCE – RELATED TO WATER MANAGEMENT
A PROSPEROUS, INCLUSIVE, SUSTAINABLE MALAYSIA

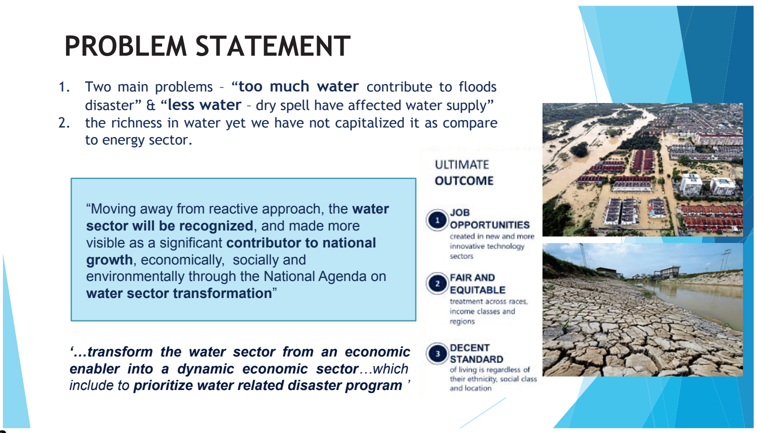

Floods in Dec 2021
RCP 6.0
DISEMBER 2021
SG GOLOK & KELANTAN
SG SETIU
SG DUNGUN
SG PAHANG
SG SELANGOR
SG KELANG
SG LANGAT
SG LINGGI
SG MUAR
Most of the rainfall stations recorded more than 100 yrs ARI

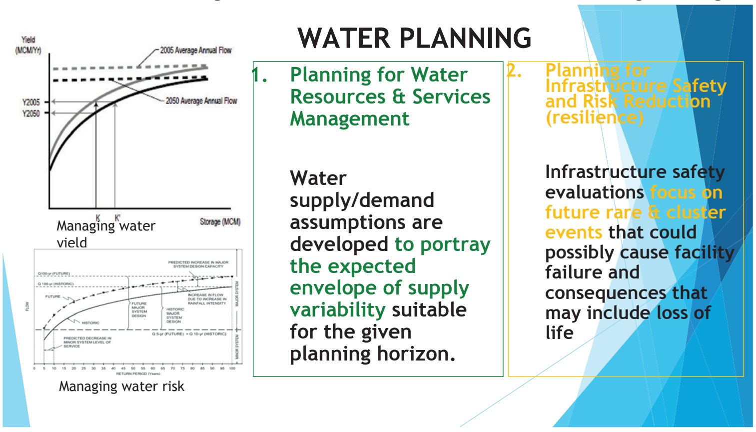

NON-CLIMATIC FORCING
CLIMATIC FORCING
(Temperature, Wind, Pressure, Radiation, Rainfall)
IMPACTS
Rapid increase in basin population
Intensive land development
Rapid loss of forests
Threat to biodiversity
Threats to riparian lands
CLIMATE VARIABILITY
EXTREME HIGH OR LOW
CLIMATE CHANGE
Increased frequency of floods
Increased catchment erosion & siltation
Increased frequency of droughts (limited water resources / supply)
Increased pollution and deterioration of river water quality
Inadequate environmental flows


Issues & Challenges – Why Water Matters
Global and National challenges facing the water sector...
9.7bn 2050
2018 7.4 bn
GROWTH
POPULATION
More than 70% of world population will live in cities by 2050
People
Lack of ownership towards water resources
Infrastructure
Insufficient and unsustainable water infrastructure to support growth
Ineffective Governance of Water Sector
Governance
Poor financial sustainability of water industry and high dependence on public funding
Lack of data-driven and science-based decision making
Finance
Information
60% in food production necessary
Increase 55% in water demand
RAPID CLIMATE CHANGE
50% in GHG emissions by 2050
10% biodiversity loss by 2050
(1.5-2.0°C) 200m people could become permanently displaced due to rising sea levels, flooding & droughts
WATER SECTOR
Source: EPU 2019

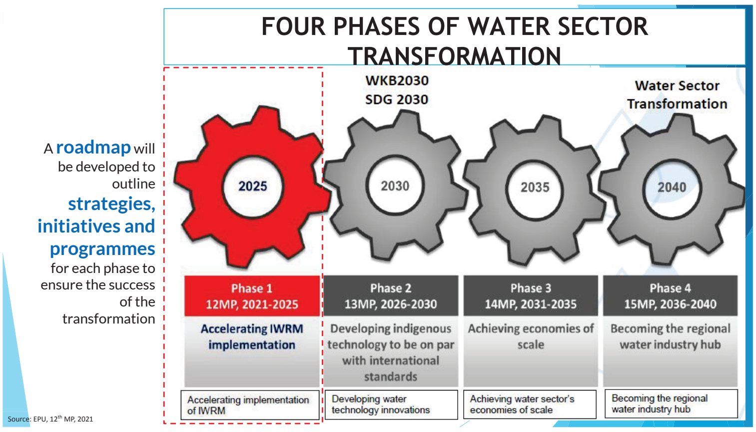

Global approach managing water
IWRM requires a cross-sectoral, multi-level approach
Components
IWRM - Integrated Water Resources Management
IRBM - Integrated River Basin Management
ILBM - Integrated Lake Basin Management
IFRM - Integrated Flood Risk Management
AWM - Agriculture Water Management
UFWM - Urban Flood Water Management
DRR - Disaster Risk Reduction
CCIA - Climate Change Impact Adaptation,
Storm water management
Urban water management
GOVERNMENT (all agencies)
IWRM
IRBM
IFRM DRR
SCIENCEs
SOCIETY (communities & private sectors)


ENHANCING THE WATER SECTOR
A PROSPEROUS, INCLUSIVE, SUSTAINABLE MALAYSIA

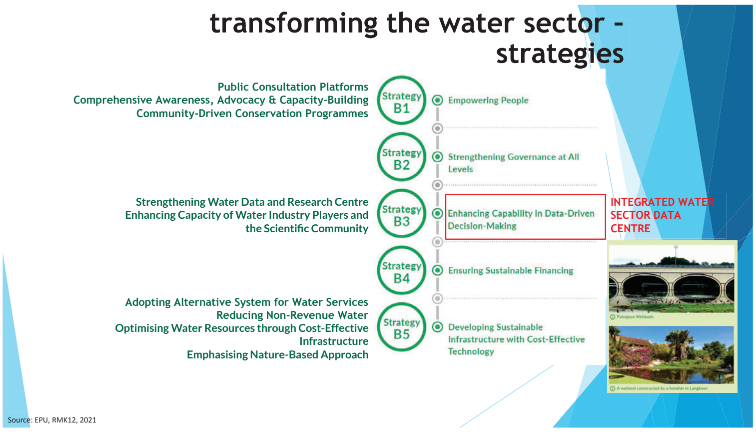

PROBLEM STATEMENT
1. Two main problems - "too much water contribute to floods disaster" & "less water - dry spell have affected water supply"
2. the richness in water yet we have not capitalized it as compare to energy sector.
"Moving away from reactive approach, the water sector will be recognized, and made more visible as a significant contributor to national growth, economically, socially and environmentally through the National Agenda on water sector transformation"
'...transform the water sector from an economic enabler into a dynamic economic sector...which include to prioritize water related disaster program'
ULTIMATE OUTCOME
1 JOB OPPORTUNITIES
2 FAIR AND EQUITABLE
3 DECENT STANDARD

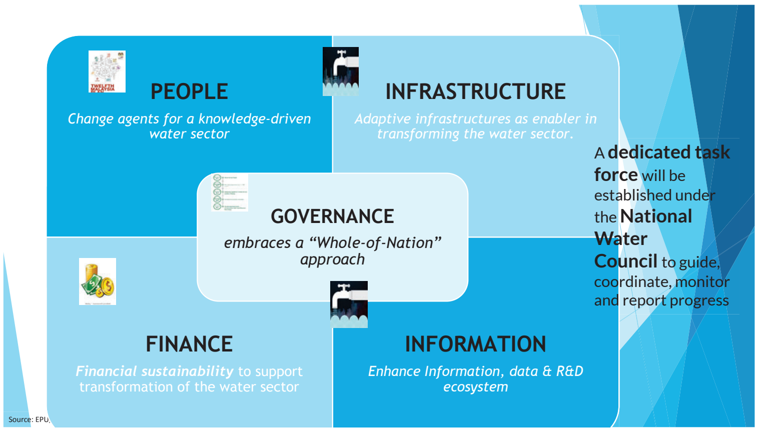

WATER PLANNING
Managing water yield
Managing water risk
1. Planning for Water Resources & Services Management
Water supply/demand assumptions are developed to portray the expected envelope of supply variability suitable for the given planning horizon.
2. Planning for Infrastructure Safety and Risk Reduction (resilience)
Infrastructure safety evaluations focus on future rare & cluster events that could possibly cause facility failure and consequences that may include loss of life

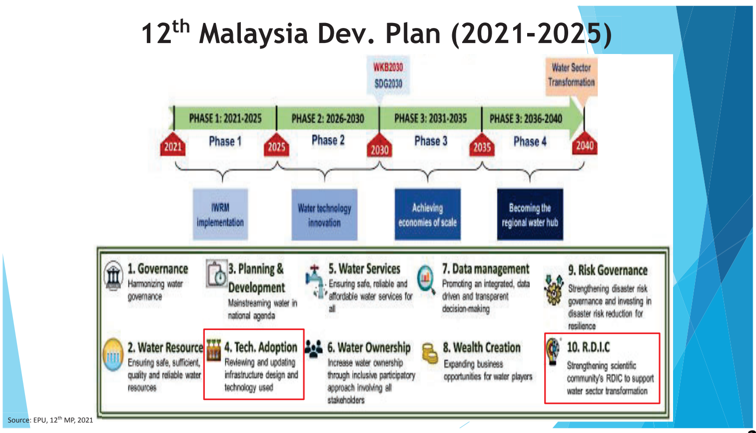

12th Malaysia Dev. Plan (2021-2025)
Chapter 8: Advancing Green Growth for Sustainability and Resilience
Chapter 9: Enhancing Energy Sustainability and Transforming the Water Sector
Priority Area A
Implementing a Low-Carbon, Clean and Resilient Development
Priority Area B
Managing Natural Resources Efficiently to Safeguard Natural Capital
Priority Area C
Strengthening the Enabling Environment for Effective Governance
Priority Area A
Ensuring Sustainable Energy for All
Priority Area B
Transforming the Water Sector
Increasing resilience against climate change & disasters
The focus now - to accelerate the implementation of IWRM to achieve sustainable development goals
Source: EPU, 12th MP, 2021

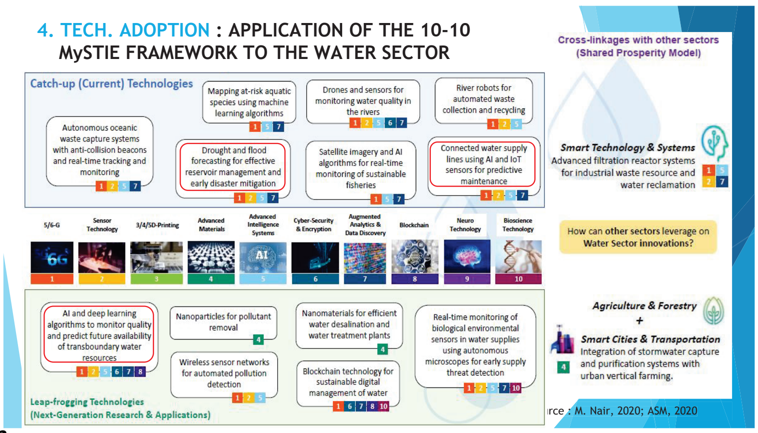

FOUR PHASES OF WATER SECTOR TRANSFORMATION
A roadmap will be developed to outline strategies, initiatives and programmes for each phase to ensure the success of the transformation
WKB2030
SDG 2030
Water Sector Transformation
2025
2030
2035
2040
Phase 1
12MP, 2021-2025
Accelerating IWRM implementation
Phase 2
13MP, 2026-2030
Developing indigenous technology to be on par with international standards
Phase 3
14MP, 2031-2035
Achieving economies of scale
Phase 4
15MP, 2036-2040
Becoming the regional water industry hub
Accelerating implementation of IWRM
Developing water technology innovations
Achieving water sector's economies of scale
Becoming the regional water industry hub
Source: EPU, 12th MP, 2021

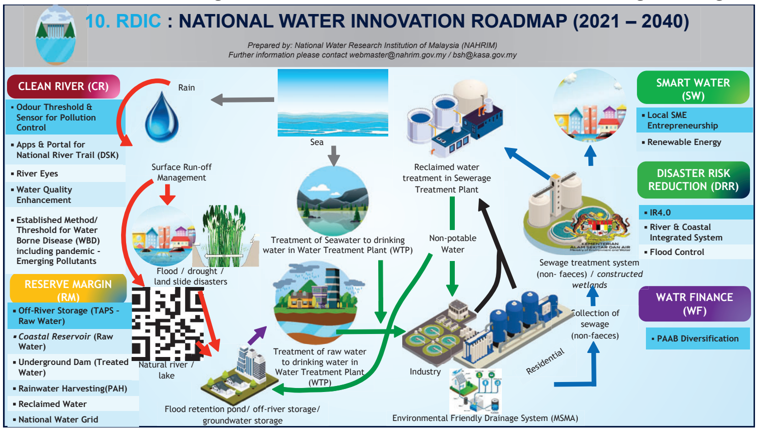

A national agenda to transform the water sector into a dynamic & vibrant economic sector that
▪ contribute significantly to the national GDP
▪ provide good quality affordable water to the people
▪ create new job opportunities
▪ facilitating resilient development of STIE & RDIC in the sector.
Twin objectives:
▪ Water security & sustainability
▪ Water as an economic opportunity
WHAT IS WATER SECTOR TRANSFORMATION?
TRANSFORMING THE WATER SECTOR:
NATIONAL INTEGRATED WATER RESOURCES MANAGEMENT PLAN
STRATEGIES AND ROAD MAP
MALAYSIA
VOLUME 1 - MAIN REPORT
Source: EPU, 12th MP, 20 21


transforming the water sector - strategies
Public Consultation Platforms
Comprehensive Awareness, Advocacy & Capacity-Building
Community-Driven Conservation Programmes
Strategy B1
Empowering People
Strategy B2
Strengthening Governance at All Levels
Strengthening Water Data and Research Centre
Enhancing Capacity of Water Industry Players and the Scientific Community
Strategy B3
Enhancing Capability in Data-Driven Decision-Making
INTEGRATED WATER SECTOR DATA CENTRE
Strategy B4
Ensuring Sustainable Financing
Adopting Alternative System for Water Services
Reducing Non-Revenue Water
Optimising Water Resources through Cost-Effective Infrastructure
Emphasising Nature-Based Approach
Strategy B5
Developing Sustainable Infrastructure with Cost-Effective Technology
Source: EPU, RMK12, 2021

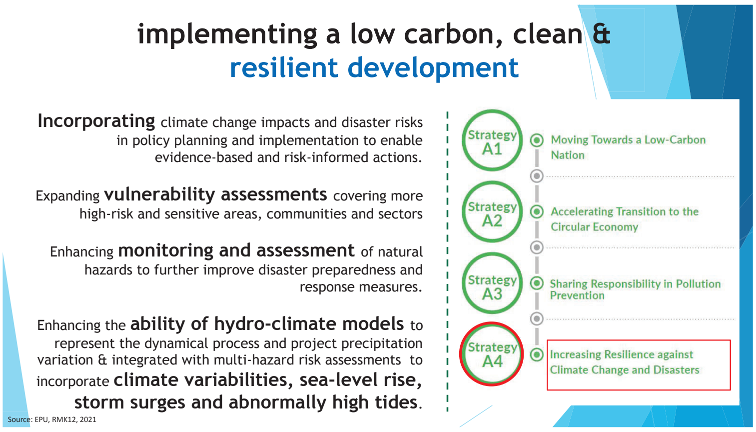

PEOPLE
Change agents for a knowledge-driven water sector
INFRASTRUCTURE
Adaptive infrastructures as enabler in transforming the water sector.
GOVERNANCE
embraces a "Whole-of-Nation" approach
FINANCE
Financial sustainability to support transformation of the water sector
INFORMATION
Enhance Information, data & R&D ecosystem
A dedicated task force will be established under the National Water Council to guide, coordinate, monitor and report progress
Source: EPU

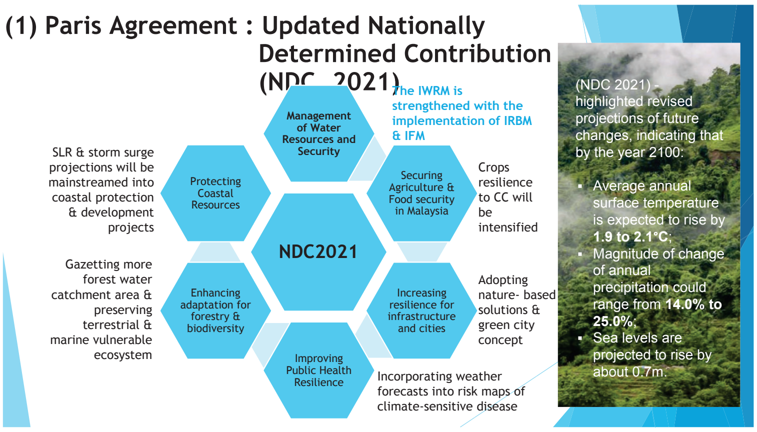

12th Malaysia Dev. Plan (2021-2025)
WKB2030 SDG2030
Water Sector Transformation
PHASE 1: 2021-2025
PHASE 2: 2026-2030
PHASE 3: 2031-2035
PHASE 3: 2036-2040
2021 Phase 1 2025 Phase 2 2030 Phase 3 2035 Phase 4 2040
IWRM implementation
Water technology innovation
Achieving economies of scale
Becoming the regional water hub
1. Governance
Harmonizing water governance
2. Water Resource
Ensuring safe, sufficient, quality and reliable water resources
3. Planning & Development
Mainstreaming water in national agenda
4. Tech. Adoption
Reviewing and updating infrastructure design and technology used
5. Water Services
Ensuring safe, reliable and affordable water services for all
6. Water Ownership
Increase water ownership through inclusive participatory approach involving all stakeholders
7. Data management
Promoting an integrated, data driven and transparent decision-making
8. Wealth Creation
Expanding business opportunities for water players
9. Risk Governance
Strengthening disaster risk governance and investing in disaster risk reduction for resilience
10. R.D.I.C
Strengthening scientific community's RDIC to support water sector transformation
Source: EPU, 12th MP, 2021

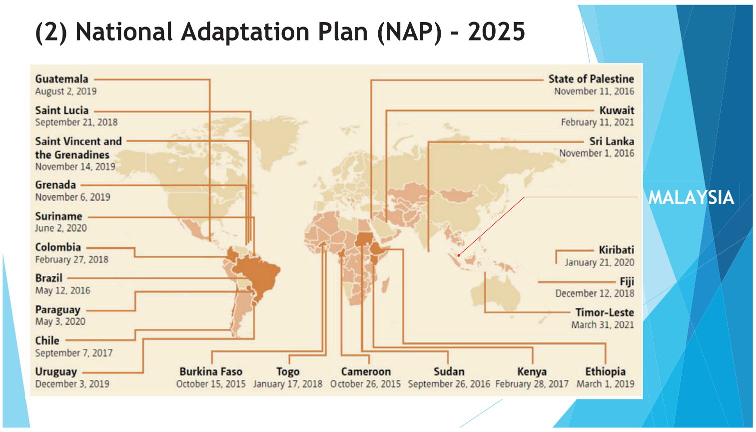

4. TECH. ADOPTION : APPLICATION OF THE 10-10 MySTIE FRAMEWORK TO THE WATER SECTOR
Catch-up (Current) Technologies
Autonomous oceanic waste capture systems with anti-collision beacons and real-time tracking and monitoring
Mapping at-risk aquatic species using machine learning algorithms
Drought and flood forecasting for effective reservoir management and early disaster mitigation
Drones and sensors for monitoring water quality in the rivers
Satellite imagery and AI algorithms for real-time monitoring of sustainable fisheries
River robots for automated waste collection and recycling
Connected water supply lines using AI and IoT sensors for predictive maintenance
5/6-G
Sensor Technology
3/4/5D-Printing
Advanced Materials
Advanced Intelligence Systems
Cyber-Security & Encryption
Augmented Analytics & Data Discovery
Blockchain
Neuro Technology
Bioscience Technology
AI and deep learning algorithms to monitor quality and predict future availability of transboundary water resources
Nanoparticles for pollutant removal
Wireless sensor networks for automated pollution detection
Nanomaterials for efficient water desalination and water treatment plants
Blockchain technology for sustainable digital management of water
Real-time monitoring of biological environmental sensors in water supplies using autonomous microscopes for early supply threat detection
Leap-frogging Technologies
(Next-Generation Research & Applications)
Cross-linkages with other sectors
(Shared Prosperity Model)
Smart Technology & Systems
Advanced filtration reactor systems for industrial waste resource and water reclamation
How can other sectors leverage on Water Sector innovations?
Agriculture & Forestry
+
Smart Cities & Transportation
Integration of stormwater capture and purification systems with urban vertical farming.
rce : M. Nair, 2020; ASM, 2020


10. RDIC : NATIONAL WATER INNOVATION ROADMAP (2021 – 2040)
Prepared by: National Water Research Institution of Malaysia (NAHRIM)
Further information please contact webmaster@nahrim.gov.my / bsh@kasa.gov.my
CLEAN RIVER (CR)
• Odour Threshold & Sensor for Pollution Control
• Apps & Portal for National River Trail (DSK)
• River Eyes
• Water Quality Enhancement
• Established Method/ Threshold for Water Borne Disease (WBD) including pandemic - Emerging Pollutants
RESERVE MARGIN (RM)
• Off-River Storage (TAPS - Raw Water)
• Coastal Reservoir (Raw Water)
• Underground Dam (Treated Water)
• Rainwater Harvesting(PAH)
• Reclaimed Water
• National Water Grid
Rain
Sea
Surface Run-off Management
Flood / drought / land slide disasters
Natural river / lake
Treatment of Seawater to drinking water in Water Treatment Plant (WTP)
Treatment of raw water to drinking water in Water Treatment Plant (WTP)
Reclaimed water treatment in Sewerage Treatment Plant
Non-potable Water
Industry
Residential
Sewage treatment system (non- faeces) / constructed wetlands
Collection of sewage (non-faeces)
Flood retention pond/ off-river storage/ groundwater storage
Environmental Friendly Drainage System (MSMA)
SMART WATER (SW)
• Local SME Entrepreneurship
• Renewable Energy
DISASTER RISK REDUCTION (DRR)
• IR4.0
• River & Coastal Integrated System
• Flood Control
WATR FINANCE (WF)
• PAAB Diversification

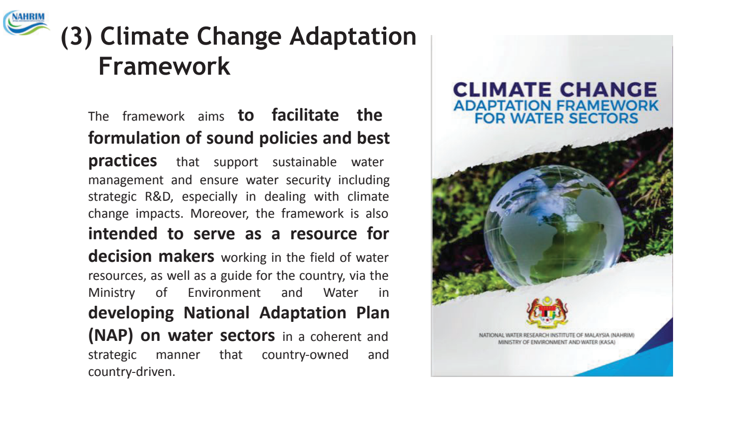

▪ IMPROVING CLIMATE RESILIENCE
A PROSPEROUS, INCLUSIVE, SUSTAINABLE MALAYSIA

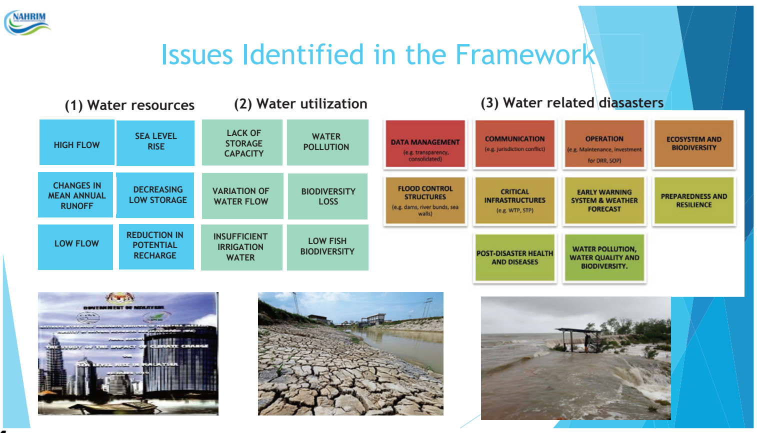

implementing a low carbon, clean & resilient development
Incorporating climate change impacts and disaster risks in policy planning and implementation to enable evidence-based and risk-informed actions.
Expanding vulnerability assessments covering more high-risk and sensitive areas, communities and sectors
Enhancing monitoring and assessment of natural hazards to further improve disaster preparedness and response measures.
Enhancing the ability of hydro-climate models to represent the dynamical process and project precipitation variation & integrated with multi-hazard risk assessments to incorporate climate variabilities, sea-level rise, storm surges and abnormally high tides.
Strategy A1 Moving Towards a Low-Carbon Nation
Strategy A2 Accelerating Transition to the Circular Economy
Strategy A3 Sharing Responsibility in Pollution Prevention
Strategy A4 Increasing Resilience against Climate Change and Disasters
Source: EPU, RMK12, 2021

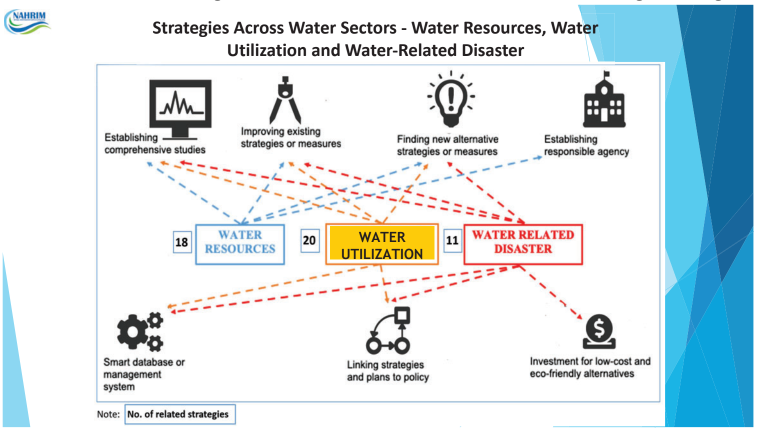

(1) Paris Agreement : Updated Nationally Determined Contribution (NDC 2021)
The IWRM is strengthened with the implementation of IRBM & IFM
Management of Water Resources and Security
Protecting Coastal Resources
Securing Agriculture & Food security in Malaysia
NDC2021
Enhancing adaptation for forestry & biodiversity
Increasing resilience for infrastructure and cities
Improving Public Health Resilience
SLR & storm surge projections will be mainstreamed into coastal protection & development projects
Gazetting more forest water catchment area & preserving terrestrial & marine vulnerable ecosystem
Crops resilience to CC will be intensified
Adopting nature- based solutions & green city concept
Incorporating weather forecasts into risk maps of climate-sensitive disease
(NDC 2021) - highlighted revised projections of future climate changes, indicating that by the year 2100:
• Average annual surface temperature is expected to rise by 1.9 to 2.1°C;
• Magnitude of change of annual precipitation could range from 14.0% to 25.0%;
• Sea levels are projected to rise by about 0.7m.

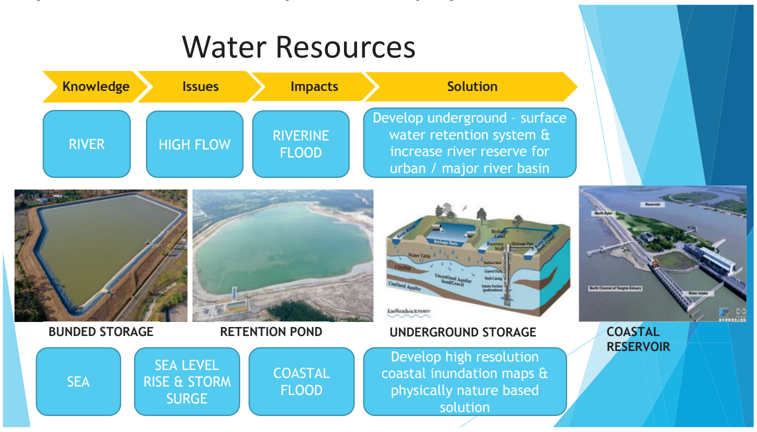

(2) National Adaptation Plan (NAP) - 2025
Guatemala August 2, 2019
Saint Lucia September 21, 2018
Saint Vincent and the Grenadines November 14, 2019
Grenada November 6, 2019
Suriname June 2, 2020
Colombia February 27, 2018
Brazil May 12, 2016
Paraguay May 3, 2020
Chile September 7, 2017
Uruguay December 3, 2019
Burkina Faso October 15, 2015
Togo January 17, 2018
Cameroon October 26, 2015
Sudan September 26, 2016
Kenya February 28, 2017
Ethiopia March 1, 2019
State of Palestine November 11, 2016
Kuwait February 11, 2021
Sri Lanka November 1, 2016
Kiribati January 21, 2020
Fiji December 12, 2018
Timor-Leste March 31, 2021
MALAYSIA

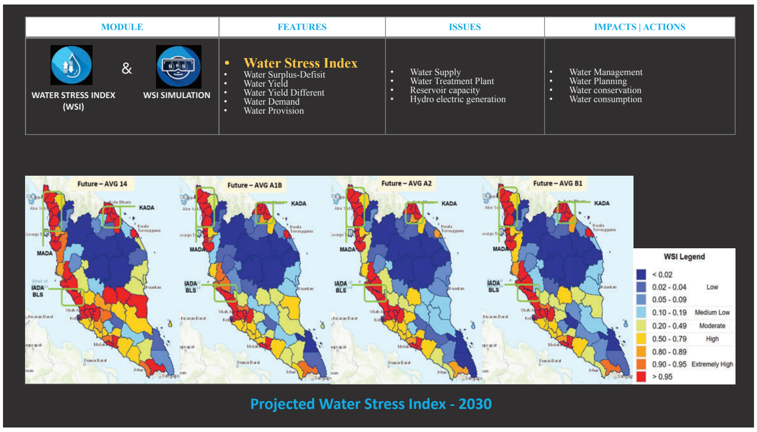

OVERCOME THE BARRIER & TO FORMULATE,IMPLEMENT AND MONITOR THE NAP PROCESS IN MALAYSIA
KEMENTERIAN ALAM SEKITAR DAN AIR
GREEN CLIMATE FUND
Management of Water Resources and Security
Protecting Coastal Resources
Securing Agriculture & Food security in Malaysia
NDC2021 | NAP 2025
Enhancing adaptation for forestry & biodiversity
Increasing resilience for infrastructure and cities
Improving Public Health Resilience
▪ Outcome 1 -Adaptation planning governance and institutional coordination strengthened
▪ Outcome 2 -Evidence basis used to design adaptation solutions for maximum impact
▪ Outcome 3 -Private sector engagement in adaptation catalysed
▪ Outcome 4 -Adaptation
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

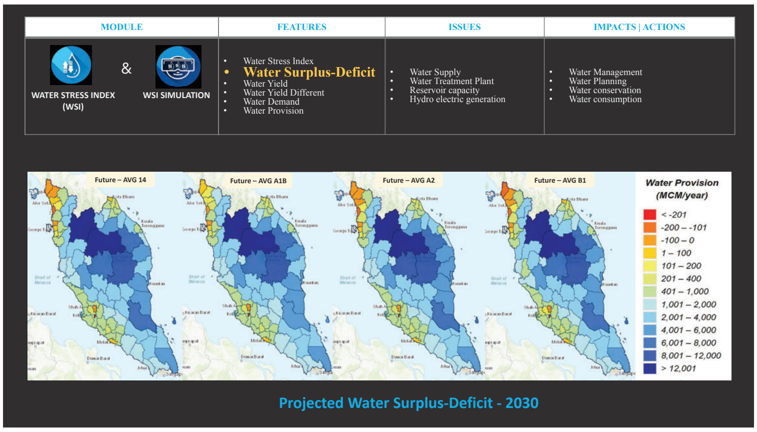

NAHRIM
(3) Climate Change Adaptation Framework
The framework aims to facilitate the formulation of sound policies and best practices that support sustainable water management and ensure water security including strategic R&D, especially in dealing with climate change impacts. Moreover, the framework is also intended to serve as a resource for decision makers working in the field of water resources, as well as a guide for the country, via the Ministry of Environment and Water in developing National Adaptation Plan (NAP) on water sectors in a coherent and strategic manner that country-owned and country-driven.
CLIMATE CHANGE
ADAPTATION FRAMEWORK
FOR WATER SECTORS
NATIONAL WATER RESEARCH INSTITUTE OF MALAYSIA (NAHRIM)
MINISTRY OF ENVIRONMENT AND WATER (KASA)

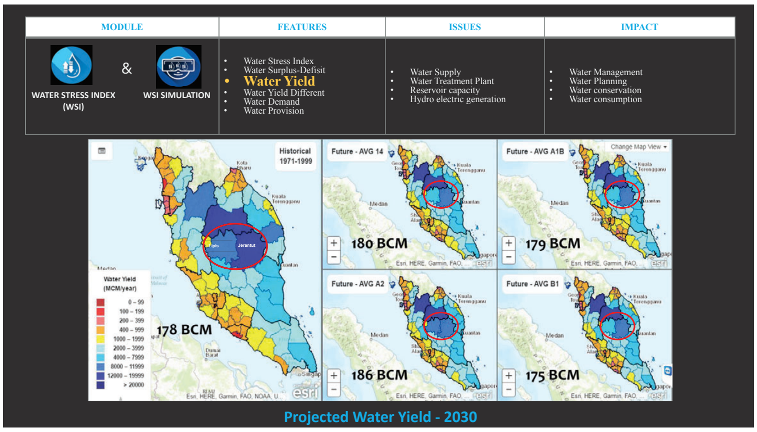

NAHRIM
Issues Identified in the Framework
(1) Water resources
HIGH FLOW
SEA LEVEL RISE
CHANGES IN MEAN ANNUAL RUNOFF
DECREASING LOW STORAGE
LOW FLOW
REDUCTION IN POTENTIAL RECHARGE
(2) Water utilization
LACK OF STORAGE CAPACITY
WATER POLLUTION
VARIATION OF WATER FLOW
BIODIVERSITY LOSS
INSUFFICIENT IRRIGATION WATER
LOW FISH BIODIVERSITY
(3) Water related disasters
DATA MANAGEMENT
COMMUNICATION
OPERATION
ECOSYSTEM AND BIODIVERSITY
FLOOD CONTROL STRUCTURES
CRITICAL INFRASTRUCTURES
EARLY WARNING SYSTEM & WEATHER FORECAST
PREPAREDNESS AND RESILIENCE
POST-DISASTER HEALTH AND DISEASES
WATER POLLUTION, WATER QUALITY AND BIODIVERSITY.

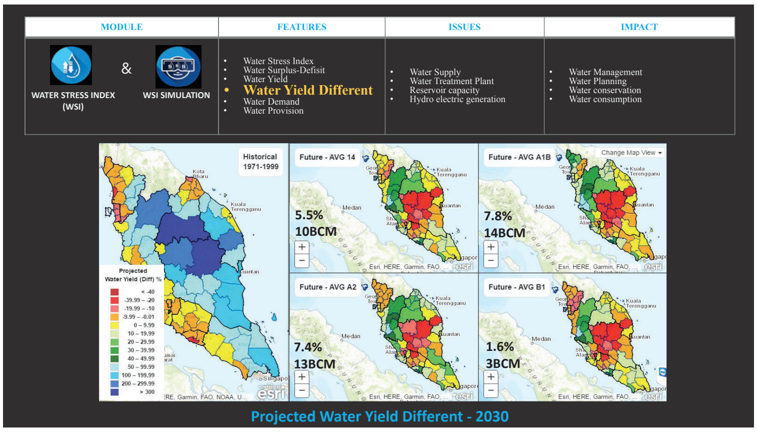

Strategies Across Water Sectors - Water Resources, Water Utilization and Water-Related Disaster
Establishing comprehensive studies
Improving existing strategies or measures
Finding new alternative strategies or measures
Establishing responsible agency
18
WATER RESOURCES
20
WATER UTILIZATION
11
WATER RELATED DISASTER
Smart database or management system
Linking strategies and plans to policy
Investment for low-cost and eco-friendly alternatives
Note: No. of related strategies


Water Resources
Knowledge
Issues
Impacts
Solution
RIVER
HIGH FLOW
RIVERINE FLOOD
Develop underground - surface water retention system & increase river reserve for urban / major river basin
BUNDED STORAGE
RETENTION POND
UNDERGROUND STORAGE
COASTAL RESERVOIR
SEA
SEA LEVEL RISE & STORM SURGE
COASTAL FLOOD
Develop high resolution coastal inundation maps & physically nature based solution


MODULE
FEATURES
ISSUES
IMPACTS | ACTIONS
WATER STRESS INDEX (WSI)
&
WSI SIMULATION
Water Stress Index
Water Surplus-Defisit
Water Yield
Water Yield Different
Water Demand
Water Provision
Water Supply
Water Treatment Plant
Reservoir capacity
Hydro electric generation
Water Management
Water Planning
Water conservation
Water consumption
Future – AVG 14
Future – AVG A1B
Future – AVG A2
Future – AVG B1
WSI Legend
Projected Water Stress Index - 2030


MODULE
FEATURES
ISSUES
IMPACTS | ACTIONS
WATER STRESS INDEX (WSI)
&
WSI SIMULATION
Water Stress Index
Water Surplus-Deficit
Water Yield
Water Yield Different
Water Demand
Water Provision
Water Supply
Water Treatment Plant
Reservoir capacity
Hydro electric generation
Water Management
Water Planning
Water conservation
Water consumption
Future – AVG 14
Future – AVG A1B
Future – AVG A2
Future – AVG B1
Water Provision (MCM/year)
Projected Water Surplus-Deficit - 2030


MODULE
FEATURES
ISSUES
IMPACT
WATER STRESS INDEX (WSI)
&
WSI SIMULATION
Water Stress Index
Water Surplus-Defisit
Water Yield
Water Yield Different
Water Demand
Water Provision
Water Supply
Water Treatment Plant
Reservoir capacity
Hydro electric generation
Water Management
Water Planning
Water conservation
Water consumption
Historical 1971-1999
178 BCM
Future - AVG 14
180 BCM
Future - AVG A1B
179 BCM
Future - AVG A2
186 BCM
Future - AVG B1
175 BCM
Projected Water Yield - 2030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WATER STRESS INDEX (WSI)
&
WSI SIMULATION
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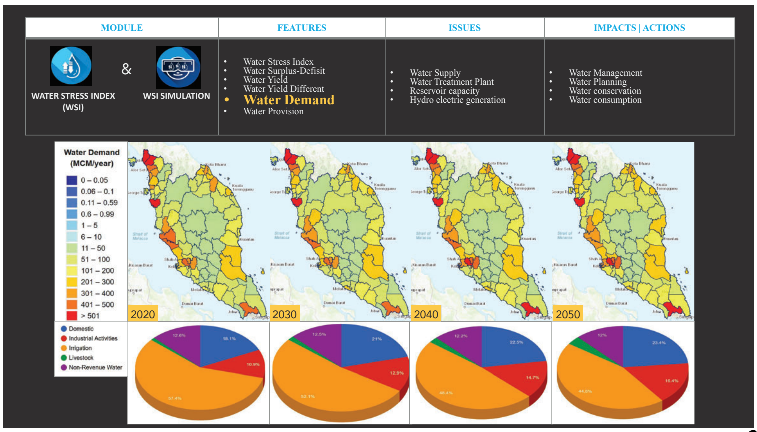
Water Yield
Water Yield Different
Water Demand
Water Provision
Water Supply
Water Treatment Plant
Reservoir capacity
Hydro electric generation
Water Management
Water Planning
Water conservation
Water consumption
Historical 1971-1999
Future - AVG 14
5.5%
10BCM
Future - AVG A1B
7.8%
14BCM
Future - AVG A2
7.4%
13BCM
Future - AVG B1
1.6%
3BCM
Projected Water Yield Different - 2030


MODULE
FEATURES
ISSUES
IMPACTS | ACTIONS
WATER STRESS INDEX (WSI)
&
WSI SIMULATION
Water Stress Index
Water Surplus-Defisit
Water Yield
Water Yield Different
Water Demand
Water Provision
Water Supply
Water Treatment Plant
Reservoir capacity
Hydro electric generation
Water Management
Water Planning
Water conservation
Water consumption
Water Demand (MCM/year)
2020
2030
2040
2050


KEY MESSAGES
A PROSPEROUS, INCLUSIVE, SUSTAINABLE MALAYSIA

KEY MESSAGES

- Planning & Implementing Water Management through IWRM towards Future Climate
- Planning, Improving & Implementing Water Infrastructure Safety and Risk Reduction for Climate Resilience
- Mainstreaming & Implementing climate change adaptation initiatives through National Adaptation Plan (NAP) & Malaysia Development Plan
- Implementing Water Sector Transformation in Malaysia Development Plan

SESSION A3 :
SUSTAINABLE GROUNDWATER MANAGEMENT TOWARDS SDGS

Session A3: Groundwater and SDG

This session title is "Sustainable Groundwater Management towards the SDGs" which particularly focuses on the groundwater part of the water but is also related to the sustainable development goals. In this topic, there are global and local groundwater issues related to the SDGs.

1. Prof. Dr. Makoto Taniguchi, the Research Institute of Humanity and Nature (RIHN), Kyoto Japan

The historical change related to groundwater and industrialization in Asia . You can see that the Y-axis real GDP share in the world and since 17th centuries up to now in the pre-industrialization period the real GDP share is highest in Asia. But during the industrialization that Europe and the US increased after 1950 (or after World War Two), Asia increased again. So, you can see the shift of the economic driver and pre-industrialization period there was large population support in Monsoon Asia can make this kind of high share of the GDP in Asia. But in the industrialization period, the global economy rises by fossil fuels and the energy transition through fossil fuels and the economic boom in Asia after World War Two. So, combining fossil fuels and abundant water including groundwater in Asia created a huge economic development and environmental problem such as land subsidence, groundwater contamination, and so on.

So, we adopted nexus approach for system dynamics and we care about a tradeoff facility between resources, including the groundwater, society, economy, environment, local, national, global, past present, and future toward the SDGs. We collect all types of hard data that are related to the SSE; social, economy, environment, and WEFL; food, energy, water, and climate change. And then we made the indices how much the indices related to the SDGs. The indices of SEE-Water, SEE-Energy, SEE-Food, SEE-Land, and SEE-WEFL SDGs are calculated and represented as warmer color shows less sustainability and blue color shows more sustainability in terms of the SEE nexus indices as shown in Figure 2.

Finally, we can summarize that enough food on the industrial material/goods which consumes groundwater are globally traded, then distant areas and countries are indirectly connected with groundwater footprint. Therefore, groundwater issue is not only local but also global issue. For achieving the sustainable development goals (SDGs), it's important to manage groundwater as nexus, which connects direct and indirect, local and global, water-energy-food, and economy-environmental-society. Increasing efficiency of the groundwater use makes reduction of the energy consumption, then it creates a synergy among the water and energy for carbon neutrality and sustainable groundwater management. And a good practice like Kumamoto with synergy of the nexus and transboundary governance of groundwater is important for achieving SDGs not only locally but also globally.

2. Dr. James W. LaMoreaux, Chairman at PELA GeoEnvironment, USA

The topic today is groundwater science issues and research trends as they relate to sustainable water and climate change management after COVID-19.

Hydrogeology plays major role in all aspects of environmental planning, execution and implementation. Without a safe sustainable water supply, life cannot exist and hopes for prosperity are limited. Much of future world demands will be made up of the groundwater component. In fact, the United Nations has identified water resources as a top priority. Attention is particularly drawn to freshwater stress which relates water withdrawal to the percentage of water available. Based on current rate of usage, the United Nations is not optimistic about the global water outlook.

The aims and scope of environmental earth sciences (EES) is concerned with the interaction between humans, natural resources, ecosystems, special climates, or unique geographic. The major disciplines include hydrogeology, hydrochemistry, geochemistry, geophysics, engineering geology, remediation science, natural resources management, environmental climatology and biota, environmental geography, soil science, and geomicrobiology. There are some of the commissions that IAH has there are groundwater and climate change, groundwater and energy, groundwater research, cars hydrogeology, managing accurate recharge, mineral and thermal waters, regional groundwater flow, and transboundary efforts.

The UN Water Partners or International Association of Hydrogeologists (IAH) is partners along with IGRAC and so forth. Their groundwater resources are under increasing pressure due to human activities and climate change. So, UNESCO and IGRAC have put out groundwater over to publication that showcases the essential issues of groundwater informs about groundwater related activities enhances knowledge exchange and collaboration, and raises awareness about our most important hidden research.

One of the groundwater overview courses is climate variability as the world’s largest distributed store of freshwater, groundwater plays a central part in sustaining ecosystems and enabling human adaptation to climate variability and change. Aquifers have a buffering capacity and they’re naturally more resistant to external impact than surface waters. Since the variability of surface water availability is increasing due to climate change, the strategic importance of aquifers for water and food security is clearly growing.

In regard to economics, groundwater resources are extensively used in production processes by large international companies all over the world. Accordingly, international investors are being encouraged to share broader societal and environmental costs of groundwater. Understanding the value of groundwater would be an additional incentive for investors and asset managers to participate, leading eventually to investment risk reduction.

Finally, as a summary, there are a number of research trends some of the more important ones include remote sensing increasingly used for aquifer management. Satellite data interpretation for drought and long-term weather forecasting. Bringing more real-time reporting data online via the web. Cross-disciplinary training. Regional, national and international emphasis on improving water use agreements and best practices. More collaborative studies among consortium universities of corporations. And water as an economic commodity or is a natural right.

3. Prof. Dr. Yonghui Yang, Center for Agricultural Resources Research, IGDB Chinese Academy of Sciences, China

The topic ‘Assessing recent hydrological changes and groundwater depletion under various policy changes and newly delivered water in the North China Plain’ was presented by Prof. Yonghui Yang. He starts the topic with the problem of groundwater depletion. Groundwater is a very big problem for food production. North China Plain is one of the world most concerned regions of groundwater depletion. He shows the groundwater depletion map in North China Plain by comparing water tables between 1974 and 2004. In total, about 180-200 km3 of groundwater was overused so far. This problem has existed for a long time. And since 2012, our central government try to make a sustainable society. They developed the policies of groundwater use by largely reducing groundwater use for industrial and domestic purposes in the cities, cutting the plantation of high-water consumption winter wheat, by 50,000-150,000 ha annual with governmental subsidy, and increasing water use from Yangtze River through the middle route of the South to North Water Transfer Project.

So, what is happening with the groundwater? He shows the shallow aquifer and the deep aquifer. Simple crop pattern needs large efforts to remain sustainable groundwater use. Present wheat plantation decrease ranging from 50,000 ha to 150,000 ha will not likely to solve the groundwater depletion problem.

In some big cities like Beijing, the groundwater is recovering because of a lot of water from the Yangtze River. He shows the observed groundwater level in Luancheng Experimental station that has been declined since 1975 but has been stabilized since 2016 because of much water from Yangtze River therefore the ground water is recovery. That is a good signal. For the North China Plain according to his analysis using the GRACE data, groundwater basically stabilizes from 2016 even it has a bit drop. However, much higher rainfall in 2016, 2018, and 2021 also large contributes to the stabilization of the groundwater level.

So, the conclusions are crop adjustment, replacing groundwater with Yangtze River water for domestic and industrial use, and relatively high rainfall is beneficial for regional groundwater sustainability. In general, groundwater decline has been greatly slowed down. However, in the whole North China Plain, groundwater depletion may still remain. Evapotranspiration is still increasing slightly especially in the South part of the area. Groundwater stabilization looks not confirmed yet. It needs to be observed in long term maybe with more efforts, especially for the Southeast part of the area.

4. Dr. Hans Thulstrup, Senior Programme Specialist, UNESCO Jakarta
Groundwater for Sustainability Contributions towards the 2030 Agenda and the Sustainable Development Goals

The SDGs are a universal call for action to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity by 2030. The presentation focused on SDG6 (clean water and sanitation). The importance of groundwater with sustainability is a cross-central goal. The groundwater system is complex and related directly or indirectly to the way we live and the way we conduct various economic activities. This is also related to climate change, biodiversity, consumption, and production. Therefore, groundwater flows through all of the SDGs because without water, there would be no life. Indeed, according to the World Water Assessment Program:

Sustainable groundwater is a key element in global resilience to climate change, a shield against ecosystem loss, and a defense against human deprivation and poverty. Groundwater underpins irrigated agriculture and energy production. It supports food security and economic development. It is essential to the health of all living things.

In Asia, there are 129 shared aquifers. The total transboundary area is more than 9 million km2. A total of 38 countries in Asia have been identified as having internationally shared aquifer basins. However, aquifer stress in the region has increased significantly over the past 50 years, especially in areas, such as the Middle East of Saudi Arabia, Jordan, and the Mekong Delta region. A survey conducted by the Transboundary Water Assessment Program reported that out of 25 transboundary aquifers in Asia, only about 50% have water resources that are entirely suitable for human consumption due to serious groundwater quality issues. Thus, there is a risk of increased regional conflict due to competition over limited water resources.

Numerous activities have been initiated to improve our understanding of this issue and to develop better transboundary aquifer inventories. However, we lack reliable comprehensive data, particularly in developing countries and regions; expertise and institutional support; and large-scale cooperation in the identification, assessment, and governance of the resource.

The presentation mentioned some reference to the Greater Mekong sub region and the challenges and efforts involved in sharing data and undertaking cooperation across Cambodia and Vietnam. There is significant stress on the Lower Mekong Delta aquifer, in which groundwater levels have significantly declined, along with the rise of sea water intrusion and arsenic pollution. Thus far, only a limited institutional framework for the investigation of transboundary aquifers has been established.

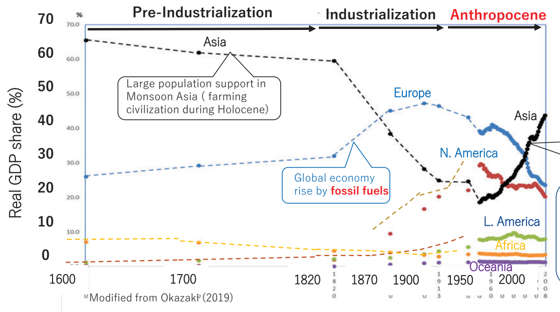
The UNESCO, FAO, and many other agencies are working together to develop new contexts to help address these challenges.

The speaker also referred to the groundwater management practices applied in Denmark. The basic principles that have allowed for the sustainable management of water resource in Denmark are strong knowledge, strong national commitment, transparent regulatory system, partnerships, and generally high levels of public and political concern and awareness. The country also used the Five M's, an integrated management approach involving mapping, measurement, monitoring, and modeling, as the basic elements that have allowed for the sustainable management of groundwater in the country.

Sustainable Groundwater Management towards SDGs

Makoto Taniguchi
Research Institute for Humanity and Nature (RIHN)

(1) Industrialization & Nexus (Water-Energy)



Shift of the economic driver

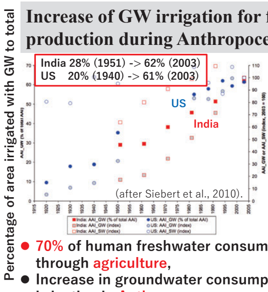
Energy transition to fossil fuels and economic boom in Asia

Combining fossil fuels and abundant water in Asia, created a huge economic development (synergy) and environmental problems (tradeoff) in Anthropocene

(2) Green revolution & Nexus (Water-Food)

HB →Chem. fertilizer ⇧→Food production ⇧ → Water consumption ⇧

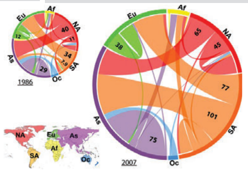
Increase of GW irrigation for food production during Anthropocene



- 70% of human freshwater consumption is through agriculture,
- Increase in groundwater consumption for irrigation in Anthropocene

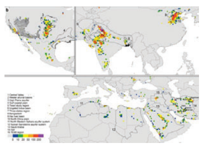
Acceleration of GW depletion

-12.6 billion ton/year (1960) → -28.3 billion ton/year (2000)



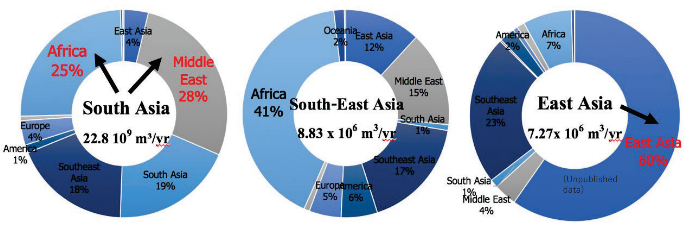
Virtual groundwater flow through global food trade

(Dallin, Taniguchi, Green, *Global Sustainability, 2020*)



GW depletion (mm/y)
(1980-2009, Döll *et al.* (2014))

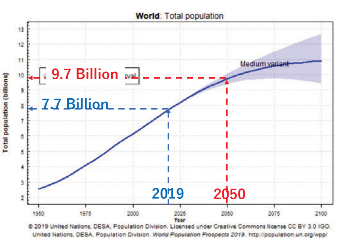
Virtual water export via food trade from sub-region in Asia



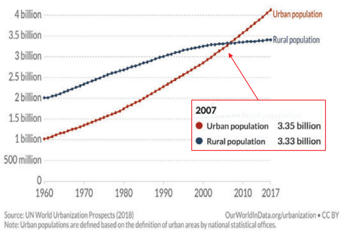
- "Footprints" which can visualize the tele-connection and internalize the external environment, are good tools for analyzing multi-scale stewardship and sustainability.
- Resources (food, water, energy, etc.) and environment are connected, and should be governed by integrated manner

(3) Urbanization & Water-Energy-Food Nexus

World Population ↑



Urbanization ↑

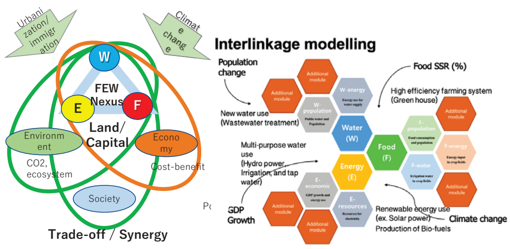


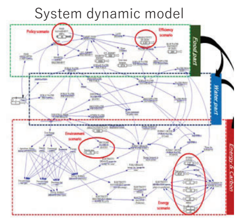
Population in Urban
30 % at 1950
68 % at 2050

Belmont Forum projects "Sustainable Urbanization Global Initiative: Food-Water-Energy Nexus"

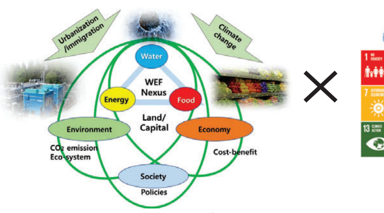
Intelligent Urban Metabolic Systems for Green Cities of Tomorrow: an FWE Nexus-based Approach (2018-2021)

Taipei	Chicago
F. Chang	L. Rodriguez
Kyoto	Sao Paulo
M. Taniguchi	J. Filho





Nexus Approach
for system dynamic



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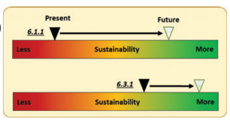
SDGs
for goals and scenarios

Tradeoff and synergy between:
- Resources (water, energy, food, land, etc.)
- Society, Economy, Environment
- Local, National, Global
- Past, Present, Future

SDGs indicators



Disconnection of governances/institutions

Conservation vs Development

Ministry of Environment ⟷ Ministry of Economy, Trade and Industry

Consumption vs Production

Consumption of resources ⟷ Production of resources

Water

Ministry of Land, Infrastructure and Transport

Energy: Ministry of Economy, Trade and Industry ⟷ **Food**: Ministry of Agriculture, Forest and fishery

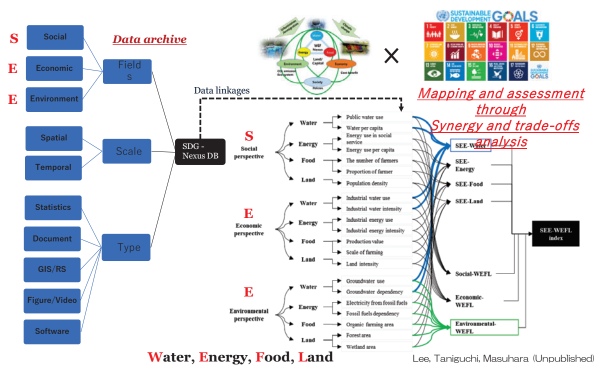
New Comers
*Hot spring power generation
*Micro hydropower
(Energy vs Water)

Global vs National vs Municipal

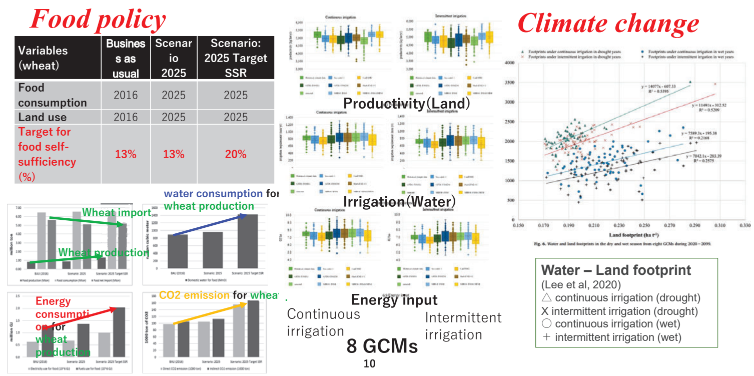
International bodies ⟷ Ministry ⟷ Municipal authority

A framework of SDGs-Nexus

SEE (Social, Economy, Environment) -WEFL (Water, Energy, Food, Land)

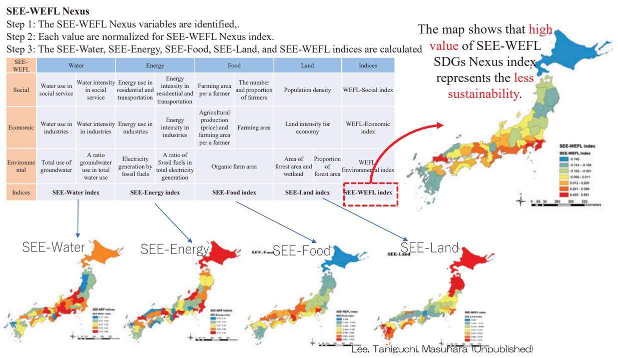


(4) Nexus analyses with scenarios

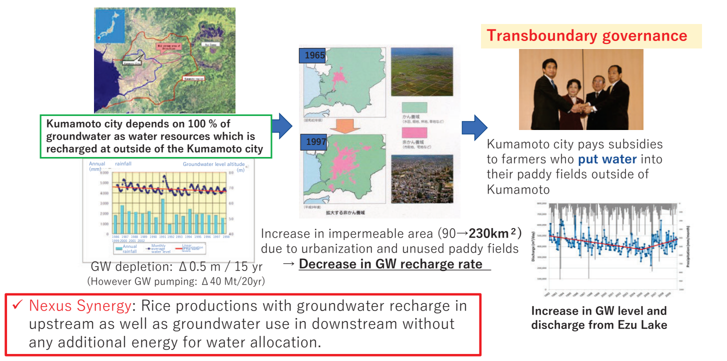


SEE-WEFL SDGs-Nexus indicators

SEE (Social, Economy, Environment) -WEFL (Water, Energy, Food, Land)

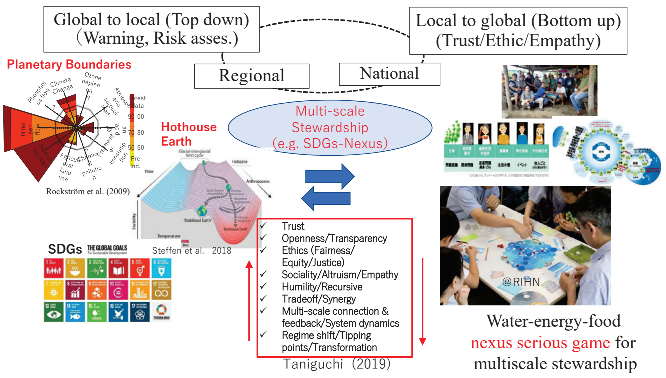


Recovery of lost synergy of water-energy-food nexus



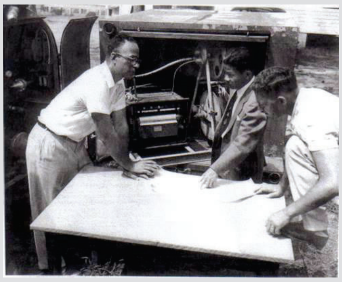
Taniguchi et al. 2019, Frontiers in Env. Sci.

Multiscale Stewardship



Summary

- Food and industrial materials/goods which consumes groundwater are globally traded, then distant areas and countries are indirectly connected with groundwater footprint. Therefore, groundwater issue is not only local but also global issue.
- For achieving the sustainable development goals (SDGs), it is important to manage groundwater as nexus, which connects direct and indirect, local and global, water-energy-food, and economy-environment-society.
- Increasing efficiency of groundwater use makes reduction of energy consumption, then it creates a synergy among water and energy for carbon neutrality and sustainable groundwater management.
- A good practice with synergy of nexus and transboundary governance of groundwater is important for achieving SDGs not only locally but also globally.



Dr. Philip LaMoreaux (left), honored as the Father of Groundwater in Thailand.

Groundwater Science: Issues and Research Trends

Presented at

THA 2022 International Conference on Moving Towards Sustainable Water and Climate Change Management After COVID-19

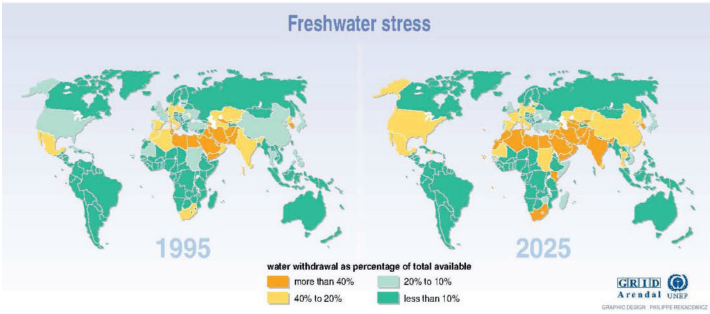
January 26 – 28, 2022

by Dr. James W. LaMoreaux
Editor Discover Water
Chairman P.E. LaMoreaux & Associates, Inc.

- **Hydrogeology plays major role in all aspects of environmental planning, execution and implementation.**
- **Without a safe sustainable water supply, life cannot exist and hopes for prosperity are limited.**
- **Much of future world demands will be made up of groundwater component.**

- **United Nations has identified water resources as a top priority.**
- **Attention is particularly drawn to freshwater stress which relates water withdrawal to percentage of water available.**
- **Based on current rate of usage, UN is not optimistic about the global water outlook.**

Global Water Outlook Not Optimistic



Source: Global environment outlook 2000 (GEO), UNEP, Earthscan, London, 1999.

AP Associated Press 1/25/2008
UN calls water top priority

To address this issue, mankind needs to embrace sustainable water development (SWD). SWD is "the development of water in a manner in which [an] adequate supply of good quality water is sustained and the watercourse ecosystem is maintained for the uses of future generations."

Source: Pichyakorn, 2002

Water quantity and water quality are inextricably linked; therefore there needs to be rapid movement towards SWD in developed and developing countries.

SWD includes five specific elements:

(1) The right to use water;
(2) The protection of water resources and prevention of water degradation;
(3) The maintenance of water flow;
(4) An ecosystem related approach; and
(5) The procedural elements to achieve sustainable development.

- Right to use water involves comprehensive permitting with continuing review; strategic counseling, crisis management, creative dispute resolution; and enhanced relations with stakeholder and community groups.
- Protection of water resources and prevention of water degradation includes addressing non- point sources of pollution on a national, regional and local basis; land use controls; integration of water and land management; and regulation of interbasin transfers.

- Maintenance of water flow involves instream flows and environmental flows and may require appropriate controls.

- An ecosystem related approach should not be limited only to watercourse mainstream or tributaries; it should also incorporate terrestrial and marine environment interaction; promote health of the entire ecosystem; and actively involve watershed management authorities.

To move toward SWD, freshwater should be managed in a holistic manner, or in other words - an ecosystem approach.

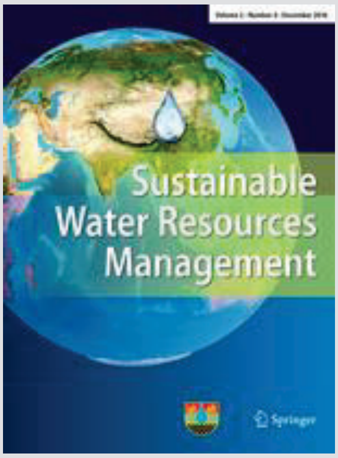
"Management of water resources is holistic when it is done on a catchment or drainage basin basis. This includes both land and water resources, since land use can have significant impacts on freshwater and related ecosystems…. Thus water legislation should provide for a holistic, ecosystem approach to the management of water…."

Steve McCaffrey and Greg Weber – **GUIDEBOOK FOR POLICY AND LEGISLATIVE DEVELOPMENT ON CONSERVATION AND SUSTAINABLE USE OF FRESHWATER RESOURCES (2005)**

UN Sustainable Development Goal 6: Access to Water and Sanitation

- Clean, accessible water for all is an essential need of the world. There is sufficient fresh water on earth to achieve this. Due to bad economics or poor infrastructure, millions of people, most of them children, die from diseases associated with inadequate water supply, sanitation and hygiene.
- Water scarcity, poor water quality and inadequate sanitation negatively impact food security, livelihood choices and educational opportunities for poor families. Drought afflicts some of the world's poorest countries, worsening hunger and malnutrition.
- By 2050 one in four people is likely to live in a country affected by chronic or recurring shortages of fresh water.

Research Trends in Selected Prominent Journals



Sustainable Water Resources Management (SWAM)

Aims and Scope: SWAM

- This peer-reviewed journal explores wide-ranging developments and challenges in pursuit of practical, sustainable water resource management; and
- Addresses a broad range of topics in water resources management;
- Covers geopolitical and socio-economic effects and constraints;
- Includes such topics as natural and man-induced contamination of water resources, surface and ground water interaction, managed aquifer recharge and storage ;
- Addresses water resources management, sustainability of water resources, ground and surface water quality and quantity, water use and reuse, surface and ground water interaction, aquifer recharge, storage and more.

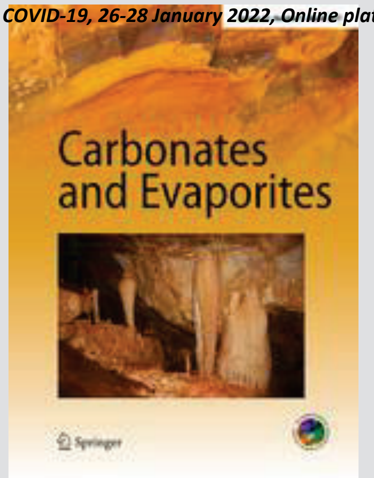
4.2 Top 10 Full-Text Article Requests 2017 (all publication years)

Title	Author	Article Type	Volume	Issue	Year	Article Requests 2017
Water quality assessment of lake water: a review	Rachna Bhateria et al.	Original Paper	2	2	2016	3,476
An overview to flood vulnerability assessment methods Open Access	Hajar Nasiri et al.	Original Paper	2	3	2016	3,409
Development of an analytical function for optimizing the capacity of spring water storage structure	A. K. Vashisht	Original Paper	2	4	2016	2,097
Removal of iron and manganese from drinking water supply	G. K. Khadse et al.	Original Paper	1	2	2015	2,058
Environmental challenges of trans-boundary water resources management: the case of Bangladesh	Mohammed Abdul Baten et al.	Original Paper	2	1	2016	1,795
A review: dew water collection from radiative passive collectors to recent developments of active collectors	B. Khalil et al.	Original Paper	2	1	2016	1,788
Assessment of water scarcity and its impacts on sustainable development in Awash basin, Ethiopia	Dereje Adeba et al.	Original Paper	1	1	2015	1,149
Domestic wastewater treatment performance using constructed wetland	J. S. Sudarsan et al.	Original Paper	1	2	2015	1,123
WEAP modeling of surface water resources allocation in Didessa Sub-Basin, West Ethiopia	Tena Bekele Adgolign et al.	Original Paper	2	1	2016	1,029
Hydropower for sustainable water and energy development in Ethiopia	Dagmawi Mulugeta Degefu et al.	Original Paper	1	4	2015	1,024

This slide excludes articles with unexplained peaks in downloads during the reporting period.
Source: COUNTER Reporting / Business Warehouse.

Sustainable Water Resources Management - 2017 Publisher's Report

Springer



Carbonates and Evaporites (CAEV)

Aims and Scope - CAEV

- Examines and provides a forum for all aspects of carbonate and evaporite geology;
- Provides a forum for the exchanges of ideas on all aspects of carbonate and evaporite geology;
- Includes origin and stratigraphy of carbonate and evaporite rocks and issues unique to these rock types;
- Karst weathering phenomena, engineering and environmental issues, mining and minerals extraction, and caves and permeability.

4.2 Top 10 Full-Text Article Requests 2017 (all publication years)

Title	Author	Article Type	Volume	Issue	Year	Article Requests 2017
Tectonic evolution and paleokarstification of carbonate rocks in the Paleozoic Tarim Basin Open Access	Xuhui Xu et al.	Original Paper	32	4	2017	567
Carbonate phases rich in magnesium in the Triassic limestones of the eastern part of the Germanic Basin Open Access	Katarzyna J. Stanienda	Original Paper	31	4	2016	334
Ultrasonic investigations of marble columns of historical structures built in two different periods	Ali Erden Babacan et al.	Original Paper	30	3	2015	286
Special topical issue: karst waters of Europe	James W. LaMoreaux	Editorial Notes	31	4	2016	280
Carbonate diagenetic products and processes from various diagenetic environments in Permian paleokarst reservoirs: a case study of the limestone strat	Xuesong Tian et al.	Original Paper	32	2	2017	275
Sedimentology and sequence stratigraphy of evaporites in the Middle Jurassic Buqu Formation of the Qiangtang Basin, Tibet, China	Xiaoqun Yang et al.	Original Paper	32	3	2017	259
Synthesis of precipitated calcium carbonate: a review	Onimisi A. Jimoh et al.	Original Paper	#	#	2017	257
A qualitative and quantitative model for climate-driven lake formation on carbonate platforms based on examples from the Bahamian archipelago Open Access	Lisa E. Park Boush et al.	Original Paper	29	4	2014	253
Laboratory simulation experiment on dissolution of limestone under hydrodynamic pressure Open Access	Qi Liu et al.	Original Paper	28	1-2	2013	251
Depositional environment characteristics of Uluk la Evaporites, Central Anatolia, Turkey	Şeref Keskin et al.	Original Paper	32	2	2017	243

This slide excludes articles with unexplained peaks in downloads during the reporting period.
Source: COUNTER Reporting / Business Warehouse.

Carbonates and Evaporites - 2017 Publisher's Report

Springer

Top ranking highest cited 2015-2016 articles for IF Year 2017 (Cont.)

Title	Author	Publication Type	Publication Date	DOI	Volume	Issue	Total Citations*	Citations for IF 2017
The importance of microbial mats for dolomite formation in the Dohat Faishakh sabkha, Qatar	Brauchli, Marisa; McKenzie, Judith A.; Strohmenger, Christian J.; Sadooni, Fadhil; Vasconcelos, Crisogono; Bontognali, Tomaso R. R.	Article	01-09-2016	10.1007/s13146-015-0275-0	31	3	5	2
The characteristics of dolomite reservoir in saline lacustrine Basin, Qaidam, China	Huang, Chenggang; Zhao, Fan; Yuan, Jianying; Wu, Lirong; Chen Gengxin	Article	01-09-2016	10.1007/s13146-015-0267-0	31	3	4	2
Facies analysis and depositional environment study of the mixed carbonate-evaporite Asmari Formation (Oligo-Miocene) in the sequence stratigraphic framework, NW Zagros, Iran	Daraei, Mehdi; Amini, Abdolhossein; Ansari, Morteza	Article	01-09-2015	10.1007/s13146-014-0207-4	30	3	4	2
Microstructures of consolidated Kaolin clay at different depths in centrifuge model tests	Cui, Zhen-Dong; Zhao, Ling-Zi; Yuan, Li	Article	01-03-2016	10.1007/s13146-015-0252-7	31	1	3	2
Identification of Neogene mixed lacustrine carbonate in western Qaidam basin	Zhao, Fan	Article	01-09-2015	10.1007/s13146-014-0210-9	30	3	3	2
Acid fluids reconstruction clastic reservoir experiment in Qaidam saline lacustrine Basin, China	Huang, Chenggang; Zhao, Fan; Yuan, Jianying; Sun, Ping; Zhang, Shiming	Article	01-09-2016	10.1007/s13146-015-0273-2	31	3	2	2

6.2 Altmetric Top 10 - 2017

How is the Altmetric score calculated? The score is a weighted count

The score is a weighted count of the different sources (newspaper stories, tweets, blog posts, comments) that mention the paper.

Why is it weighted? To reflect the relative importance of each type of source. It's easy to imagine that the average newspaper story is more likely to bring attention to the paper than the average tweet. This is reflected in the default weightings.

News	Blogs	Q&A forums	Twitter	Google+	Facebook
8	5	2.5	1	1	0.25

Score	Article DOI	Title	Author(s)	Publication Date
11	10.1007/bf03175407	Blue holes: Definition and genesis	JOHN E. MYLROIE, JAMES L. CAREW, AUDRA I. MOORE	01-09-1995
8	10.1007/s13146-017-0402-1	Methods for reconstruction of paleo-seawater pH based on boron isotopes in evaporative depositional sequences: case study using the Cambrian–Lower Ordovician evaporite sequence in the Tarim Block, NW China	JUNFENG YANG, YUNFENG ZHANG, YONGQUAN CHEN, LIJUAN ZHANG, CHANGJIAN ZHU, ZHENYU WANG	03-11-2017
3	10.1007/s13146-017-0337-6	Mathematical modeling of karstogenesis: an approach based on fracturing and hydrogeological processes	ANTOINE LAFARE, HERVÉ JOURDE, VÉRONIQUE LÉONARDI, SÉVERIN PISTRE, NATHALIE DÖRFLIGER	07-03-2017
2	10.1007/s13146-017-0341-x	Synthesis of precipitated calcium carbonate: a review	ONIMISI A. JIMOH, KAMAR SHAH ARIFFIN, HASHIM BIN HUSSIN, ADESUJI E. TEMITOPE	09-03-2017
2	10.1007/s13146-016-0311-8	Messinian evaporites in the Mesaoria Basin, North Cyprus: facies and environmental interpretations	BAKI VAROL, CAVIT ATALAR	16-07-2016

Score	Article DOI	Title	Author(s)	Publication Date
2	10.1007/s13146-016-0307-4	Tectonic evolution and paleokarstification of carbonate rocks in the Paleozoic Tarim Basin	XUHUI XU, QIANGLU CHEN, CHENGLIN CHU, GUORONG LI, CUNGE LIU, ZHENG SHI	14-07-2016
2	10.1007/s13146-017-0333-x	Using stable isotopes and major ions to identify hydrogeochemical characteristics of karst groundwater in Xide country, Sichuan Province	JIANFEI YUAN, FEN XU, GUOSHI DENG, YEQI TANG	14-02-2017
2	10.1007/s13146-017-0360-7	Genesis of Paleocene and Lower Eocene shallow-water nodular limestone of South Tibet (China)	MICHAELA M. KAHSNITZ, HELMUT WILLEMS	30-06-2017
2	10.1007/s13146-017-0345-6	Micropalaeontology and sedimentology of an inter-evaporite Arab-C carbonate exposure, Riyadh, Saudi Arabia	G. WYN HUGHES, R. F. LINDSAY	18-03-2017
2	10.1007/s13146-017-0340-y	Evaporation stage of paleo-saline lake in North Shaanxi salt basin China: insight from fluid inclusions in halite	TING DING	11-03-2017

Environmental Earth Sciences (EES)

Aims and Scope (EES)

- Environmental Earth Sciences is concerned with interaction between humans, natural resources, ecosystems, special climates or unique geographic zones, and the earth.
- Major disciplines include: hydrogeology, hydrochemistry, geochemistry, geophysics, engineering geology, remediation science, natural resources management, environmental climatology and biota, environmental geography, soil science and geomicrobiology.

- Water and soil contamination caused by waste management and disposal practices;
- Environmental problems associated with transportation by land, air, or water;
- Geological processes that may impact biosystems or humans;
- Man-made or naturally occurring geological or hydrological hazards;
- Environmental problems associated with the recovery of materials from the earth;
- Environmental problems caused by extraction of minerals, coal, and ores, oil and gas, water and alternative energy sources;
- Environmental impacts of exploration and recultivation – Environmental impacts of hazardous materials;
- Management of environmental data and information in data banks and information systems;
- Dissemination of knowledge on techniques, methods, approaches and experiences to improve and remediate the environment.

4 Usage

4.2 Top 10 Full-Text Article Requests 2017 (all publication years)

Title	Author	Article Type	Volume	Issue	Year	Article Requests 2017
Anthropogenic contamination of groundwater with nitrate in arid region: case study of southern Hodna (Algeria) Open Access	Salah Abdesselam et al.	Original Paper	70	5	2013	2,337
Mineralogical and geochemical analysis of Fe-phases in drill-cores from the Triassic Stuttgart Formation at Ketzin CO2 storage site before CO2 arrival Open Access	Monika Kasina et al.	Original Paper	76	4	2017	2,045
Environmental degradation assessment in arid areas: a case study from Basra Province, southern Iraq Open Access	Mushtak T. Jabbar et al.	Original Paper	70	5	2013	1,653
Energy storage in the geological subsurface: dimensioning, risk analysis and spatial planning: the ANGUS+ project Open Access	Alina Kabuth et al.	Original Paper	76	1	2017	1,630
Hydraulic fracturing: a toxicological threat for groundwater and drinking-water?	Birgit C. Gordalla et al.	Original Paper	70	8	2013	1,326
Impacts of climate change on stream flow and hydro power generation in the Alpine region Open Access	T. Wagner et al.	Original Paper	76	1	2017	1,265
Physical weathering of building stones induced by freeze–thaw action: a laboratory long-term study Open Access	J. Ruedrich et al.	Original Paper	63	7-8	2011	1,193
Aquatic effects of peat extraction and peatland forest drainage: a comparative sediment study of two adjacent lakes in Central Finland Open Access	T. Kauppila et al.	Original Paper	75	23	2016	1,069
Optimized extraction of dimension stone blocks Open Access	S. Mosch et al.	Original Paper	63	7-8	2011	1,060
Analysis of changes in climate and river discharge with focus on seasonal runoff predictability in the Aksu River Basin Open Access	Z. W. Kundzewicz et al.	Original Paper	73	2	2015	1,011

This slide excludes articles with unexplained peaks in downloads during the reporting period.
Source: COUNTER Reporting / Business Warehouse.

Environmental Earth Sciences - 2017 Publisher's Report

Springer

4 Usage

4.2 Top 10 Full-Text Article Requests 2017 (publication years 2015–2017)

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Analysis of changes in climate and river discharge with focus on seasonal runoff predictability in the Aksu River Basin Open Access	Z. W. Kundzewicz et al.	Original Paper	73	2	2015	1,011
GIS-based assessment of combined AHP and SAW methods for selecting suitable sites for landfill in Al-Musayiab Qadhaa, Babylon, Iraq Open Access	Ali Jalil Chabuk et al.	Original Paper	76	5	2017	959
Developing a groundwater vulnerability map for unconventional oil and gas extraction: a case study from South Africa Open Access	Surina Esterhuyse	Original Paper	76	17	2017	952
Field spectroscopy and radiative transfer modelling to assess impacts of petroleum pollution on biophysical and biochemical parameters of the Amazon r Open Access	Paul Arellano et al.	Original Paper	76	5	2017	947
The future Aral Sea: hope and despair	Philip Micklin	Original Paper	75	9	2016	935
Forensic hydrology: what function tells about structure in complex settings Open Access	Gunnar Lischeid et al.	Original Paper	76	1	2017	864

This slide excludes articles with unexplained peaks in downloads during the reporting period.
Source: COUNTER Reporting / Business Warehouse.

Environmental Earth Sciences - 2017 Publisher's Report

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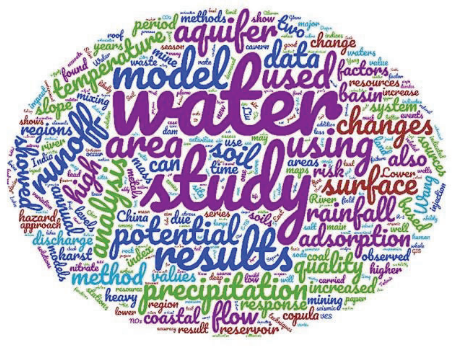
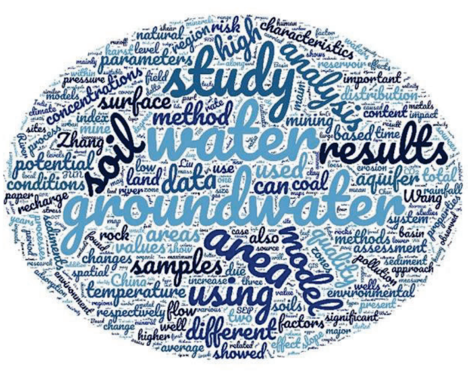


(a) Highly cited papers

(b) 2018-2019 (impact factor 2020)



(c) 2020

100 most cited papers from all years since 2009 (using Wordle*TM*)

15 Most Cited Articles 2015-16

- Abdullaev I, Rakhmatullaev S (2015) Transformation of water management in central Asia: from state-centric, hydraulic mission to socio-political control.
- Aishan T, Halik U, Kurban A et al (2015) Eco-morphological response of floodplain forests (*Populus euphratica* Oliv.) to water diversion in the lower Tarim River, northwest China.
- Azarnivand A, Hashemi-Madani FS, Banihabib ME (2015) Extended fuzzy analytic hierarchy process approach in water and environmental management (case study: Lake Urmia Basin, Iran).
- Belletti B, Rinaldi M, Buijse AD et al (2015) A review of assessment methods for river hydromorphology.
- Beskese A, Demir HH, Ozcan HK, Okten HE (2015) Landfill site selection using fuzzy ahp and fuzzy topsis: a case study for Istanbul.
- Chalov S, Jarsjo J, Kasimov NS et al (2015) Spatio-temporal variation of sediment transport in the Selenga River Basin, Mongolia and Russia.
- Gordalla BC, Ewers U, Frimmel FH (2013) Hydraulic fracturing: a toxicological threat for groundwater and drinking-water?
- Hajihassani M, Armaghani DJ, Monjezi M, Mohamad ET, Marto A (2015) Blast-induced air and ground vibration prediction: a particle swarm optimization-based artificial neural network approach.
- Karthe D, Chalov S, Borchardt D (2015) Water resources and their management in central Asia in the early twenty first century: status, challenges and future prospects.

15 Most Cited Articles, continued

- Kim H-S, Kim K-R, Kim H-J, Yoon J-H, Yang JE, Ok YS, Owens G, Kim K-H (2015) Effect of biochar on heavy metal immobilization and uptake by lettuce (*Lactuca sativa* l.) in agricultural soil.
- Li P, Qian H, Howard KWF, Wu J (2015) Building a new and sustainable "silk road economic belt".
- Lim LBL, Priyantha N, Mansor NHM (2015) *Artocarpus altilis* (breadfruit) skin as a potential low-cost biosorbent for the removal of crystal violet dye: equilibrium, thermodynamics and kinetics studies.
- Ren F, Wu X, Zhang K, Niu R (2015) Application of wavelet analysis and a particle swarm-optimized support vector machine to predict the displacement of the shuping landslide in the three gorges, China.
- Wu J, Li P, Qian H (2015) Hydrochemical characterization of drinking groundwater with special reference to fluoride in an arid area of China and the control of aquifer leakage on its concentrations.
- Youssef AM, Pradhan B, Jebur MN, El-Harbi HM (2015) Landslide susceptibility mapping using ensemble bivariate and multivariate statistical models in Fayfa area, Saudi Arabia.
- Zhang J, Zhang Q, Sun Q, Gao R, Germain D, Abro S (2015) Surface subsidence control theory and application to backfill coal mining technology.

Discover Water
(DW)

Aims and Scope

Discover Water is part of the Discover journal series committed to providing a streamlined submission process, rapid review and publication, and a high level of author service at every stage. It is an open access, community-focussed journal publishing research from across all fields relevant to water research.

Discover Water is a broad, open access journal publishing research from across all fields relevant to the science and technology of water research and management. *Discover Water* covers not only research on water as a resource, for example for drinking, agriculture and sanitation, but also the impact of society on water, such as the effect of human activities on water availability and pollution. As such it looks at the overall role of water at a global level, including physical, chemical, biological, and ecological processes, and social, policy, and public health implications. It is also included that articles published in *Discover Water* may help to support and accelerate United Nations Sustainable Development Goal 6: 'Clean water and sanitation'.

Research Trends
International Societies

International Association of Hydrogeologists

- Scientists, engineers, water managers and other professionals;
- Groundwater research, management and protection;
- Has 4,000 members worldwide in 40 countries;
- Worldwide networking;
- Eight specialized research commissions.

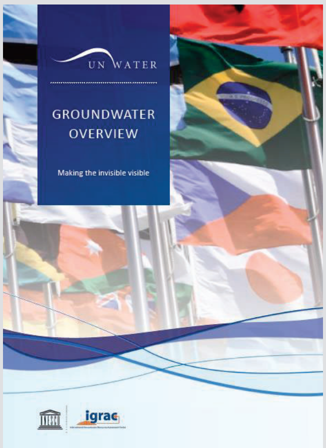
IAH Specialized Commissions

- Commission on Groundwater and Climate Change;
- Commission on Groundwater and Energy;
- Commission on Groundwater Outreach;
- Commission on Karst Hydrogeology;
- Commission on Managing Aquifer Recharge ;
- Commission on Mineral and Thermal Waters ;
- Commission on Regional Groundwater Flow ;
- Commission on Transboundary Aquifers.

UN Water Partners

Global groundwater resources are under increasing pressure due to human activities and climate change. The UNESCO/IGRAC Groundwater Overview -

- Showcases the essential issues of groundwater,
- Informs about groundwater-related activities,
- Enhances knowledge exchange and collaboration, and
- Raises awareness about our most important hidden resource: GROUNDWATER.



Climate Variability

As the world's largest distributed store of fresh water, groundwater plays a central part in sustaining ecosystems and enabling human adaptation to climate variability and change. Aquifers have a buffering capacity and they are naturally more resistant to external impact than surface waters. Since variability of surface water availability is increasing due to climate change, strategic importance of aquifers for water and food security is clearly growing. (UNESCO/IGRAC)

PELA

Natural Disasters, Conflicts and Human Rights

Aquifers can substitute affected drinking water supplies in time after catastrophic events, such as tsunamis. Relief organisations need to know about availability of groundwater for water supply when settling displaced communities (after natural disasters and/or conflicts). Groundwater is often a possible solution for the people without access to safe drinking water - still more than 600 million. (UNESCO/IGRAC)

PELA

Governance, Law, and Transboundary Issues

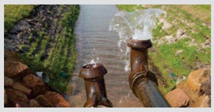
- Groundwater is a common-pool resource and is often utilized at an individual level regardless of overall impact on the aquifer because neither use nor impact are necessarily immediately visible.
- This becomes even more complex when aquifers cross state or national borders (transboundary). Aquifers need to be governed through a process of shared responsibility and participation, information availability and transparency, and rule of law. (UNESCO/IGRAC)

PELA

Groundwater and the Environment

Various kinds of ecosystems depend on groundwater:

- Aquatic - wetlands, rivers and lakes receiving groundwater.
- Terrestrial - phreatophyte vegetation, either shallow-rooted in alluvial settings or deep-rooted in arid zones .
- Subterranean - limestone formations with karstic caverns.
- Accordingly, groundwater is an essential part of any ecosystem-based adaptation measure, green infrastructure or a nature-based solution. (UNESCO/IGRAC)



PELA

Groundwater in Settlements

Groundwater is the main source of water supply in many cities around the world and increasingly under pressure due to continuous urbanisation, climate change and inadequate water management. Groundwater depletion and land subsidence are serious problems. The pumping rates in the megacities may be reduced and compensated by urban rainwater harvesting, rural-urban water transfers, aquifer recharge with wastewater and similar measures. (UNESCO/IGRAC)

PELA

Sanitation, Health and Pollution

- Water-related disease remains one of the major health concerns in the world. The improvement of groundwater quality control, in conjunction with improvement in sanitation and personal hygiene, is the main strategy to reduce water-related disease.
- Groundwater can be polluted from agriculture, sanitation, industry and mining, landfills and waste disposals, traffic and transport and also from chemical processes within geological environments.
- Regular groundwater monitoring, vulnerability assessment, protection from point-source and diffuse pollution, and pollutant removal, are some of necessary actions in preserving and improving groundwater quality and health. (UNESCO/IGRAC)

PELA

Food and Energy

- About 2/3 of all abstracted groundwater is used in agriculture. Global food production increasingly relies on groundwater over-abstraction. Groundwater depletion eventually leads to decline of food production.
- About 1/4 of the energy used globally is spent on food production and supply, including groundwater pumping.
- Deep aquifers, as a potential source and a sink for heat, can play a much more prominent role in the provision of renewable geothermal energy.

PELA

Economics

- Groundwater resources are extensively used in production processes by large international companies all over the world. Accordingly, international investors are being encouraged to share broader societal and environmental costs of groundwater.
- Understanding the value of groundwater would be an additional incentive for investors and asset managers to participate, leading eventually to investment risk reduction.

PELA

Summary of Research Trends

- Remote sensing increasingly used for aquifer management.
- Satelite data interpretation for drought and long-term weather forecasting.
- Bringing more real-time reporting data online via web.
- Cross-disciplinary training.
- Regional, national and international emphasis on improving water use agreements and best practices.
- More collaborative studies among consortium universities or corporations.
- Water as an economic commodity or as a natural right.

PELA

THA 2022 International Conference on
Moving Towards a Sustainable Water and Climate Change Management After COVID-19
26 - 28 January 2022 09.00 - 16.30 hrs.

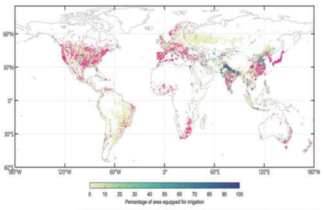
Assessing recent hydrological changes and groundwater depletion under various policy changes and newly delivered water in the North China Plain

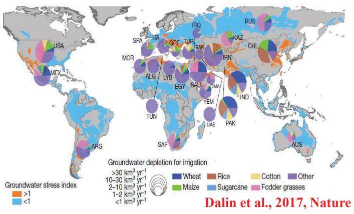
Prof. & Dr. Yonghui Yang
Center for Agricultural Resources Research
IGDB, Chinese Academy of Sciences

Content

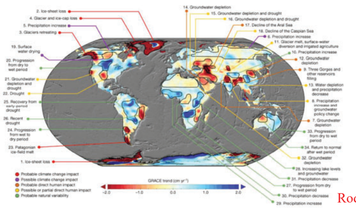
- Problem of groundwater depletion
- Implementing measurements by the government
- What is really happening?
- Will groundwater issues be solved?

North China Plain is one of the world most concerned region of groundwater depletion





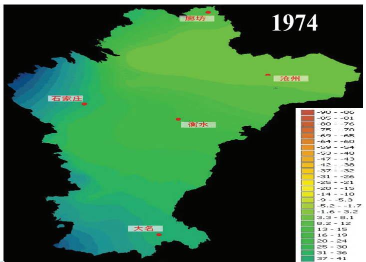
Dalin et al., 2017, Nature

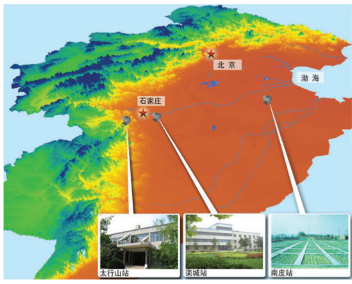


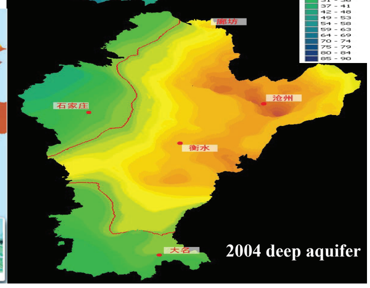
Rodell et al, 2018, Nature 557

Groundwater depletion

Groundwater overuse: 180-200 km^3







Content

- Problem of groundwater depletion
- Implementing measurements by the government
- What is really happening?
- Will groundwater issues be solved?

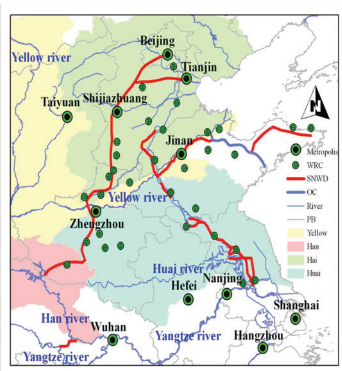
Limiting groundwater abstraction

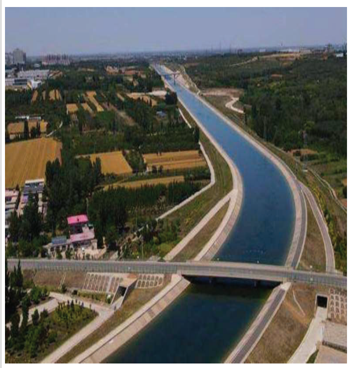
- Largely reduce groundwater use for city and rural domestic purpose.
- Cutting the plantation of high water consumptive winter wheat by 50,000-15,000 ha annual with governmental subsidy.
- Increasing water use from Yangtze River

Content

- Problem of groundwater depletion
- Implementing measurements by the government
- What is really happening?
- Will groundwater issues be solved?

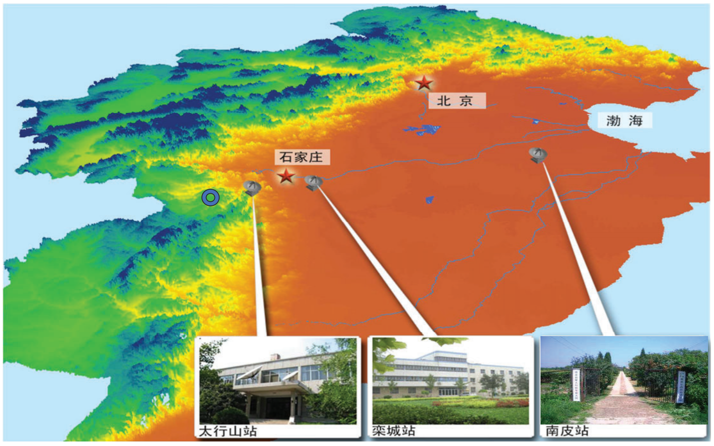
1. South to North Water Transfer Projects





Middle route: total investment: 208 billion RMB Yuan.
Water delivery: 9.5 billion per year.
Total water delivered : 23 km^3 to Beijing-Tianjin-Hebei area since 2015.

Haihe Catchment:



As the biggest water user, effect of reducing wheat plantation

The paradox of irrigation efficiency

Higher efficiency rarely reduces water consumption

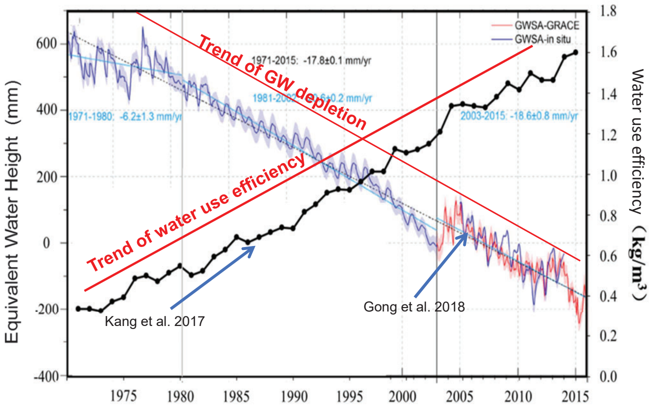
By R. Q. Grafton[1,2], J. Williams[1], C. J. Perry[3], F. Molle[4], C. Ringler[5], P. Steduto[6], B. Udall[7], S. A. Wheeler[8], Y. Wang[9], D. Garrick[10], R. G. Allen[11]

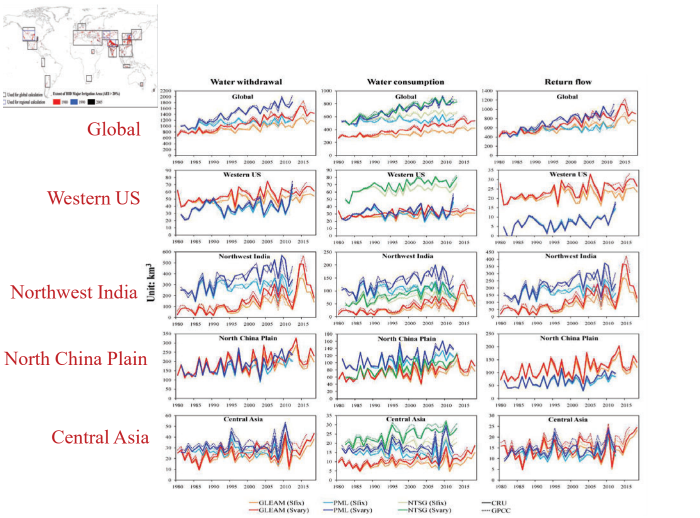
increased IE rarely delivers the presumed public-good benefits of increased water availability. Decision-makers typically have not known or understood the importance of

stored for irrigation in the soil) (2). Annually, governments spend billions of dollars subsidizing advanced irrigation technologies, such as sprinklers or drip systems (3). Sometimes

Science 24 Aug 2018: Vol. 361, Issue 6404, pp. 748-750
DOI: 10.1126/science.aat9314

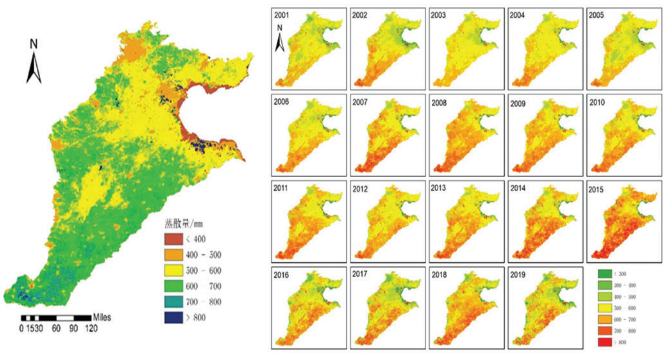
2. Agricultural Water saving



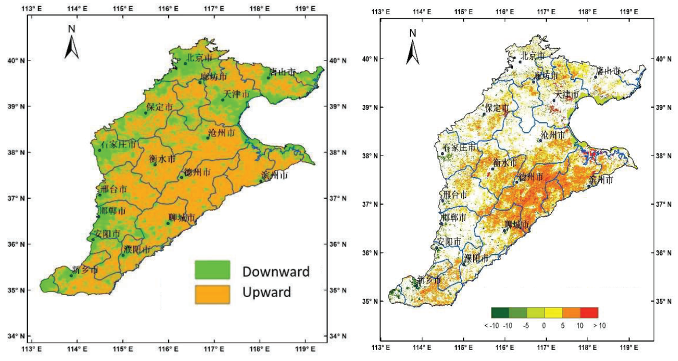


Zhou et al. 2021, Agri Water Manage

Evapotranspiration changes:



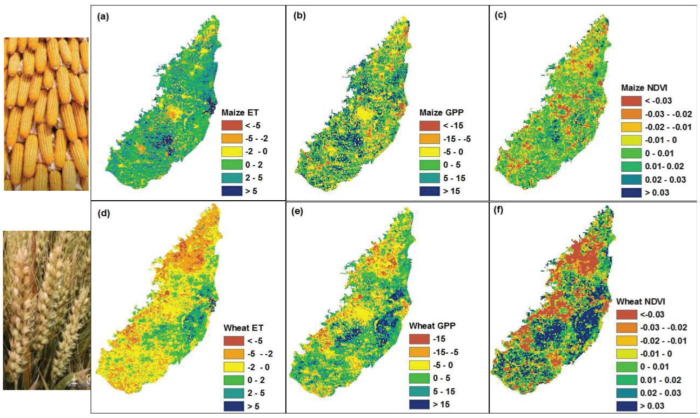
Is ET increasing？



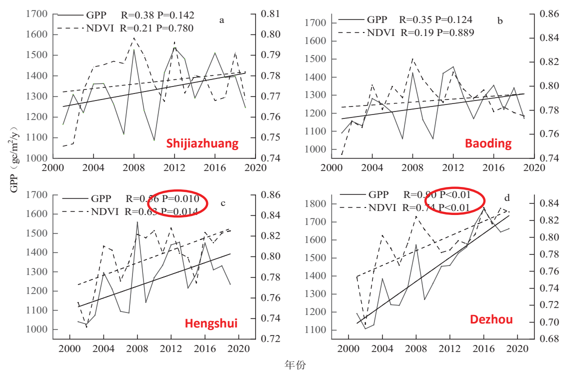
ET trend in 2001-2019

ET Significance（P<0.05）

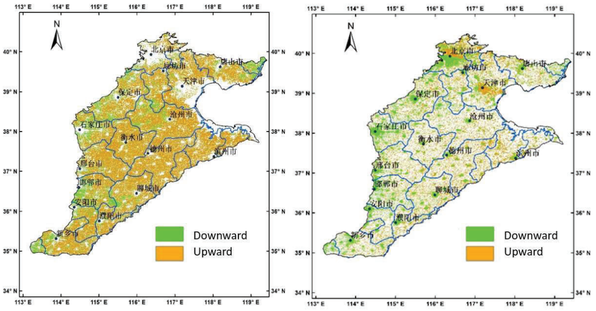
Wheat ET is decreasing.



NDVI & GPP changes in four typical regions

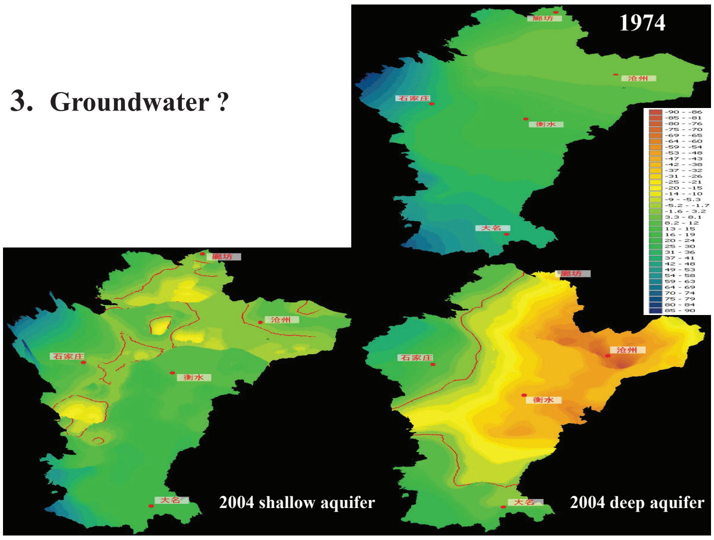


ET trend in irrigated field and non-irrigated fields.



- ET in agricultural regions is still increasing.
- ET in central part of the city is increasing but decrease in the outside along urbanization.

3. Groundwater ?



Simple crop pattern needs large efforts to remain a sustainable groundwater use.

Table 1 Cropping adjustment solutions according to the three groundwater sustainability targets

	Irrigation water requirement (mm)	Water saving compared with cropping pattern S_{base} (mm)	Target 1: IWR is less than or equal to 187 mm (%)	Target 2: IWR is less than or equal to 226 mm (%)	Target 3: IWR is less than or equal to 284 mm (%)
S_{base}	330				
S_W	174	156	92	67	31
S_M	72	258	55	41	18
S_{MWMF}	180	150	95	70	31
S_{MWFW}	253	77	–	–	61
S_F	– 85	415	34	25	11

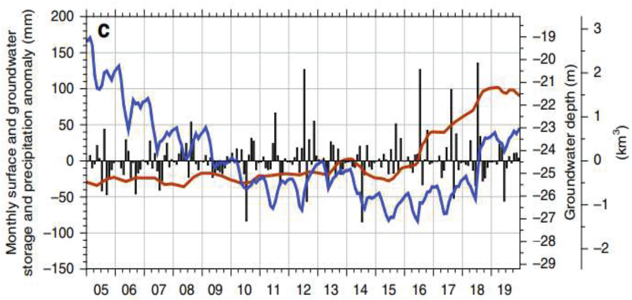
Target 1: Sustainable groundwater use according to the correlation between groundwater and IWR established in this study (annual irrigation of less than 187 mm); Target 2: Sustainable groundwater use based on 0.2 billion m^3 (39 mm) of extra water supply. In this case, the upper limit for irrigation can increase to 226 mm; Target 3: Sustainable use of groundwater based on 0.5 billion m^3 (97 mm) of additional water supply. The upper limit for irrigation can increase to 284 mm

Ren et al, 2021, SERRA

Present wheat plantation decrease, ranging from 50,000 ha to 150,000 ha will not likely solve the groundwater depletion problem.

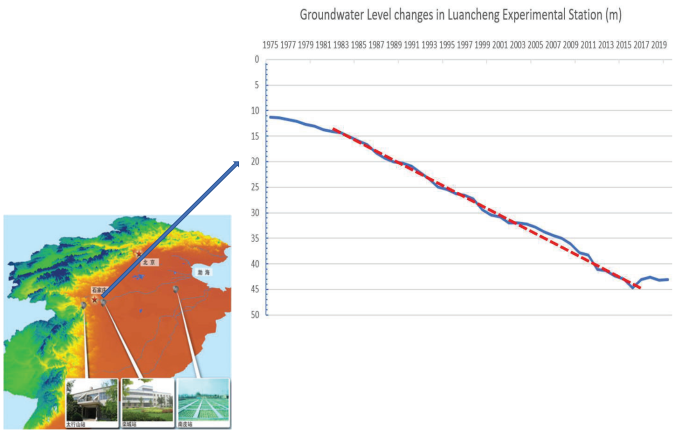
South-to-North Water Diversion stabilizing Beijing's groundwater levels

Di Long[1], Wenting Yang[1], Bridget R. Scanlon[2], Jianshi Zhao[1], Dagen Liu[3], Peter Burek[4], Yun Pan[5],

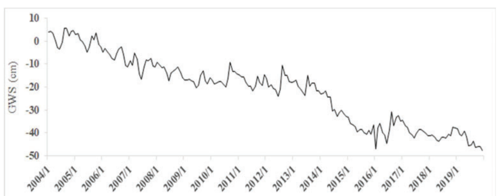


But Beijing's area is only 6300 km^2, while Hebei Plain is 81,459 km^2.
13 times of Beijing's area, water is only 3 times.

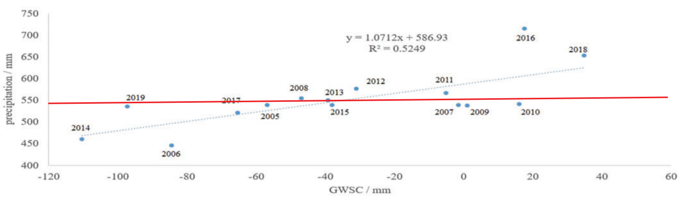
Observed groundwater level decline (1975-2020) in Luancheng Experimental Station.



Groundwater storage in the North China Plain



Groundwater Storage Changes from GRACE data for the Hebei Plain



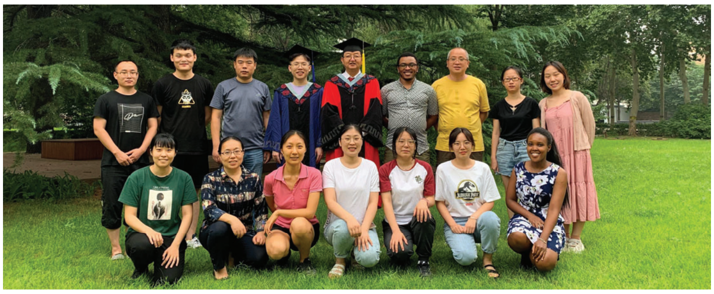
Precipitation & GWSC

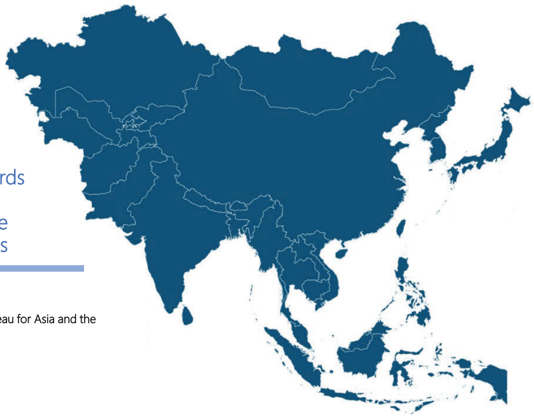
Ma et al., Draft paper.

Conclusions

- Crop adjustment, replacing groundwater by Yangtze River water for domestic and industrial use, less vegetation water use driven by urbanization, and relatively high rainfall is beneficial for regional groundwater.
- However in the whole NCP, ET is still increasing slightly.
- In general, groundwater decline has been greatly slowed down, but stabilization looks not yet confirmed.

Thanks for your attentions.





Groundwater for sustainability: contributions towards the 2030 Agenda and the Sustainable Development Goals

Hans Dencker Thulstrup
Senior Programme Specialist
UNESCO Regional Sciences Bureau for Asia and the Pacific

SUSTAINABLE DEVELOPMENT GOALS

… a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity.
The 17 SDGs are integrated—they recognize that action in one area will affect outcomes in others, and that development must balance social, economic and environmental sustainability.

Groundwater management is most directly associated with SDG 6: Clean Water And Sanitation.

However, it is also related SDG 1, 2, 3, 9, 11,13, 15, and 17, because groundwater systems are complex and relate directly or indirectly to consumption patterns, economic activities, climate change, biodiversity, and more.

It could be said that water flows through all of the Sustainable Development Goals.

The case for groundwater

Sustainable groundwater is a key element in global resilience to climate change, a shield against ecosystem loss, and a defense against human deprivation and poverty.

Groundwater underpins irrigated agriculture and energy production. It supports food security and economic development. It is essential to the health of all living things.

Groundwater provides drinking water to at least 50% of the global population, and worldwide, approximately 2.5 billion people depend solely on groundwater resources to satisfy their basic daily water needs.

UNESCO World Water Development Report 2012

…however:

Groundwater is a hidden and vulnerable resource and is not physically visible, which can make it difficult for the general population and decision-makers to connect up with the challenges affecting this resource. Appreciation of groundwater is not taught in elementary schools. Many university programs do not have hydrogeology courses in their undergraduate curricula. (IGRAC 2021)

The challenge

- Appreciation of groundwater is not taught in elementary schools.
- Many university programs do not have hydrogeology courses in their undergraduate curricula.
- Many people do not know that surface water and groundwater are closely connected, that pollution of one can pollute the other, that rivers and lakes derive water from underground baseflow.
- Many decision makers do not know that, in drylands, slight changes in groundwater levels, due to over-pumping or climate change, can diminish or eradicate springs and wells.
- Many people do not know that an estimated 20% of the world's aquifers being over-exploited (IGRAC).

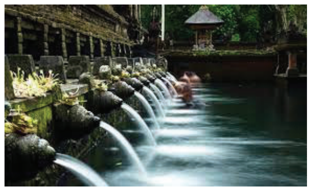
- In spite of all this, groundwater is closely associated with human civilizations across the world and across millennia – a sacred treasure, a prized resource and a source of conflict.

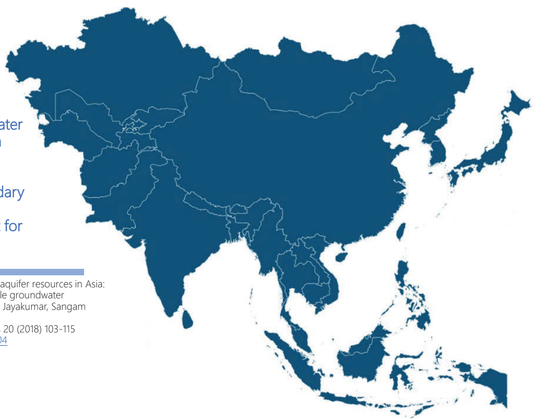
IGRAC, 2021: https://www.un-igrac.org/stories/groundwater-key-sustainable-development-goals-sdgs

The consequences

The lack of systematic communication and data information on groundwater is one of the most significant impediments to its sound management and governance.

This has direct impacts on the contributions of groundwater to the SDGs. This is particularly true in the case of transboundary aquifers.





Transboundary groundwater in Focus: progress in Asia towards indicator 6.5.2

Proportion of transboundary basin area with an operational arrangement for water cooperation

Source: Assessment of transboundary aquifer resources in Asia: Status and progress towards sustainable groundwater management. Eunhee Lee, Ramasamy Jayakumar, Sangam Shrestha, Zaisheng Han
Journal of Hydrology: Regional Studies 20 (2018) 103-115
https://doi.org/10.1016/j.ejrh.2018.01.004

INVENTORY OF TBAS IN ASIA

- There are 129 shared aquifers in Asia (2015). The total area of TBAs in Asia measures approximately 9 million km2, covering about 20% of the entire region.

- According to the global TBA inventory, a total of 38 countries in Asia are identified as having internationally shared aquifer basins.

- Aquifer stress (AQSI)* for Asia's aquifers has increased more than 250% over the last 50 years. For example, Saq-Ram Aquifer System between Saudi Arabia and Jordan and Mekong Delta region.

- A survey by TWAP (Transboundary Water Assessment Programme) identified that among 25 TBAs in South, Southeast and East Asia, only about 50% of the region's TBAs are suitable for human consumption due to showed serious groundwater quality problems. Notable case, Indus River Plain Aquifer, estimated about 80% of the aquifer area within the Pakistan territory is unsuitable for human consumption as a result of elevated amounts of natural salinity as well as high levels of fluoride and arsenic. In addition, Mekong Delta aquifer intensive extraction for agriculture has led to seawater intrusion into the aquifer.

LEGAL AND INSTITUTIONAL FRAMEWORKS FOR TBA MANAGEMENT IN ASIA

Given the significant role of TBAs in linking hydrological, social, and economic sectors between neighboring countries, shared aquifer management should be dealt with by institutional and legal frameworks

However, across much of Asia, the issues have been scarcely addressed in international water policy, legislation, and institutional instruments

Source: https://doi.org/10.1016/j.ejrh.2018.01.004

Hydrology Map of Asia

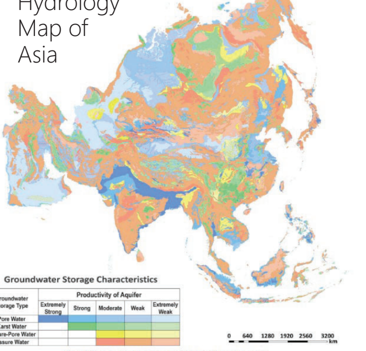


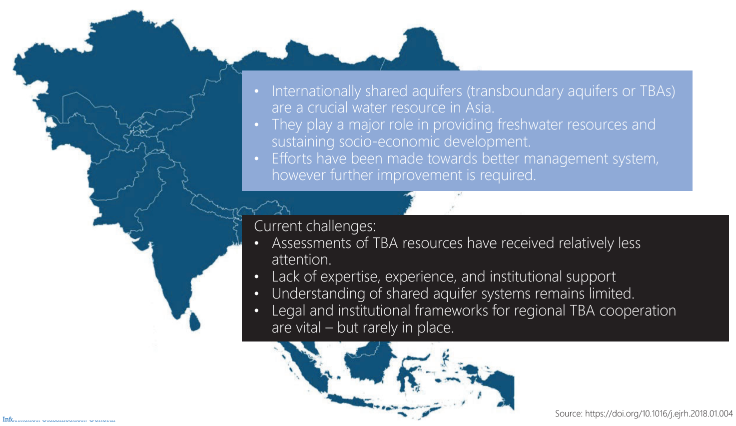
Fig. 1. Hydrogeology Map of Asia (Scale: 1: 8 000 000, modified from CGS (2012)).

TBA STATUS

- Asia consumes more than 70% of global groundwater; supported growth of the agricultural sector
- Many TBAs are vastly exploited, led to the reduction and deterioration of groundwater resources. With increased population density and economic development, stress on shared aquifers is expected to increase further in the future.
- These challenges to likely exacerbate regional conflicts by countries competing over the limited water resources

- Many activities have been undertaken to develop TBA inventories and gain a better understanding of shared aquifer systems
- Lack of reliable TBA data, particularly for the developing countries, cooperation in identification, assessment, and governance mechanisms
- Initiatives have been launched to promote the establishment of legal/institutional frameworks for TBA cooperation, which has led to the recognition of the importance of TBAs and the need to cooperate
- Several countries have cooperated internationally by establishing TBA institutes and agreements with neighboring countries - a significant milestone.
- Many developing countries do not have the capacity to carry out groundwater investigation and proper groundwater management practices
- More attention should be paid to establish a link between hydrogeological knowledge on groundwater management practices

Source: https://doi.org/10.1016/j.ejrh.2018.01.004



- Internationally shared aquifers (transboundary aquifers or TBAs) are a crucial water resource in Asia.
- They play a major role in providing freshwater resources and sustaining socio-economic development.
- Efforts have been made towards better management system, however further improvement is required.

Current challenges:
- Assessments of TBA resources have received relatively less attention.
- Lack of expertise, experience, and institutional support
- Understanding of shared aquifer systems remains limited.
- Legal and institutional frameworks for regional TBA cooperation are vital – but rarely in place.

Source: https://doi.org/10.1016/j.ejrh.2018.01.004

6 CLEAN WATER AND SANITATION

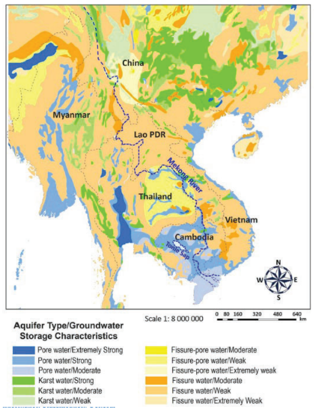
SDG INDICATOR 6.5.2
TRANSBOUNDARY WATER COOPERATION

SDG target 6.5 calls for countries to "implement integrated water resources management at all levels, including through transboundary cooperation as appropriate

Indicator 6.5.2 has been defined as the "proportion of transboundary basin area [within a country] with an operational arrangement for water cooperation
UNECE and UNESCO were entrusted as co-custodian agencies for indicator 6.5.2.

- Twenty-five out of 30 countries in the Central, Eastern, Southern and South-Eastern Asia region share transboundary river and lake basins.
- In 2017, river and lake basin data were only available for six countries within the region, whereas 2017–2020 combined data are now available for 15 countries.
- These combined data show that there is still a considerable number of countries where operational arrangements are lacking. Only six countries out of 25 sharing transboundary river and lake basins reported having operational arrangements covering 90 per cent or more of their basin area.
- These countries include several of the Mekong River Basin countries (Cambodia, Lao People's Democratic Republic (Lao PDR) and Thailand), as well as Kazakhstan, Uzbekistan and Indonesia.

Information Classification: General



STATUS AND MANAGEMENT OF TBAS IN THE GREATER MEKONG SUBREGION (GMS)

- Mekong River is the longest river in Southeast Asia
- The culture and livelihood of the GMS countries (Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam) are closely interconnected.
- The TBA provides water for drinking, irrigation, and industry and supporting natural river water flows and associated ecosystems.
- One significant challenge is high exposure to climate-related risks (floods and droughts). Strong spatial and temporal variations rainfall is not uniformly distributed; about 80% of the total precipitation is concentrated during the wet season.

Source: https://doi.org/10.1016/j.ejrh.2018.01.004

STATUS AND MANAGEMENT OF TBAS IN THE GREATER MEKONG SUBREGION (GMS)

TBA distribution in GMS: an example

- The Cambodia-Mekong River Delta Aquifer is shared by Cambodia and Vietnam, with 63% of the TBAs within Cambodia where the Tonle Sap lake serves as a natural regulating reservoir.
- Due rapidly increasing population and fast economic development, the demand for water resources is increasing, leading to the over-exploitation of groundwater. This results in groundwater reduction and quality deterioration threatening future GMS water security.
- Groundwater levels have significantly declined, while increased salinity has affected freshwater supply capacity.
- GMS is vulnerable to seawater intrusion, has experienced occurrence of arsenic pollution. In Cambodia, around 20% of aquifers are not suitable for human consumption, mainly associated with elevated levels of arsenic.
- Limited institutional framework for the co-investigation of TBAs and limited coordination among hydrological databases between the two countries; which have restricted the strategic planning of cooperative management.
- UNESCO contributes towards several new project proposals to address these challenges.

Information Classification: General

Source: https://doi.org/10.1016/j.ejrh.2018.01.004

THE GENEVESE TRANSBOUNDARY AQUIFER (SWITZERLAND-FRANCE): 40 years of successful transboundary management

The **Genevese** aquifer is used for the supply of drinking water harnessed from ten wells on the Swiss side and four on the French side.

During the 1960s and 1970s, over-pumping lowered the groundwater level by more than 7 m.

While technical and scientific studies were being undertaken to resolve the problem of over exploitation, negotiations were being conducted with various local and national authorities in France.

The aim was to engage in a collaborative effort to fund the work and to establish a joint water management system. The agreements signed in 1978 and in 2007 attest to the success of the joint management plan.

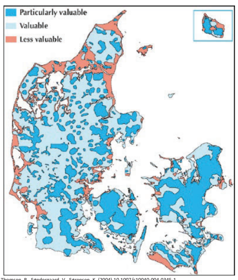
KEYS OF SUCCESS

- **Focus on the common water resource**
  safeguard the water resource from over exploitation.
  excellent technical data and monitoring of the groundwater
- **The handling of the administrative and policy aspects of aquifer management at the local level**
  Presence autonomy to local authority results in successful negotiations in the 1970s agreement. Autonomy makes local authorities feel at greater ease as signatories, accountable to their own citizens
- **The ability of the canton of Geneva to handle transboundary matters directly**
  The Canton of Geneva had led the recharge project and the management of the stakeholders, demonstrated its ability to guarantee optimal groundwater management over the first thirty years. Experience has shown that, whereas it might be necessary to deal with ten different interlocutors in a project with the French neighbours, in the State of Geneva there is usually only one entity with which to contend.

Information Classification: General

https://doi.org/10.1016/j.ejrh.2018.02.003

GROUNDWATER MANAGEMENT IN DENMARK



Thomsen, R., Søndergaard, V., Sørensen, K. (2004) 10.1007/s10040-004-0345-1

Denmark is entirely dependent on groundwater for drinking water supply.

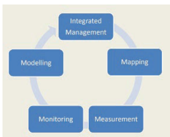
Factors that support sustainable groundwater management include:

- Tradition and history
- Strong knowledge and research base
- National commitment
- Transparent regulatory system
- Partnerships across sectors
- Public and political concern and awareness

Challenges include:

- Contamination from
- diffuse and point source pollution
- Over-abstraction and depletion due to geographically uneven recharge patterns
- Impacts of climate change

Bjørn Kaare Jensen (2015): https://circabc.europa.eu/sd/a/3f5806ff-aded-4937-917d-62542458a66c/China%20-%20Presentation%20-%20Integrated%20groundwater%20management%20in%20Denmark.pdf



Climate change impacts

- More precipitation and cloudbursts leading to groundwater flooding
- Enhanced transport of contaminants in soil and groundwater
- Enhanced saltwater intrusion in coastal areas due to sea level rise
- Enhanced breaking and leakage from sewer systems
- Drought leading to lowering of water table and soil subsidence requiring revised groundwater abstraction strategies
- Increased infiltration of rainwater in urban areas leading to elevated groundwater levels and potential damage to infrastructure

Information Classification: General

Thank you!
h.thulstrup@unesco.org

SESSION A4 :
WATER MANAGEMENT UNDER WATER SECURITY/SDGS

Session A4: Water Management towards Water Security/SDGs

Panelists:
Dr. Thomas Panella
Professor Seungho Lee
Dr. Nguyen Minh Khuyen (Representative: Dr. Phạm Van Tuan)
Mr. Somchai Wangwattanapanich

This Executive Panel Session focuses on water management towards water security and sustainable development. The first presentation was by Dr. Thomas Panella, Director for Environment, Natural Resources, and Agriculture in the East Asia Department and Chair of the Water Sector Committee, Asian Development Bank (ADB) . The key findings from Asian Water Development Outlook 2020 (AWDO 2020) , which is the assessment of national water security across five key dimensions in Asia-Pacific, including case studies were presented. There are also two reports on water governance and finance and water security by OECD. The new normal and associated water sector investments for water security should focus on building capacity and strengthening financial sustainability and building resilience to absorb shocks and stresses due to pandemics, disasters, and climate change with good water governace.

Figure 1. Asian Water Development (AWDO) 2020 (ADB, 2020)

Professor Seungho Lee from Graduate School of International Studies, Korea University presented research on water security assessment and the institutional and technical transformations for water security in South Korea. The research on assessment of water security for Asia includes five key areas: 1) social equity; 2) economic efficiency; 3) resilience to water-related disasters; 4) environmental sustainability; and 5) government competency. The water sector reform in 2018 in Korea involved the establishment of The Water Management Basic Act based on IWRM, river basin management, stakeholder participation, and demand management, and the empowerment of the Ministry of Environment (ME) with more mandate shifted from Ministry of Land, Infrastructure and Transport (MOLIT) to Ministry of Environment (ME). In addition, the integrated dam operation in Korea was demonstrated aiming to avoid socio-economic and environmental impact, minimize and mitigate without significant gaps between regions. The water resources management in South Korea is moving from structural measures and economic growth and industrialization towards non-structural measures and sustainable development.

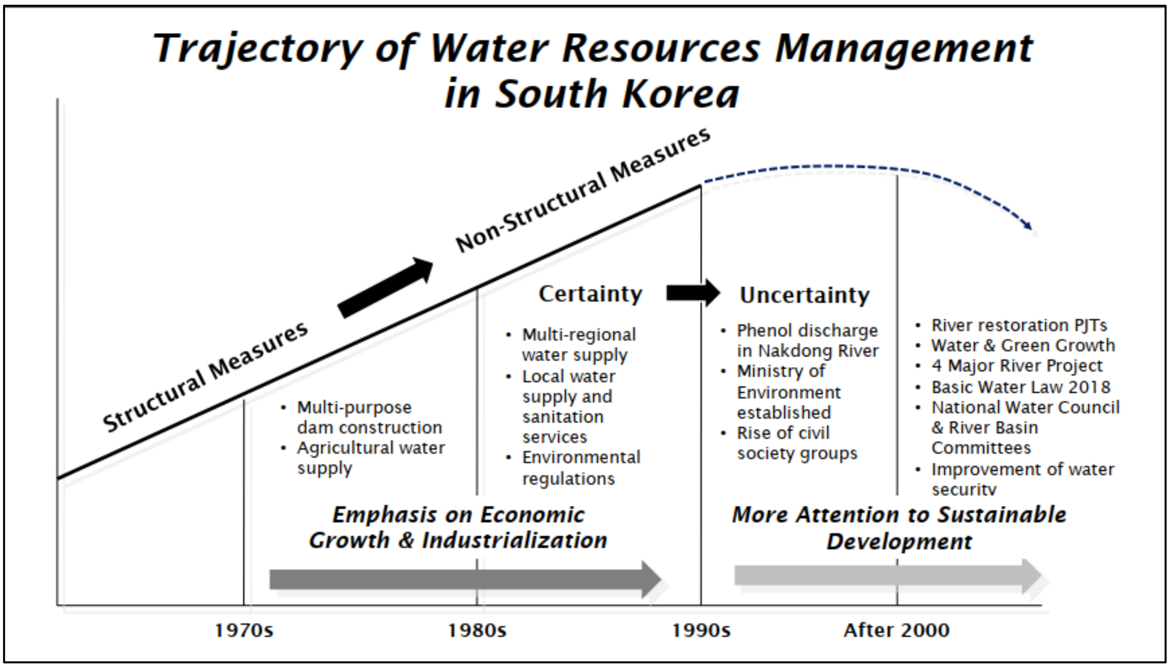


Figure 2. Trajectory of Water Resources Management in South Korea (Lee, 2022)

Dr. Nguyen Minh Khuyen, Deputy Director of Department of Water Resources Management, Ministry of Natural Resources and Environment (MONRE) presented on institutional structure of water resources management, challenges and solutions towards water security in Vietnam (with Dr. Phạm Van Tuan as a representative). Vietnam has several transboundary river basins with more than 63% of flow from outside of Vietnam territory. The water use efficiency is quite low. There are pressures from socio-economic development resulting in increasing water demand and water allocation conflicts as well as water pollution, impacts from climate change and management issues. To achieve water security, the plans are to revise the Law on Water Resources, implement IWRM to integrate water resources management and other natural resources, increase investment to improve water use efficiency, and strengthen international cooperation.

Mr. Somchai Wangwattanapanich, advisor to the President & CEO, SCG, Vice Chairman of the Federation of Thai Industries (F.T.I), and Chairmanof Water and Environment Institute for Sustainability (WEIS) shared private sector perspectives on preparation and plan for water security in Eastern Economic Corridor (EEC) area of Thailand. The EEC is area-based development in three provinces: Rayong, Chonburi, and Chachoengsao focusing on investment in health and well-being, digital, decarbonization, and logistics. Water management towards water security focuses on water supply, water demand, and water management. Water supply management aims to reduce vulnerability of scarcity by investment in increasing water supply. Water demand management is to increase water efficiency using 3R technology to reduce water usage, reduce water loss, and optimize water utilization. For water management, private sector has engaged with government to share data and information for planning and operation.

The key recommendations to achieve water security and reduce water insecurity from the Executive Panel Discussion are effective institutional reform, good governance, building resilience, and financing.

Achieving Water Security and Resilience in Asia Pacific: Asian Water Development Outlook 2022

Dr. Tom Panella, Chair of the Water Sector Committee, ADB

THA 2022 International Conference on
Moving Towards a Sustainable Water and Climate Change Management After COVID-19
Thursday **27 January 2022**
Conducted in English | Online via zoom
26 - 28 January 2022
09.00 - 16.30 hrs. (GMT+7 Bangkok)

Asian Water Development Outlook (AWDO) 2020

ADB Water Sector Flagship Publication

AWDO 2020 Contents

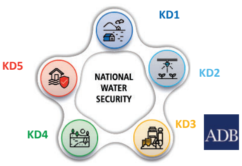
1. Key Dimensions of Water Security (KD)
   - KD1: Household Water Security (rural)
   - KD 2: Economic Water Security
   - KD 3: Urban Water Security
   - KD 4: Environmental Water Security
   - KD 5: Water-Related Disasters Security
2. Finance and Governance and Water Security
3. Policy in Action – ADWO 2020 Country Cases Studies: India, PRC, Thailand and Timor-Leste

AWDO 2020 Objectives

- Provide an overview and communication tool on water security for Asia and the Pacific
- Inform and guide policy reforms and investments
- Show water security progress - 2013, 2016, 2020

AWDO 2020 Partners

OECD, IWMI, KICT, International WaterCentre



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ADB and Water Security

2007 – ADB in cooperation with Asia Pacific Water Forum embraced Water Security for AWDO

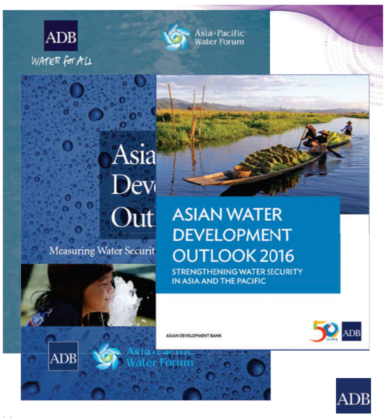
2013 – Developed the first methodology to quantify National Water Security

2016 – Improved the methodology and tracked progress

New in AWDO 2020:

- **Improved methodology**
  - KD1 focused rural households
  - KD5 includes risk and resilience
  - New databases (all public)
- **Finance and Governance**
  - Sections by OECD
- **Country Case Studies** (Thailand, Karnataka, PRC, Timor-Leste)
- **Future Risk Framework** (e.g. climate change, health)
- **Living AWDO Website**
  - Ongoing Knowledge and Policy in Action

Launching November 2020



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Key Dimensions and the SDGs

KEY DIMENSION 1
- SDG 6 — **TARGET 6.1:** By 2030, achieve universal and equitable access to safe and affordable drinking water for all.
- **TARGET 6.2:** By 2030, achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.

KEY DIMENSION 2
- SDG 2 — **TARGET 2.3:** By 2030, double the agricultural priority.
- SDG 6 — **TARGET 6.3:** By 2030, substantially increase water-use efficiency across sectors; substantially reduce the number of people suffering from water scarcity.
- SDG 7 — **TARGET 7.2:** By 2030, increase substantially the share of renewable energy.
- SDG 8 — Promote, sustained, inclusive, and sustainable growth, and full and productive employment.

KEY DIMENSION 3
- SDG 6 — **TARGET 6.1:** By 2030, achieve universal and equitable access to safe and affordable drinking water for all.
- **TARGET 6.2:** By 2030, achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.
- SDG 11 — Make cities and human settlements inclusive, resilient, and sustainable.

KEY DIMENSION 4
- SDG 3 — Ensure healthy lives and promote well-being for all at all ages.
- SDG 14 — Conserve and sustainably use the oceans, seas, and marine resources.
- SDG 15 — Sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss.
- SDG 6 — Ensure access to water and sanitation for all.

KEY DIMENSION 5
- SDG 3 — Ensure healthy lives and promote well-being for all at all ages.
- SDG 6 — Ensure access to water and sanitation for all.
- SDG 9 — Build resilient infrastructure, promote sustainable industrialization, and foster innovation.
- SDG 11 — Make cities inclusive, safe, resilient, and sustainable.
- SDG 13 — Take urgent action to combat climate change and its impacts.
- SDG 14 — Conserve and sustainably use the oceans, seas, and marine resources.
- SDG 15 — Sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss.

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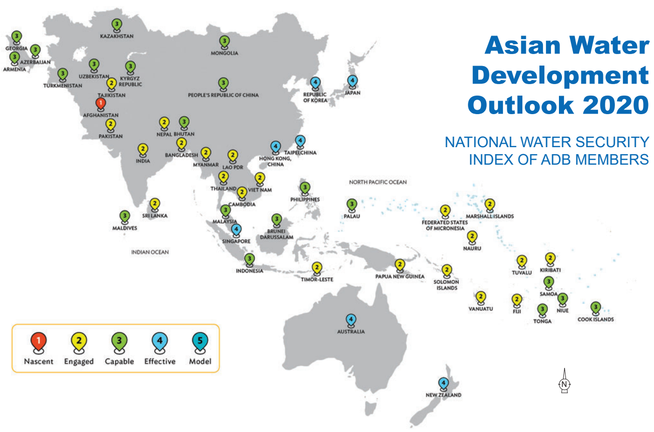
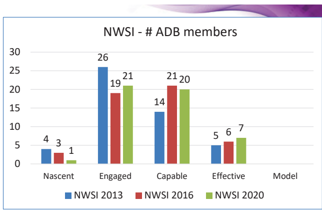


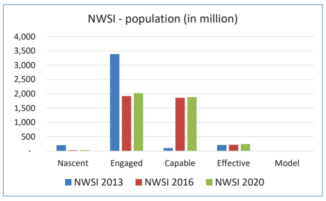
Asian Water Development Outlook 2020

NATIONAL WATER SECURITY INDEX OF ADB MEMBERS

Number of ADB members and people in development stages 2013 – 2016 – 2020

- Positive trend – several ADB members have improved from the Nascent and Engaged Rating to the Capable and Effective Rating
  - PRC from Engaged to Capable (2013-16)
  - India from Nascent to Engaged (2013-16)
- However, many people are still living in Nascent and Engaged stages of Water Security





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KEY DIMENSION 1

RURAL HOUSEHOLD WATER SECURITY

RESULTS:

- KD1 now measures only rural household water supply and includes 4 sub indicators
  - although only a relatively small volume of water, KD1 has huge social and health impacts
- KD1 is closely linked with the "for all" principle of the SDGs
- The Maldives has made the greatest improvement since 2013 because of their increased access
- While their scores have remained low, India, Nepal and Cambodia have all shown strong improvements in their access to sanitation and Lao PDR has shown the most improvement in water supply
- Most of the countries that have regressed in KD1 were in the Pacific

RECOMMENDATIONS:

- A holistic systems strengthening approach is needed and focusing on a single element will not achieve SDG 6
- For example, many countries have comprehensive WASH policies but have severely inadequate resources (both capital and human resources) to implement them.
- Systems strengthening should specifically include:
  - Better engagement and empowering of socially vulnerable groups
  - Addressing the severe shortage of human resources and capacity
  - Locally appropriate solutions are needed, particularly in the Pacific

KEY DIMENSION 1

- Access to Water Supply
- Access to Sanitation
- Health Impacts
- Affordability

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KEY DIMENSION 2

ECONOMIC WATER SECURITY

RESULTS:

- Economic water security is a measure of the assurance of adequate water to sustainably satisfy a country's economic growth and accommodate economic losses due to water-induced disasters.
- Changes to economic water security take years of planning and policy prioritization to achieve.
  - East Asia has showed the greatest advancement thanks to decades of policy and investment prioritization on food and water security.
  - Some members in Central Asia also benefit from investments in infrastructure that help mitigate lower natural water availability.
- Most regions have been relatively stable or shown minor improvements since 2013.
- Despite limited progress, increasing stress on water resources is shown with declining scores for countries in each region since 2016, and the greatest challenges in the Pacific Islands.

RECOMMENDATIONS:

- Enhance water resources monitoring, measurement and data availability.
- Improve water productivity by ensuring that adequate water is available when and where it is needed.
- Apply Integrated Water Resources Management and ensure adequate storage and distribution systems that can both help mitigate and adapt to climate changes and sectoral reallocation.

KEY DIMENSION 2
- Broad Economy
- Agriculture
- Energy
- Industry

KEY DIMENSION 3

URBAN WATER SECURITY

RESULTS:

- KD3 primarily measures safely managed and affordable water and sanitation services in urban and informal settlements to sustainably achieve desired, (and ideally agreed), outcomes
- 5 countries Nascent – 4 in the Pacific (Marshall Islands, Micronesia, Nauru, Papua New Guinea) and 1 in South East Asia (Timor-Leste), in total 1. 7 million people in urban areas
- Despite major investments, level of urban water security has remained about the same in the period 2013 till 2020 due to urbanization. In total 600 million urban people still do not have adequate access to water supply and sanitation services.

RECOMMENDATIONS:

- Increased attention on Pacific and South Asia including affordable water supplies.
- View wastewater, stormwater, and rainwater as a resource
- More integrated solutions and leapfrogging opportunities
- Improved attention to future risks and management of issues including urban growth, non-revenue water, water consumption (and efficiency), energy use costs, climate change
- Improved management of data and information, including systematic updating and improve monitoring and evaluation
- Future AWDO editions could benefit from more precise urban definitions, clarity on informal settlement inclusion and quantification of "future security" risks

KEY DIMENSION 3
- Access to Water Supply
- Access to Sanitation
- Affordability
- Drainage/floods
- Environment

KEY DIMENSION 4

ENVIRONMENTAL WATER SECURITY

RESULTS:

- Majority of countries show only moderate changes in KD4 from 2016 – 2020
  - most of these changes were declines
  - these countries represented all regions
- The performance of eight countries improved mainly due to a higher score for the Environmental Governance sub-index
  - these countries also represented all regions

RECOMMENDATIONS:

- The health of aquatic ecosystems is under considerable pressure
- It has been difficult to compare countries because of lack of data; remote sensing products under development will continue to improve monitoring
- There is a risk in traditional/grey infrastructure without environmental protocols that may boost one dimension of water security while impacting another; healthy ecosystems are not just something for rich countries
- The twin pressures of short-term human alterations and longer-term impacts of climate change will affect how ecosystems function throughout the region

KEY DIMENSION 4
- Catchment and Aquatic System Health
- Environmental Governance

KEY DIMENSION 5

WATER RELATED DISASTER SECURITY

RESULTS:

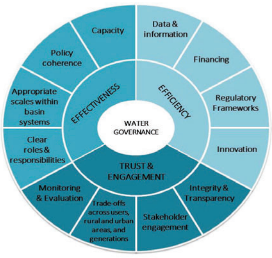
- Water-related Disaster Security is a national-level assessment of risk to water-related disasters—comprising Climatological (drought), Hydrological (flood), and Meteorological (storm) risks—based on assessments of the scale of the hazard, the exposure, the vulnerability, and the capacity of the nation.
- Capacity across Asia-Pacific has increased slightly while Vulnerability has decreased slightly from the first reporting of KD5 in 2013—both are signs of progress
- The East Asia region has shown the most progress in reducing Risk recently while the Pacific is the most challenged by Water-Related Disaster in recent years
- Drought is the most prominent Risk out of the three Hazard categories across Asia-Pacific

RECOMMENDATIONS:

- Enhance international efforts for standardized data collection of disaster impacts, in particular, gathering gender-disaggregated data
- Promote a gender-responsive approach to disaster risk reduction and climate change adaptation
- Adhere to international agreements like the Hyogo and Sendai frameworks and promote cooperation in reducing the risks of water-related disaster

KEY DIMENSION 5
- Climatological risk / drought
- Hydrological risk / flooding
- Meteorological risk / storms

GOVERNANCE AND WATER SECURITY



Source: www.oecd.org/governance/oecd-principles-on-water-governance.htm

RESULTS:

- Most countries have an overarching water policy framework and coordination mechanisms in place
- Limited implementation of water-related policies due to capacity constraints and funding gaps
- Insufficient data and monitoring constrains water policies evaluation
- Limited uptake of water policy instruments to manage trade-offs
- Limited use of economic instrument to manage water resources
- Limited scope and effectiveness of regulatory frameworks: water services focus
- Limited uptake of integrity practices and tools

RECOMMENDATIONS:

- Strengthen the implementation and monitoring of water-related disaster
- Adopt water policy instruments to manage trade-offs
- Adopt water economic instruments to manage water resources and generate associated sustainable funding
- Address capacity and data gaps
- Develop further stakeholder engagement in water decision making
- Mainstream integrity and transparency practices across water policies, institutions and governance frameworks

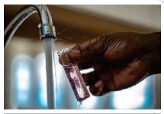
FINANCE AND WATER SECURITY

PROJECTED INVESTMENT NEEDS:

- Water supply and sanitation
  - Most countries will need to allocate between 1 and 2% of GDP to invest in water supply and sanitation infrastructure over the period 2015-2030
  - Outliers: Afghanistan, Nepal, Pakistan, Timor Leste
- Flood risk exposure
  - Afghanistan, Bangladesh, Cambodia, Kyrgyz Republic, Tajikistan and Viet Nam may all have flood risks exceeding 6% of GDP in 2030
- Irrigation expansion and efficiency improvements. Driven by:
  - Growing populations
  - Changes in dietary preferences
  - The effects of climate change

SOURCES OF FUNDING:

- Public taxes are the main source of finance for water-related infrastructure
- Official Development Assistance remains a low share of investment in water infrastructure and may not be targeting those countries who need it most
- Water supply and sanitation tariffs are under-utilized, although affordability acts as a barrier in selected countries



FINANCE AND WATER SECURITY

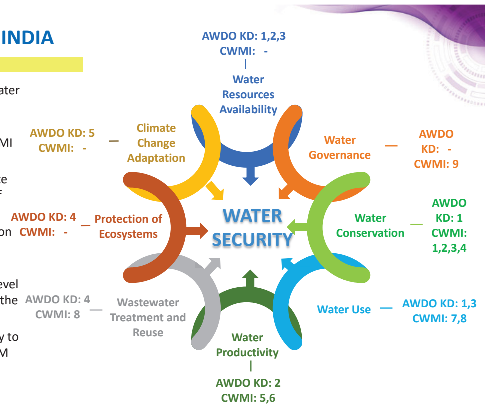
POLICY OPTIONS:

- Make the best use of available assets and financial resources
  - Enhance the operational efficiency of service providers
  - Build capacity for economic regulation
  - Encourage connections with central systems when these are available
  - Strengthen capacity and monitoring
- Minimize future investment needs
  - Develop climate-resilient plans to future-proof the water sector
  - Support plans with realistic financing strategies
  - Encourage policy coherence across water policies and other policy domains
  - Manage water demand and strengthen water resources allocation practices
  - Develop cost-effective flood risk mitigation strategies
  - Exploit innovation in line with adaptive capacities.
- Harness additional sources of finance
  - Ensure tariffs for water services reflect the costs of service provision
  - Consider new sources of finance from users and beneficiaries
  - Leverage funds to crowd-in commercial finance

It is not all about more money.

CASE STUDY: KARNATAKA, INDIA

- India's NITI Ayog developed a Composite Water Management Index (CWMI)
- ACIWRM applied AWDO methodology for Karnataka state (province) and mapped CWMI indicators against AWDO indicators
- Index was very handy to shape the new State Water Policy - articulating several aspects of water sub-sectors with priority
- Karnataka started streamlining data collection and setting up a database (KWRIS) for easy compilation of water security index
- Will explore to compute at river sub-basin level and district (sub-provincial) level and adapt the index further for local realities
- AWDO exercise was a good tool/opportunity to galvanize all departments/agencies for IWRM
- A separate detailed report is published as Karnataka Water Development Outlook (KWDO)




Water Sector Assessment in the Yellow River Basin - ADB Technical Assistance
18 indications in five key dimensions were selected for this assessment based on AWDO methodology the TOR of this project, the characteristics and problems of Yellow River basin and referring to ADB indications for similar purpose.
Indicators of ADB
Figure 1: Water Security Framework of Five Interdependent Key Dimensions
Key Dimension 1
HOUSEHOLD WATER SECURITY
Key Dimension 2
ECONOMIC WATER SECURITY
Key Dimension 3
URBAN WATER SECURITY
Key Dimension 4
ENVIRONMENTAL WATER SECURITY
Key Dimension 5
RESILIENCE TO WATER-RELATED DISASTERS
NATIONAL WATER SECURITY
Source: ADB.
17 indicators in five key dimensions
Indicators for this assessment
KD1: Water Supply Security
Available water resources per capita
Rate of access to tap water in rural areas
Water quality pass rate of centralized drinking water sources
Runoff regulation capacity
Development and utilization rate of surface water
KD2: Economic Water Security
Ratio of GDP per capita in the basin to the national average
Grain yield per m3 of water
Industrial added value per cubic meter of water
KD3: Ecological Water Security
Ecological basic flow guarantee rate of important sections
Water and soil conservation rate
Ecological health index of important rivers and lakes
KD4: Environmental Water Security
Water qualification rate of important water function zones
Wastewater and sewage treatment rate
High water quality rate of important tributaries
KD5: Water-related Disaster Security
Flood losses to GDP ratio
Rate of important reach management through flood prevention works
Warning & forecasting and dispatching coverage
Proportion of areas affected by drought
Water security
18 indicators in five key dimensions
ADB
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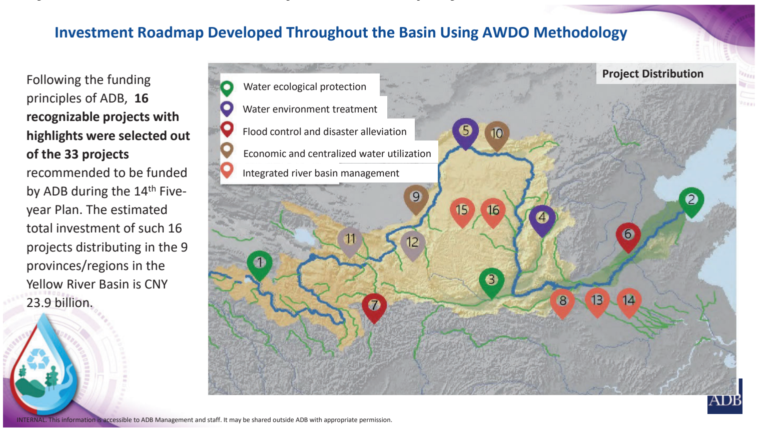
Investment Roadmap Developed Throughout the Basin Using AWDO Methodology
Following the funding principles of ADB, 16 recognizable projects with highlights were selected out of the 33 projects recommended to be funded by ADB during the 14th Five-year Plan. The estimated total investment of such 16 projects distributing in the 9 provinces/regions in the Yellow River Basin is CNY 23.9 billion.
Water ecological protection
Water environment treatment
Flood control and disaster alleviation
Economic and centralized water utilization
Integrated river basin management
Project Distribution
1
2
3
4
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ADB
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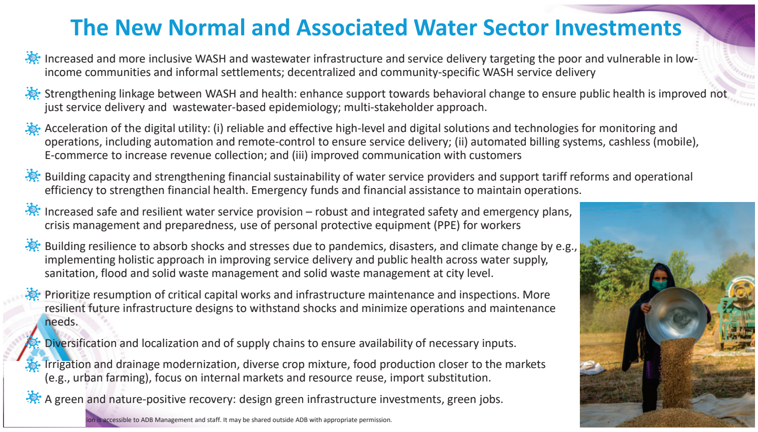
The New Normal and Associated Water Sector Investments
Increased and more inclusive WASH and wastewater infrastructure and service delivery targeting the poor and vulnerable in low-income communities and informal settlements; decentralized and community-specific WASH service delivery
Strengthening linkage between WASH and health: enhance support towards behavioral change to ensure public health is improved not just service delivery and wastewater-based epidemiology; multi-stakeholder approach.
Acceleration of the digital utility: (i) reliable and effective high-level and digital solutions and technologies for monitoring and operations, including automation and remote-control to ensure service delivery; (ii) automated billing systems, cashless (mobile), E-commerce to increase revenue collection; and (iii) improved communication with customers
Building capacity and strengthening financial sustainability of water service providers and support tariff reforms and operational efficiency to strengthen financial health. Emergency funds and financial assistance to maintain operations.
Increased safe and resilient water service provision – robust and integrated safety and emergency plans, crisis management and preparedness, use of personal protective equipment (PPE) for workers
Building resilience to absorb shocks and stresses due to pandemics, disasters, and climate change by e.g., implementing holistic approach in improving service delivery and public health across water supply, sanitation, flood and solid waste management and solid waste management at city level.
Prioritize resumption of critical capital works and infrastructure maintenance and inspections. More resilient future infrastructure designs to withstand shocks and minimize operations and maintenance needs.
Diversification and localization and of supply chains to ensure availability of necessary inputs.
Irrigation and drainage modernization, diverse crop mixture, food production closer to the markets (e.g., urban farming), focus on internal markets and resource reuse, import substitution.
A green and nature-positive recovery: design green infrastructure investments, green jobs.
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Thank You
tpanella@adb.org
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Institutional and Technical Transformations for Water Security in South Korea

Professor Seungho Lee
Korea University
Professor Joo-Heon Lee
Joongbu University

International Conference on Moving Towards Sustainable Water & Climate Change Management after COVID-19
Bangkok, Thailand
26~28 January 2022

Source: korea.net

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Introduction

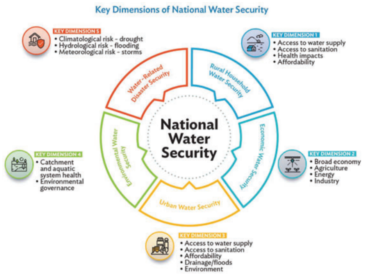
- Research Purpose
  - Conceptualization of water security
  - Assessment of water security for Asian countries
  - Good practices from South Korea: institutional & technical transformations for improving water security
- Rationale & Background
  - Complex challenges in water resources management ➔ the need to avoid water insecurity & to enhance water security in society
  - A useful framework to assess water security in Asia
  - Good practices for countries with water insecurity

Concept of Water Security

- Definition of UNESCO-IHP (2012)
  - The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability
- Major components
  - Adequate water supply, safeguarding a good quality of water, protection from water-related disasters and water-borne diseases
  - Ecosystem protection & the roles of sound water management for SD

Concept of Water Security

- *Asian Development Bank's 5 key dimensions for water security*



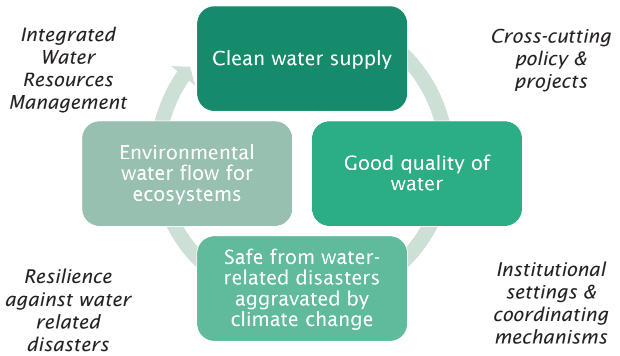
1) *Household water security*: access to piped water supply & improved sanitation and hygiene
2) *Economic water security*: agricultural, industrial, energy and impacts on broad economy
3) *Urban water security*: water supply, wastewater treatment, drainage/flood & river health
4) *Environmental water security*: river health, hydrological alteration & environmental governance
5) *Resilience to water-related disasters*: floods & windstorms, droughts and storm surges & coastal floods

Source: ADB (2020)

Concept of Water Security

- **Definition of water security in the Korean context**
  - To ensure access to clean water for human beings & ecosystems and cope with water related disasters
  - Recognition of water supply, water quality control, safety from water related disasters and water for ecosystems
- Major principles
  - IWRM, including river basin management
  - Cross-cutting policy & projects
  - Resilience against Climate Change induced water events
  - Institutional settings & coordinating mechanisms

Korea's Water Security

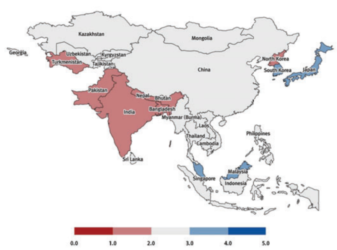


Assessment of Water Security for Asia

- **5 key areas**: 1) social equity; 2) economic efficiency; 3) resilience to water-related disasters; 4) environmental sustainability); and 5) government competence
- *Social equity*: basic water services for human dignity, i.e., clean water and adequate sanitation services
- *Economic efficiency*: effectiveness of water use in agriculture and industry
- *Resilience to water-related disasters*: to construct and operate dams, embankment or reservoirs and related systems and regulations
- *Environmental sustainability*: to restore water-related ecosystems and promote economic regulations such as burdening environmental costs for pollutants and paying for ecosystems.
- *Government's competency*: strengthening institutional aspects, e.g., water resources planning and management, institutions, and organizations, and ensuring democratic political decisions, the progress of policy establishment and enforcement, and a social system

Water Security Assessment Framework

Assessment Result of Water Security Index in Asia

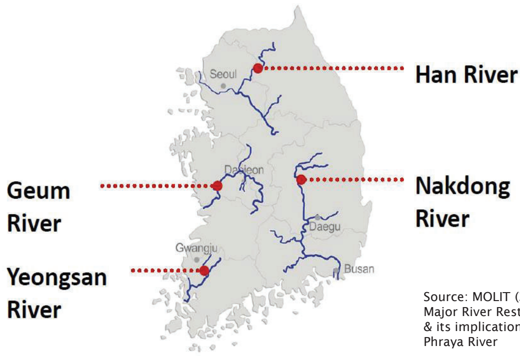


Nations	Core Area 1	Core Area 2	Core Area 3	Core Area 4	Core Area 5	Result
Bangladesh	2.0	1.3	2.2	1.0	2.0	1.7
Bhutan	3.8	1.3	2.5	3.0	3.7	2.9
Brunei Darussalam	3.3	1.0	2.5	3.0	3.7	2.7
Cambodia	2.3	2.7	2.7	2.0	2.2	2.4
China	3.0	2.0	3.0	2.0	2.8	2.6
Georgia	3.5	1.0	3.3	1.5	3.5	2.6
India	1.5	1.0	2.3	1.0	2.8	1.7
Indonesia	2.0	1.3	2.0	3.0	2.8	2.2
Japan	4.0	3.3	2.8	1.5	4.3	3.2
Kazakhstan	3.8	1.3	3.0	2.0	2.7	2.6
Kyrgyzstan	3.8	0.7	4.0	2.0	2.3	2.6
Laos	3.0	1.0	3.2	3.0	2.0	2.4
Malaysia	4.0	2.7	2.5	3.0	3.5	3.1
Mongolia	2.0	1.7	2.8	3.5	3.2	2.6
Myanmar	2.8	1.0	2.0	3.0	2.0	2.2
Nepal	1.8	1.3	2.5	2.0	2.3	2.0
North Korea	3.0	0.0	3.3	1.5	1.3	1.8
Pakistan	2.0	1.3	2.3	1.0	1.8	1.7
Philippines	2.5	1.0	2.2	2.0	2.7	2.1
Singapore	4.0	2.7	2.5	-	4.7	2.8
South Korea	4.0	3.3	3.0	1.0	4.0	3.1
Sri Lanka	3.0	1.0	3.2	1.0	3.0	2.2
Tajikistan	3.3	1.0	3.5	2.5	1.8	2.4
Thailand	3.5	1.7	3.2	1.0	2.7	2.4
Timor-Leste	2.3	1.0	2.5	2.0	2.5	2.1
Turkmenistan	2.3	0.3	3.5	2.0	1.8	2.0
Uzbekistan	3.5	0.3	3.5	2.0	2.0	2.3
Viet Nam	2.5	0.7	3.0	2.0	2.8	2.2

Water Sector Reform 2018 in Korea

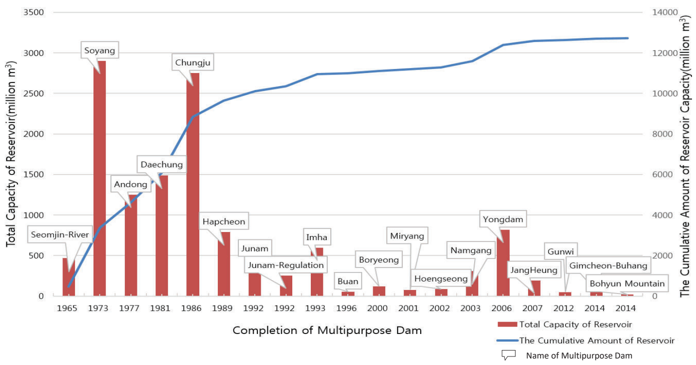
- Overview of water resources management
  - Large dams (multi-purpose): 1) water supply for industries; 2) flood prevention (typhoons); and 3) hydropower ➔ 20 multi-purpose dams
  - 17,000 dams for irrigation as of 2018
  - Multi-regional water supply systems
  - Water quality control in the Four Major Rivers (Han, Geum, Nakdong, Youngsan-Sumjin)
  - More attention to ecosystem services since the mid-1990s after phenol discharge in the Nakdong River

Four Major Rivers in South Korea



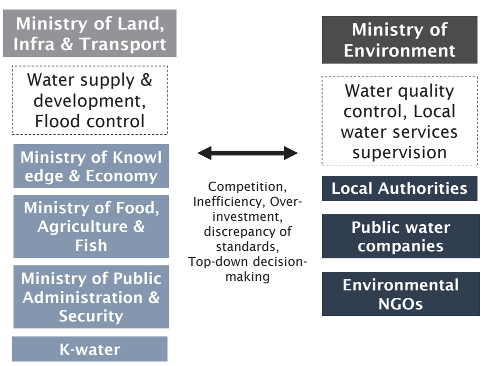
Source: MOLIT (2011) The Four Major River Restoration Project & its implications to the Chao Phraya River

Multi-Purpose Dams: Total Capacity of Reservoir

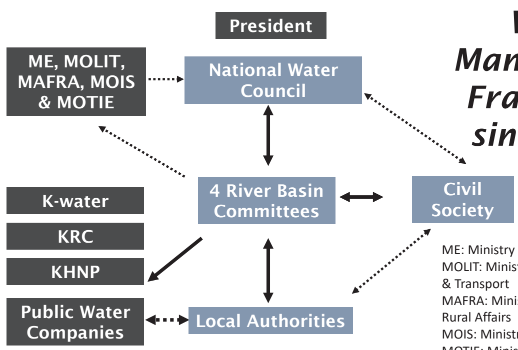


Multi-Purpose Dams

River Basin	Multipurpose Dam	Basin Area (km²)	Data: Height (m)	Data: Length (m)	Total Capacity of Reservoir (million ㎥)	Active Capacity of Reservoir (million ㎥)	Installed Capacity of Power station (MW)	Enterprise Effect: Flood Control (million ㎥)	Enterprise Effect: Water Supply (million ㎥/year)	Construction Period
Han-River	Soyang	2,703	123	530	2,900	1,900	200	500	1,213	"67-"73
	Chungju	6,648	97.5	447	2,750	1,789	412	616	3,380	"78-"86
	Hoengseong	209	48.5	205	86.9	73.4	1.3	9.5	119.5	"90-"02
Nakdong-River	Andong	1,584	83	612	1,248	1,000	91.5	110	926	"71-"77
	Imha	1,361	73	515	595	424	51.06	80	591.6	"84-"93
	Hapcheon	925	96	472	790	560	101.2	80	599	"82-"89
	Namgang	2,285	34	1,126	309.2	299.7	14	269.8	573.3	"87-"03
	Miryang	95.4	89	535	73.6	69.8	1.3	6	73	"90-"02
	Gunwi	87.5	45	390	48.7	40.1	0.5	3.1	38.3	"00-"12
	Gimcheon-Buhang	82.0	64	472	54.3	42.6	0.6	12.3	36.3	"02-"14
	Bohyun Mountain	32.61	58.5	250	22.11	17.88	1.414	3.49	14.87	"10-"14
Guem-River	Daechung	4,134	72	495	1,490	790	90.8	250	1,649	"75-"81
	Yongdam	930	70	498	815	672	26.2	137	650.43	"90-"06
Seomjin-River	Seomjin-River	763	64	344.2	466	370	34.8	32	350	"61-"65
	Junam	1,010	58	330	457	352	1.44	60	270.1	"84-"92
	Junam Regulation	134.6	99.9	562.6	250	210	22.5	20	218.7	"84-"92
Others	Buan	59	50	282	50.3	35.6	0.193	9.3	35.1	"90-"96
	Boryeong	163.6	50	291	116.9	108.7	0.701	10	106.6	"90-"00
	Jangheung	193	53	403	191	171	0.8	8	127.8	"96-"07



Water Management Framework prior to 2018



Water Management Framework since 2018

ME: Ministry of Environment
MOLIT: Ministry of Land, Infrastructure & Transport
MAFRA: Ministry of Agriculture, Food & Rural Affairs
MOIS: Ministry of the Interior & Safety
MOTIE: Ministry of Trade, Industry & Energy

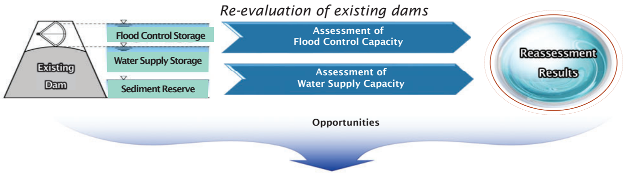
Water Sector Reform 2018 in Korea

- Basic Water Law 2018
  - Principles: IWRM, River Basin Management, Stakeholder Participation, Demand Management
  - National Water Council & River Basin Committees
  - IWRM Plan & River Basin Plans
- Empowerment of the Ministry of Environment
  - Reflection of growth-centered water policy
  - More mandate shifted from MOLIT to ME due to political bargaining
  - Voices accepted in favor of fundamental environmentalism

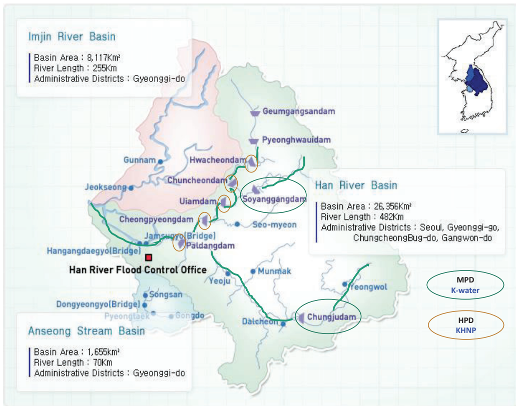
Water Sector Reform 2018 in Korea

- Challenges
  - Basic water law as a foundation for a further institutional reform
  - Launch of river basin management & stakeholder participation
  - River basin management as a basic unit for water resources management, not administrative boundaries
  - More responsibilities given to one ministry ➔ more coherent & efficient planning & management expected
  - More emphasis placed on eco-friendly policies instead of construction & development-oriented policies

Integration of Dam Operation in Korea



- Temporary use of storage allocated for future conservation purposes and sediment
- Seasonal use of flood control space during the dry season and for the multi use space
- Reallocation of flood control or water supply space
- Modification of reservoir operation (hydropower) plan and the method of regulation
- Elevating existing dams for an increase of storage capacity
- Use of water supply storage not under contract

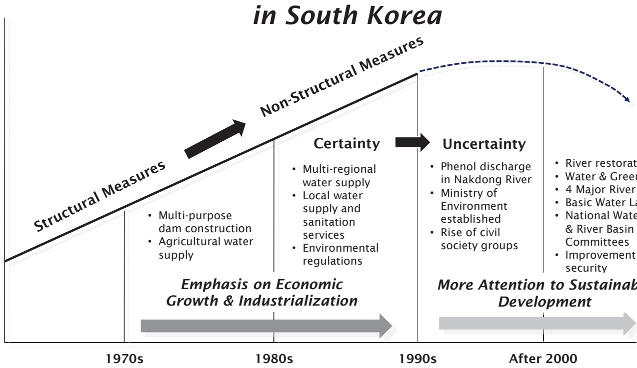


Integrated Hydropower Dam Operation in the Han River

Towards the integrated dam operation in Korea

Issues	Progress	Challenges ahead
Assessment	Adequate & effective assessment of dams in the Han River Basin	• Socio-economic aspects • Technical aspect: single/joint operation
Management	Adequate & effective management pl ans & processes	• Transfer of dam ownership • Consignment management
Stakeholders Engagement	Effective stakeholder engagement	• Communication & consultation for good governance
Expected Outcomes	Socio-economic & environmental imp acts avoided, minimized & mitigated without significant gaps between reg ions	• Increased flood control capacity • Increased water supply capacity • Increased hydropower generation

Trajectory of Water Resources Management in South Korea



Conclusions

- Towards a water-secure society
  - Various dimensions of water resources management
  - Water security assessment ➔ disclosing the risk of water insecurity & unlocking the potential for int'l cooperation, i.e., in Asia & the Pacific
- Good practices of South Korea
  - Water sector reform: the institutional path to water security
  - The integrated approach to dam operation ➔ linking dams with dams for sustainability in river basins

BỘ TÀI NGUYÊN VÀ MÔI TRƯỜNG
CỤC QUẢN LÝ TÀI NGUYÊN NƯỚC

ĐỊNH HƯỚNG BẢO ĐẢM AN NINH NGUỒN NƯỚC TẠI VIỆT NAM

Nguyễn Minh Khuyến
Phó Cục trưởng Cục Quản lý tài nguyên nước

Tháng 01/2022

NỘI DUNG

I. HỆ THỐNG TỔ CHỨC QUẢN LÝ TÀI NGUYÊN NƯỚC Ở VIỆT NAM

Cấp Trung ương

Chính phủ ← Hội đồng quốc gia về TNN

MONRE
(Bộ Tài nguyên & Môi trường)
Chịu trách nhiệm trước Chính phủ thực hiện quản lý nhà nước về tài nguyên nước, quản lý lưu vực sông trong phạm vi cả nước
- Chủ trì xây dựng VBPL về TNN;
- Điều hoà, phân bổ TNN
- Lập chiến lược, quy hoạch, quy trình vận hành liên hồ, kế hoạch chuyển nước các LVS;
- Tổ chức thực hiện các hoạt động điều tra cơ bản, giám sát TNN;
- Thường trực Hội đồng quốc gia về TNN, các tổ chức LVS;
- Xây dựng cơ sở dữ liệu, hệ thống thông tin TNN;
- Cấp phép khai thác sử dụng TNN…

Các ngành sử dụng nước

MOIT *(Bộ Công Thương)* Quản lý các công trình thuỷ điện, các cơ sở sản xuất công nghiệp, dịch vụ (sử dụng nước cho thuỷ điện, công nghiệp, dịch vụ)

MOC *(Bộ Xây dựng)* Quản lý cấp, thoát nước đô thị

MARD *(Bộ Nông nghiệp và phát triển nông thôn)* Quản lý hệ thống công trình thuỷ lợi (nước cho nông nghiệp), cấp nước nông thôn

MOT *(Bộ Giao thông vận tải)* Quản lý công trình đường thuỷ (nước cho giao thông)

Cấp địa phương

Uỷ ban nhân dân cấp tỉnh

Sở Tài nguyên và môi trường — Sở Công Thương; Sở Xây dựng; Sở NN&PTNT; Sở GTVT

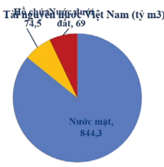
MỘT SỐ KẾT QUẢ ĐẠT ĐƯỢC TRONG QUẢN LÝ TÀI NGUYÊN NƯỚC
Giai đoạn 2012-2021

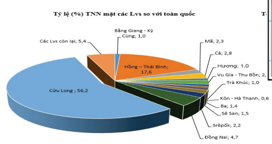
Hệ thống văn bản QPPL trong lĩnh vực tài nguyên nước
- Luật Tài nguyên nước 2012
- 09 Nghị định của Chính phủ
- 02 Quyết định của Thủ tướng Chính phủ
- 32 thông tư hướng dẫn của Bộ Tài nguyên và Môi trường

- ✔ Quản lý tổng hợp tài nguyên nước theo lưu vực sông, coi TNN là tài sản, là nguồn lực chung của quốc gia và phải được quản lý thống nhất.
- ✔ Điều tra cơ bản, chiến lược, quy hoạch TNN
- ✔ Bảo vệ tài nguyên nước (phòng, chống ô nhiễm; hành lang bảo vệ nguồn nước; bảo vệ phát triển nguồn sinh thuỷ; bảo vệ các dòng sông; bảo vệ nước dưới đất…)
- ✔ Khai thác, sử dụng TNN tiết kiệm, hiệu quả và phòng, chống các tác hại do nước gây ra;
- ✔ Tài chính TNN (thuế TNN, tiền cấp quyền khai thác TNN,…)
- ✔ Quan hệ quốc tế về TNN
- ✔ Phân công, phân cấp trong quản lý TNN

II. HIỆN TRẠNG, THÁCH THỨC ĐỐI VỚI AN NINH NGUỒN NƯỚC VIỆT NAM
TỔNG QUAN TÀI NGUYÊN NƯỚC

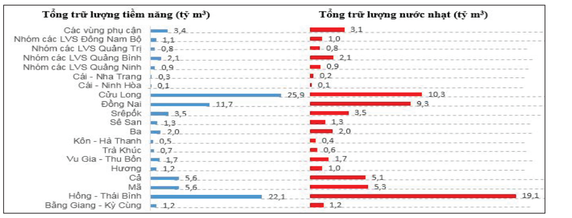
Tài nguyên nước mặt
- Việt Nam có 106 lưu vực sông với 3450 sông chiều dài > 10km.
- 13 lưu vực sông lớn, quan trọng (Hồng-Thái Bình, Bằng Giang - Kỳ Cùng, Mã, Cả, Hương, Vu Gia-Thu Bồn, Trà Khúc, Kôn - Hà Thanh, Ba, Sê San, Srê Pốk, Đồng Nai, Mê Công). Trong đó, 7/1 LVS liên quốc gia.
- Tổng dòng chảy bình quân nhiều năm: 844,3 tỷ m^3 (8.500 m^3/ng) TNN sinh ra trong lãnh thổ Việt Nam: 340 tỷ m^3 (40,3%).
- Dòng chảy mùa lũ 60%-80% dòng chảy năm. Tháng kiệt nhất chỉ chiếm 1%-3% lượng nước cả năm. TNN mùa khô cl 131 tỷ m^3, 54 tỷ trữ trong hồ chứa (1.920m^3/ng).





TỔNG QUAN TÀI NGUYÊN NƯỚC VIỆT NAM

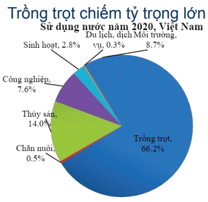
Nước dưới đất
- Tổng lượng tiềm năng khoảng **91,5 tỷ m^3/năm** (nước nhạt khoảng **69 tỷ m^3/năm**, nước mặn khoảng **22,4 tỷ m^3/năm**).
- Tổng lượng nước nhạt có thể khai thác khoảng **22,3 tỷ m^3/năm**, tập trung chủ yếu ở khu vực đồng bằng thuộc các LVS: Hồng - Thái Bình, hạ lưu LVS Đồng Nai, LVS Cửu Long.



Tổng lượng tài nguyên nước dưới đất trên các lưu vực sông

HIỆN TRẠNG KHAI THÁC SỬ DỤNG NƯỚC

NHU CẦU NƯỚC
- Nhu cầu nước 2020: 106 tỷ m^3, chiếm 11% tổng lượng nước
- Trồng trọt chiếm tỷ trọng lớn 66%



CÁC NGÀNH DÙNG NƯỚC CHÍNH

Nông nghiệp	Thủy sản
Lúa: trên 7 triệu ha, giảm DT, SL Chuyển đổi mạnh từ lúa >> cây có giá trị cao Xuất/nhập khẩu Chăn nuôi tăng	Diện tích: 1,3 triệu ha 7,5 triệu m^3 lồng nước mặn 2,5 triệu m^3 lồng nuôi nước ngọt
Công nghiệp	**Thủy điện**
395 KCN lớn, DT 122.000 ha 968 CCN, DT 30.000ha Tập trung: ĐBSH, ĐBSCL, Đồng Nai và Đông Nam bộ	Khai thác cơ bản tiềm năng TĐ Công suất gần 30.000 Mw Dung tích hữu ich 54 tỷ m3 Góp phần chống lũ, cập nước

NGUỒN NƯỚC

Chủ yếu nước mặt; NDĐ mới khai thác 3,8 tỷ m^3 chiếm 3,5%

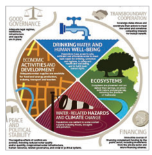
Đã xây dựng 96.000 công trình KTSDN, trong đó 87.750 CT khai thác nước mặt

Có 8080 hồ chứa (8.4%), gồm: 6.785 hồ thủy lợi có dung tích từ 0,05 triệu m^3 trở lên; 705 hồ thủy điện; 27.700 cống (28,7%) và 20.250 trạm bơm (21%)

II. HIỆN TRẠNG, THÁCH THỨC VỀ AN NINH NGUỒN NƯỚC VIỆT NAM

Khái niệm An ninh nguồn nước

*"**An ninh nguồn nước** là khả năng dân số có thể đảm bảo sự tiếp cận bền vững với lượng nước cần thiết và có chất lượng tốt để duy trì sinh kế, phúc lợi và phát triển kinh tế - xã hội, nhằm đảm bảo sự bảo vệ, chống lại các vấn đề ô nhiễm và thiên tai liên quan đến nguồn nước, và nhằm bảo tồn hệ sinh thái trong điều kiện hòa bình và ổn định chính trị" - UN-Water, 2013*



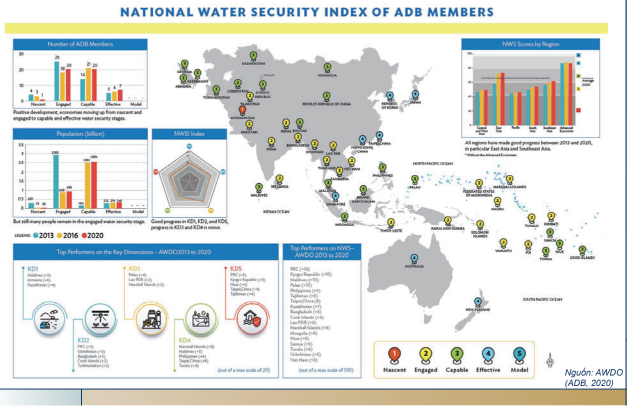
Chỉ số đánh giá ANNN quốc gia (ADB,2020)

ANNN là loại hình an ninh phi truyền thống, liên quan mật thiết đến an ninh quốc gia.

Pháp luật Việt Nam chưa quy định khái niệm ANNN, thiếu khung pháp lý được xây dựng theo cách tiếp cận quản lý tổng hợp, đa ngành cho ANNN mặc dù nội hàm và trách nhiệm quản lý về ANNN đã được quy định trong nhiều văn bản pháp luật khác nhau. => Khái niệm ANNN dự kiến sẽ được xem xét, bổ sung trong quá trình rà soát, sửa đổi Luật tài nguyên nước (2022-2023).

II. HIỆN TRẠNG, THÁCH THỨC VỀ AN NINH NGUỒN NƯỚC VIỆT NAM

❖ ADB (các năm 2013, 2016 và 2020) đánh giá ANNN quốc gia của Việt Nam chỉ đạt mức bảo đảm 2/5 và ở mức thấp.



Nguồn: AWDO (ADB, 2020)

II. HIỆN TRẠNG, THÁCH THỨC VỀ AN NINH NGUỒN NƯỚC VIỆT NAM

❖ Báo cáo về an ninh nguồn nước sinh hoạt và sản xuất
(Ủy ban KHCNMT của Quốc hội (10/2020)

❖ Đề án Đảm bảo An ninh tài nguyên nước quốc gia
(Bộ TN&MT chủ trì xây dựng, trình Chính phủ tháng 8/2021)

❖ Dự thảo Nghị quyết Quốc hội về bảo đảm an ninh nguồn nước quốc gia
(Trình Quốc hội tháng 10/2021)

❖ Hồ sơ đề xuất sửa Luật Tài nguyên nước 2012
(Bộ TN&MT chủ trì xây dựng, trình Chính phủ 12/2021)

09 thách thức về an ninh nguồn nước của Việt Nam:

(1) Nguồn nước Việt Nam chủ yếu phụ thuộc vào nước ngoài
(2) Tài nguyên nước phân bố không đều theo không gian, thời gian
(3) Hiệu quả khai thác, sử dụng nước thấp
(4) Áp lực phát triển KTXH, nhu cầu, mâu thuẫn KTSD nước gia tăng
(5) Ô nhiễm nguồn nước
(6) Khả năng tiếp cận nước sạch an toàn chưa cao
(7) Duy trì, phát triển rừng, bảo vệ nguồn sinh thủy
(8) Tác động của biến đổi khí hậu
(9) Vấn đề quản trị và nguồn lực.

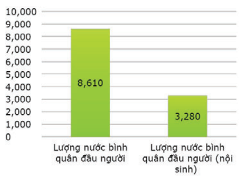
THÁCH THỨC VỀ AN NINH NGUỒN NƯỚC VIỆT NAM

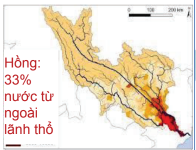
❖ **Nguồn nước Việt Nam chủ yếu phụ thuộc vào nước ngoài**

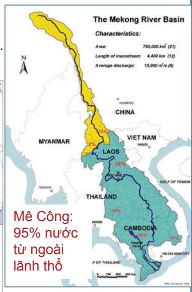
- **7/13 LVS lớn, quan trọng là LVS liên quốc gia.**
- **71,7% diện tích** các LVS nằm ngoài lãnh thổ.
- **63% tổng lượng dòng chảy** của các sông từ ngoài lãnh thổ.

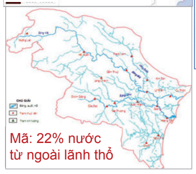
Tổng lượng nước bình quân đầu người: **8.610 m³/người/năm.**

Nếu chỉ xét nguồn nước nội sinh, tổng lượng nước bình quân đầu người: **3.280 m³/người/năm.**









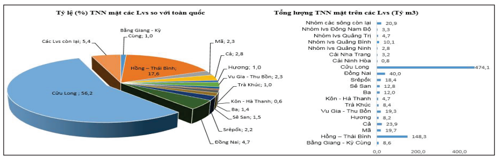
Đồng bằng sông Cửu Long - Nguồn nước chủ yếu phụ thuộc vào nước ngoài

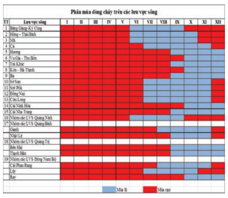
- 95% tổng lượng nước của ĐBSCL từ thượng nguồn sông Mê Công (Trung Quốc, Myanmar, Thái Lan, Lào, Campuchia).
- Các hoạt động đắp đập, chặn dòng, chuyển nước, mở rộng diện tích tưới, xây dựng và vận hành của các công trình thủy điện ở các quốc gia thượng nguồn LVS Mê Công là nguy cơ trực tiếp làm suy giảm nguồn nước chảy vào Việt Nam.

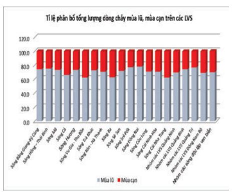
- ***Thượng nguồn (Trung Quốc):*** đã hoàn thành và vận hành 11 công trình thủy điện (riêng 02 hồ lớn Tiểu Loan và Nọ Trác Độ có dung tích khoảng 38 tỷ m³.)
- ***Phần trung lưu (Lào và Campuchia):*** 11 dự án thủy điện.
- ***Thái Lan:*** các dự án chuyển nước ra ngoài và trong lưu vực với quy mô lớn.

THÁCH THỨC VỀ AN NINH NGUỒN NƯỚC VIỆT NAM

❖ **Tài nguyên nước phân bố không đều theo không gian, thời gian**







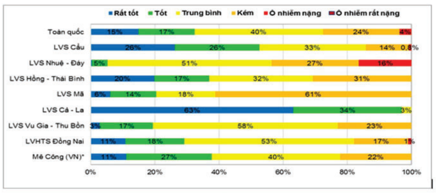
Phân mùa và tỷ lệ phân phối TNN mặt theo mùa trên các lưu vực sông

THÁCH THỨC VỀ AN NINH NGUỒN NƯỚC VIỆT NAM

❖ **Hiệu quả khai thác, sử dụng nước thấp**

- Tỷ lệ thất thoát nước cho cấp nước đô thị và nông thôn ở mức **cao (25%).**
- Hệ thống công trình thủy lợi chỉ đạt **50-90%** năng lực thiết kế khai thác. Thất thoát nước tưới nông nghiệp khoảng **30%.**
- **Hiệu quả sử dụng nước thấp.** Chỉ tạo ra 2,37 đôla GDP/m³ nước bằng khoảng 1/10 so với mức trung bình toàn cầu là 19,42 đôla, thấp hơn Philippin 2,58 USD.
- Hiệu suất sử dụng nước của các ngành nông nghiệp, công nghiệp và dịch vụ lần lượt là 0,2 USD/m³, 15,3 USD/m³ và 43,5 USD/m³ (FAO, 2018).

❖ **Ô nhiễm nguồn nước**



Tỷ lệ chỉ số chất lượng nước các LVS giai đoạn 2016-2020.

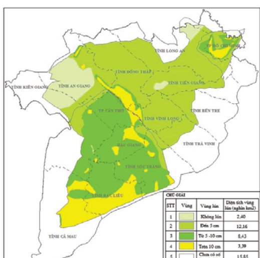
ĐỒNG BẰNG SÔNG CỬU LONG

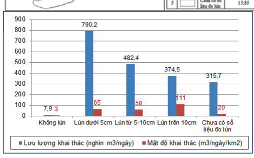
❖ **Hạ thấp nước dưới đất và sụt lún đất**

Mực nước dưới đất các TCN trong vùng bị hạ thấp liên tục do lượng khai thác tăng liên tục. Trị số hạ thấp của các TCN thường một vài mét; các tâm phễu cục bộ như tại Cà Mau, Bạc Liêu, Sóc Trăng, Long An hạ thấp tới gần 20 m. Vùng có mực nước ngầm bị hạ thấp lớn nhất là khu vực Hóc Môn, Thủ Đức - đạt tới 30 m.

Đánh giá sơ bộ (Bộ TNMT, 2019):
+ Vùng không bị lún hoặc nâng: 9% (2,4 nghìn km²)
+ Vùng lún dưới 5cm: 46% (12,2 nghìn km²)
+ Vùng lún từ 5 - 10cm: 32% (8,4 nghìn km²)
+ Vùng lún trên 10cm: 13% (3,4 nghìn km²).

***Nguyên nhân: Tự nhiên + Do các hoạt động của con người** (khai thác nước dưới đất quá mức, xây dựng đô thị, các công trình kết cấu hạ tầng,...).*

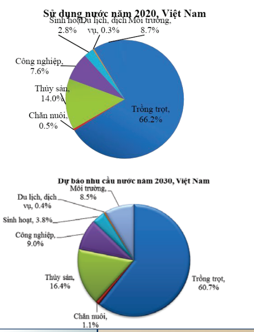


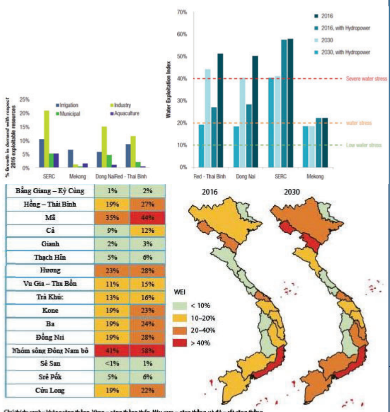


THÁCH THỨC VỀ AN NINH NGUỒN NƯỚC VIỆT NAM

❖ **Áp lực phát triển KTXH, nhu cầu, mâu thuẫn KTSD nước gia tăng**

Dự báo nhu cầu nước
- Năm 2025 khoảng 120 tỷ m³,
- Năm 2030 khoảng 122 tỷ;
- Năm 2050 khoảng 131 tỷ m³

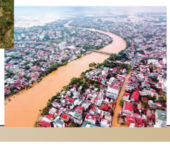




THÁCH THỨC VỀ AN NINH NGUỒN NƯỚC VIỆT NAM

❖ **Tác động của biến đổi khí hậu**

- Hạn hán, xâm nhập mặn (2016, 2019)
- Lũ lụt (2020)



Kịch bản BĐKH 2020:
Nguy cơ ngập (nước biển dâng do BĐKH cao 100cm): 13,2% diện tích Đồng bằng sông Hồng, 1,53% diện tích đất các tỉnh ven biển miền Trung, khoảng 17,15% diện tích Tp. Hồ Chí Minh, 47,29% diện tích ĐBS Cửu Long.

THÁCH THỨC VỀ AN NINH NGUỒN NƯỚC VIỆT NAM

❖ **Vấn đề quản trị và nguồn lực**

- **Chồng chéo, giao thoa** trong công tác quản lý giữa các Bộ, ngành; **cơ chế phối hợp yếu**.
- Đầu tư, bố trí nguồn lực còn thiếu cân đối; **thiếu kinh phí, thiếu đồng bộ, hiệu quả chưa cao**. Kinh phí bố trí cho điều tra cơ bản tài nguyên nước, quy hoạch, xây dựng cơ sở dữ liệu, … còn thiếu và chưa đồng bộ để giải quyết dứt điểm những vấn đề đặt ra.
- **Chưa tính đúng, tính đủ giá trị tài nguyên nước**; lãng phí, sử dụng nước không tiết kiệm, hiệu quả.
- **Chưa thực sự triển khai quản lý tổng hợp, thống nhất tài nguyên nước**, thiếu các tổ chức lưu vực sông có đủ thẩm quyền quản lý.
- **Thiếu cơ chế, chính sách khuyến khích, tăng cường xã hội hoá** lĩnh vực TNN (phục hồi ô nhiễm, suy thoái nguồn nước; quan trắc TNN…)

III. NHIỆM VỤ, GIẢI PHÁP BẢO ĐẢM AN NINH NGUỒN NƯỚC VIỆT NAM

QUAN ĐIỂM

1. Bảo đảm ANNN là vấn đề thiết yếu, cấp bách, cấp bách trong bối cảnh nguồn nước ngày càng bị ô nhiễm, suy thoái, cạn kiệt trước tác động mạnh mẽ của quá trình phát triển kinh tế - xã hội, biến đổi khí hậu và phụ thuộc lớn vào nguồn nước liên quốc gia.

2. Quản lý tài nguyên nước phải thống nhất về số lượng và chất lượng nước; giữa nước mặt và nước dưới đất; giữa thượng lưu và hạ lưu, kết hợp với quản lý các nguồn tài nguyên thiên nhiên khác. Tách bạch quản lý tổng hợp thống nhất về tài nguyên nước với quản lý, vận hành công trình khai thác, sử dụng nước.

3. Phải coi sản phẩm nước là hàng hoá, khuyến khích, thu hút các nguồn lực xã hội, các thành phần kinh tế nhằm nâng cao hiệu quả công tác bảo vệ, phát triển nguồn nước, giảm thiểu tác hại do nước gây ra và nâng cao giá trị của nước.

4. Khai thác, sử dụng tài nguyên nước phục vụ sinh hoạt, phát triển kinh tế - xã hội phải gắn với khả năng đáp ứng của nguồn nước và bảo vệ, phát triển tài nguyên nước.

5. Đầu tư cho bảo vệ và phát triển bền vững tài nguyên nước phải kết hợp hài hoà giải pháp công trình và phi công trình, đảm bảo hiệu quả kinh tế - xã hội, môi trường và phát triển bền vững, tối ưu hóa nguồn lực phát triển.

6. Hợp tác, chia sẻ lợi ích, bảo đảm công bằng và hợp lý trong khai thác, sử dụng, bảo vệ, phát triển nguồn nước liên quốc gia.

IV. QUAN ĐIỂM, NHIỆM VỤ, GIẢI PHÁP BẢO ĐẢM AN NINH NGUỒN NƯỚC VIỆT NAM

NHIỆM VỤ, GIẢI PHÁP ĐẾN NĂM 2030

a) Hoàn thiện, đổi mới thể chế, chính sách, cơ chế tài chính ngành nước theo hướng quản trị thông minh; thu hút nguồn lực xã hội đầu tư phát triển ngành nước và điều chỉnh nhu cầu sử dụng nước theo hiệu quả sử dụng nước.

b) Nâng cao hiệu quả công tác quản lý, giám sát, bảo vệ, phát triển, điều hòa phân bổ tài nguyên nước đảm bảo chủ động nguồn nước cấp cho các mục đích sinh hoạt và sản xuất.

c) Chủ động kế hoạch sử dụng nước trên sông xuyên biên giới trên cơ sở giám sát, hợp tác với các quốc gia có chung nguồn nước trong việc chia sẻ thông tin, số liệu quan trắc, vận hành khai thác nguồn nước.

d) Cải thiện, phục hồi các dòng sông bị suy thoái, cạn kiệt và ô nhiễm, bảo vệ nguồn nước, bảo vệ và phát triển bền vững nguồn sinh thủy, các hệ sinh thái ngập nước quan trọng, đảm bảo an ninh nước cho môi trường.

e) Tăng cường đầu tư, nâng cấp, nâng cao hiệu quả sử dụng nước, chỉ tiêu đảm bảo an ninh tài nguyên nước, chủ động nguồn nước cho các ngành, lĩnh vực: sinh hoạt, công nghiệp, nông nghiệp, năng lượng, giao thông và các ngành sử dụng nước khác.

IV. QUAN ĐIỂM, NHIỆM VỤ, GIẢI PHÁP BẢO ĐẢM AN NINH NGUỒN NƯỚC VIỆT NAM

NHIỆM VỤ, GIẢI PHÁP ĐẾN NĂM 2030

f) Nâng cao năng lực ứng phó tác động biến đổi khí hậu và các rủi ro khác liên quan đến nước.

g) Tăng cường đầu tư, nâng cấp, nâng cao chỉ tiêu đảm bảo an ninh tài nguyên nước trong thu gom, xử lý nước thải và thoát nước.

h) Tăng cường các hoạt động nghiên cứu, hợp tác quốc tế, chuyển giao khoa học công nghệ.

i) Xây dựng, vận hành hệ thống chỉ tiêu theo dõi, đánh giá an ninh tài nguyên nước quốc gia.

j) Tăng cường thanh tra, kiểm tra, tuyên truyền, giáo dục, nâng cao nhận thức và khuyến khích sự tham gia của cộng đồng trong việc đảm bảo an ninh tài nguyên nước quốc gia.

NHIỆM VỤ, GIẢI PHÁP ĐẾN NĂM 2045

a) Hoàn thiện các giải pháp chính sách, các công cụ quản lý, công cụ kinh tế để chủ động bảo vệ, điều hoà, phân bổ nguồn nước hiệu quả theo các kịch bản đảm bảo số lượng, chất lượng nước đáp ứng đủ nhu cầu sử dụng nước.

b) Nâng chỉ số an ninh tài nguyên nước quốc gia lên nhóm các quốc gia đảm bảo an ninh tài nguyên nước hiệu quả trong khu vực.

KẾT LUẬN

❖ **Bộ TNMT chịu trách nhiệm trước Chính phủ thực hiện quản lý nhà nước về tài nguyên nước, quản lý lưu vực sông trong phạm vi cả nước; chủ trì điều hoà, phân phối tài nguyên nước cho các ngành sử dụng nước như thuỷ điện, thủy lợi, cấp nước đô thị, nông thôn, sản xuất công nghiệp…**

❖ **Tài nguyên nước Việt Nam đang đối mặt với những thách thức lớn về an ninh nguồn nước: phụ thuộc nguồn nước nước ngoài; tài nguyên nước phân bố không đồng đều; nhu cầu nước gia tăng; ô nhiễm nước gia tăng; sử dụng nước lãng phí, kém hiệu quả; hạn hán thiếu nước xảy ra thường xuyên (ở Miền trung Tây nguyên và Đồng bằng sông Cửu Long); chị tác động mạnh bởi BĐKH; quản trị nước chưa đủ mạnh.**

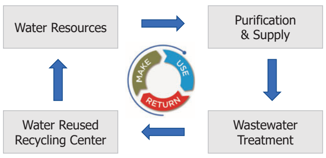
❖ **Trong thời gian tới Bộ TNMT sẽ tiếp tục tham mưu trình Chính phủ, Quốc hội ban hành Luật Tài nguyên nước sửa đổi bao gồm những chính sách lớn về quản lý tài nguyên nước như an ninh nguồn nước, tài chính nước, xã hội hoá ngành nước để tạo nguồn lực cho ngành nước; tăng cường hợp tác quốc tế và các biện pháp quản lý để nâng cao hiệu quả quản trị tài nguyên nước.**

BỘ TÀI NGUYÊN VÀ MÔI TRƯỜNG
CỤC QUẢN LÝ TÀI NGUYÊN NƯỚC

XIN TRÂN TRỌNG CẢM ƠN!

Nguyễn Minh Khuyến
Phó Cục trưởng Cục Quản lý tài nguyên nước
Khuyentnn@gmail.com

How private sector prepare and plan for water security
in EEC area Thailand
& Things to be considered and prepared for more security



1

The new development from Eastern Seaboard to Eastern Economic Corridor (EEC) Thailand

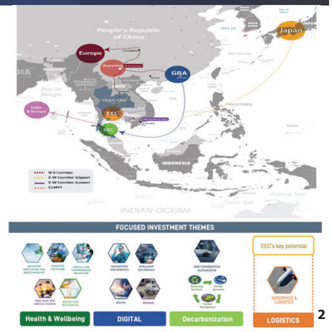
Past - Present

The Eastern Seaboard of Thailand is home to several industrial estates, including Map Ta Phut Industrial Estate, whose focus is on petrochemicals and heavy industries. Petroleum & petrochemicals in eastern seaboard contribution represent 8% of Thai GDP (36 billion USD)

Future

The Eastern Economic Corridor (EEC) is area-based development in 3 provinces Rayong, Chonburi, and Chachoengsao focusing on investment theme : Health & Wellbeing, Digital, Decarbonization and Logistics.

EEC promoted zones for target industrial such as Automation & Robotic, Digital Park, Medical Hub, Bio-Technology etc.in 26 industrial Estates.



2

Water Management under Water Security / SDGs

SUPPLY

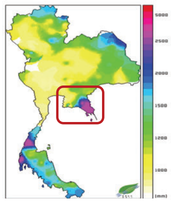
DEMAND

WATER MANAGEMENT

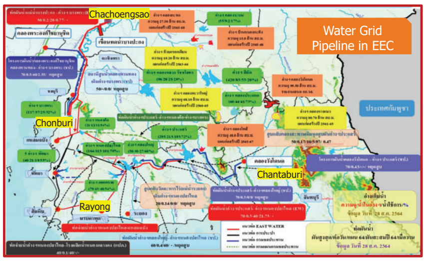
3

Water Supply | Strengthen Water supply management to reduce vulnerability of scarcity to business.

Precipitation



Thailand Rainfall Map

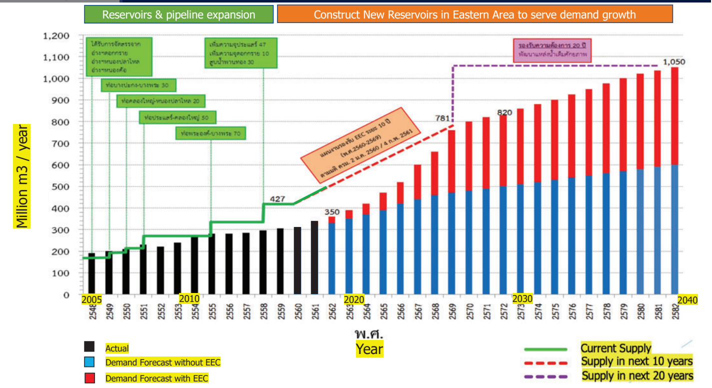


Current
- Average rainfall in Eastern part of Thailand 1,000 – 2,500 mm./year.
- Connecting Water grid network (492 km.) from reservoirs (High precipitation area) distributed to demand side areas to ensure water supplyability during uncertainty period.

Future
- According to EEC demand growth, Governement set Water Resource Master Plan (20Y) to construct new reservoirs which located on high precipitation areas in Chantaburi Province to transfers raw water through network by minimizing water drain out to the ocean.

4

Water Projection | Water Supply – Demand Projection in EEC



5

Supply Projects | Cooperate with Government to expedite water management projects in EEC

Highlight Project in 20 years

- Overall project could generate water in EEC 706.2 million m3. (Total Investment Cost 1.1 Billion USD.)

ประเภทโครงการ (Supply Side Management)	Project Detail	Water Quantity (Million m3)
อ่างเก็บน้ำสร้างใหม่ (ขนาดกลาง)	อ่างพะวาใหญ่ อ่างคลองหางแมว อ่างกระแส อ่างเขาจอมแห-เขานั่งยอง (อ่างวังโตนด* อ่างห้วยกรอกเคียน* อ่างคลองกะพง* อ่างหนองกระทิง* อ่างคลองโพล้* อ่างคลองน้ำเขียว*) ชป.+ จังหวัดระยอง	208.7
ปรับปรุงอ่างเก็บน้ำเดิม	อ่างหนองปลาไหล อ่างหนองค้อ อ่างบ้านบึง อ่างมาบประชัน อ่างคลองสียัด อ่างคลองหลวง ชป.	91.5
ปรับปรุงระบบเครือข่ายน้ำเดิม	เครือข่ายน้ำอ่างคลองใหญ่-อ่างหนองปลาไหล ชป.	-
	ผันน้ำแม่น้ำบางปะกง – อ่างบางพระ East Water	20
ก่อสร้างระบบเครือข่ายน้ำใหม่	ผันน้ำพานทอง – อ่างบางพระ + เครือข่ายน้ำอ่างประแสร์-อ่างหนองค้อ-อ่างบางพระ ชป.	20
ระบบสูบกลับ	สูบกลับคลองสะพานอ่างประแสร์ (เส้นที่ 1) ชป.	50
	สูบกลับคลองสะพานอ่างประแสร์ (เส้นที่ 2) ชป.	50
ขุดลอกคลอง	ในพื้นที่ชลประทาน (คบ.พระองค์ไชยานุชิต) ชป.	7
พัฒนาพื้นที่น้ำท่วมซ้ำซากเป็นแก้มลิง	พัฒนาพื้นที่น้ำท่วมซ้ำซากเป็นแก้มลิง (คบ.บางพลวง) ชป.	200
พัฒนากลุ่มบ่อน้ำบาดาลสำหรับภาคอุตสาหกรรม	Industrial Well Field ทบ.	12
สระสำรองน้ำเอกชน	สระทับมา East Water + ภาคเอกชน	47
แผนงานก่อสร้างปรับปรุงขยาย กปภ.	กปภ.สาขาชลบุรี-พนัสนิคม-(พานทอง)-(ท่าบุญมี) ระยะที่ 1 กปภ.สาขาบ้านฉาง (รองรับ EEC) กปภ.สาขาพัทยา-แหลมฉบัง-ศรีราชา กปภ.สาขาชลบุรี-พนัสนิคม-(พานทอง)-(ท่าบุญมี) ระยะที่ 2 กปภ.	-
ก่อสร้างระบบเครือข่ายน้ำใหม่	ระบบท่อส่งน้ำดิบอ่างเก็บน้ำคลองหลวง-ชลบุรี เพิ่มประสิทธิภาพและปริมาณการจ่ายน้ำท่อส่งน้ำหนองปลาไหล-หนองค้อ East Water	-
ผลิตน้ำจืดจากน้ำทะเล (Desalination)	สทนช.+สกพอ.	50-75
	รวม (629.2+77 = 706.2)	706.2

6

Demand Projects | Increasing Water Efficiency by 3R technology to reduce surface water withdrawal

Water Management Strategy

Water Footprint

- Reduce Water Usage
  - Reduce water loss in process
    - Optimize water utilization

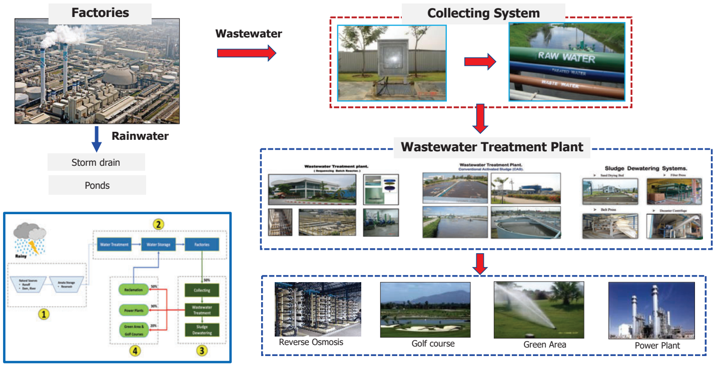
Reduce water usage by increasing the efficiency of production processes and products
- ✓ Continuously improve the production process to increase efficiency reducing water withdrawal from natural sources with the expansion of sustainability practices throughout the entire supply chain.

Reused Treated Wastewater
- ✓ Install high-quality wastewater treatment systems, and apply the Advanced Internal Water Treatment Process to reuse treated wastewater and add value in the production processes, instead of discharge.

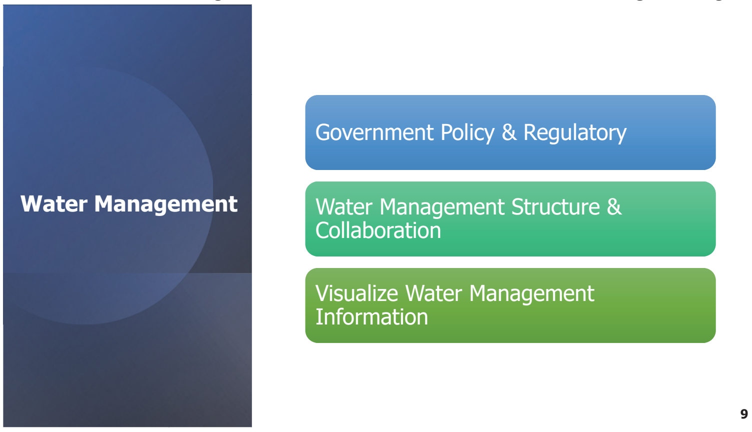
Develop the capability of water management personnel
- ✓ Raise the awareness and understanding of the importance of water resources, the social and environmental impact, through training and practice. To cultivate the thinking process, management, and business development skills.

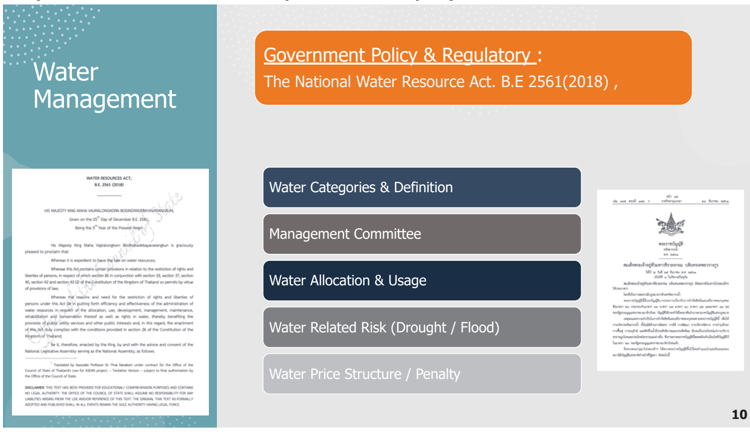
7

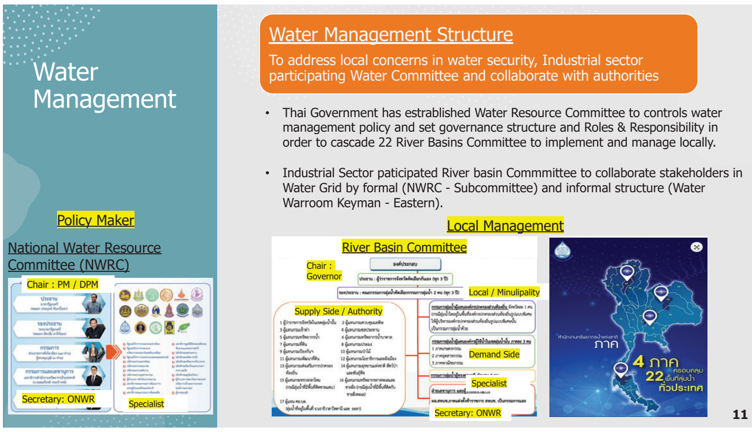
3R Projects | Sample Project adopting Circular Economy concept to reclaim water

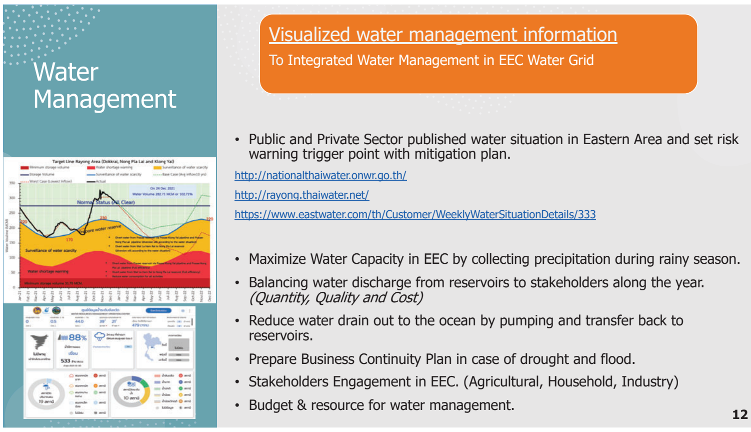


8


Water Management
Government Policy & Regulatory
Water Management Structure & Collaboration
Visualize Water Management Information
9


Water Management
Government Policy & Regulatory :
The National Water Resource Act. B.E 2561(2018) ,
Water Categories & Definition
Management Committee
Water Allocation & Usage
Water Related Risk (Drought / Flood)
Water Price Structure / Penalty
10


Water Management
Water Management Structure
To address local concerns in water security, Industrial sector participating Water Committee and collaborate with authorities
• Thai Government has estrablished Water Resource Committee to controls water management policy and set governance structure and Roles & Responsibility in order to cascade 22 River Basins Committee to implement and manage locally.
• Industrial Sector paticipated River basin Commmittee to collaborate stakeholders in Water Grid by formal (NWRC - Subcommittee) and informal structure (Water Warroom Keyman - Eastern).
Policy Maker
National Water Resource Committee (NWRC)
Chair : PM / DPM
Secretary: ONWR
Specialist
Local Management
River Basin Committee
Chair : Governor
Local / Minulipality
Supply Side / Authority
Demand Side
Specialist
Secretary: ONWR
4 ภาค
22 ลุ่มน้ำ
ทั่วประเทศ
11


Water Management
Visualized water management information
To Integrated Water Management in EEC Water Grid
• Public and Private Sector published water situation in Eastern Area and set risk warning trigger point with mitigation plan.
http://nationalthaiwater.onwr.go.th/
http://rayong.thaiwater.net/
https://www.eastwater.com/th/Customer/WeeklyWaterSituationDetails/333
• Maximize Water Capacity in EEC by collecting precipitation during rainy season.
• Balancing water discharge from reservoirs to stakeholders along the year. (Quantity, Quality and Cost)
• Reduce water drain out to the ocean by pumping and transfer back to reservoirs.
• Prepare Business Continuity Plan in case of drought and flood.
• Stakeholders Engagement in EEC. (Agricultural, Household, Industry)
• Budget & resource for water management.
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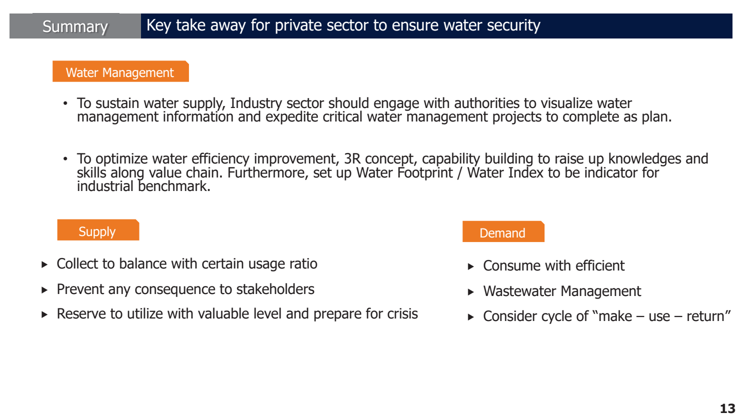
Summary
Key take away for private sector to ensure water security
Water Management
• To sustain water supply, Industry sector should engage with authorities to visualize water management information and expedite critical water management projects to complete as plan.
• To optimize water efficiency improvement, 3R concept, capability building to raise up knowledges and skills along value chain. Furthermore, set up Water Footprint / Water Index to be indicator for industrial benchmark.
Supply
Collect to balance with certain usage ratio
Prevent any consequence to stakeholders
Reserve to utilize with valuable level and prepare for crisis
Demand
Consume with efficient
Wastewater Management
Consider cycle of "make – use – return"
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Thank you
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INVITED SPEAKER

SESSION A:
WATER MANAGEMENT AND CLIMATE CHANGE

THA 2022 International Conference on
Moving Towards Sustainable Water and Climate Change Management After COVID-19

Super Drought Hotspots over East Asia in the Last Decade

Wen CHEN[1], Lin WANG[1], Jinling PIAO[1],
Gang HUANG[1], Chakrit CHOTAMONSAK[2], Atsamon LIMSAKUL[3], and Qiang FU[4]

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[2] Department of Geography, Faculties of Social Sciences, Chiang Mai University, Chiang Mai, Thailand
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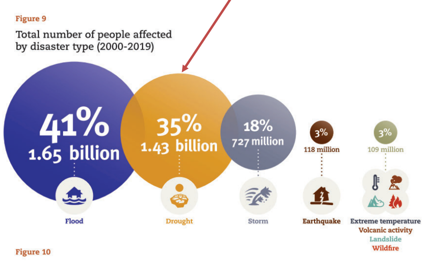
[4] Department of Atmospheric Sciences, University of Washington, Seattle, USA

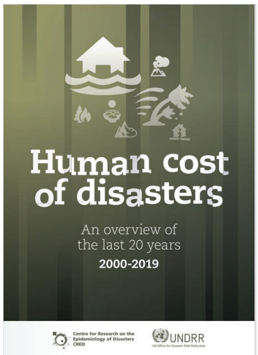
Outline

- ➤ Background and Motivation
- ➤ Data and Methods
- ➤ Super Drought Hotspots identification
- ➤ Attribution Analysis
- ➤ Conclusions

Background and Motivation

UN 2021 report: The global population affected by drought in the first 20 years of the 21st century is estimated to be 1.43 billion

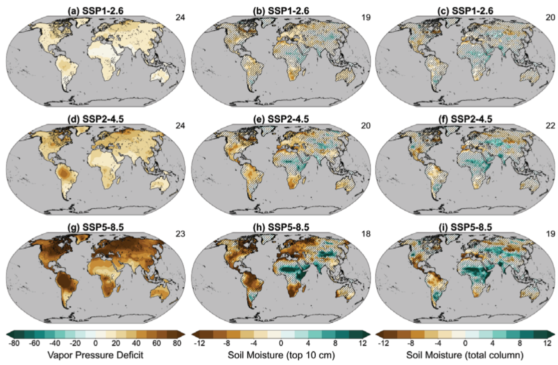




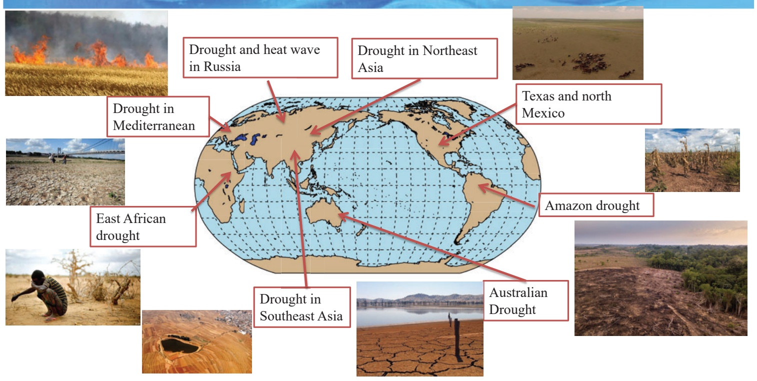
Global drought is projected to increase

IPCC AR6

coherent increases in projected soil moisture drought and vapor pressure deficit

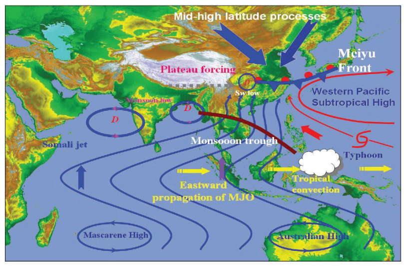


Unprecedented droughts in many parts of the world during the last 20 years



Focus on East Asia

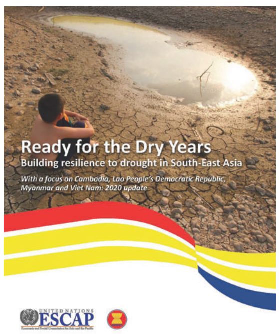
- Drought-prone with high vulnerability
- Complex air-sea-land interaction and monsoon climate dynamics



Frequent and extensive droughts in East Asia during last decade

These devastating droughts have not only attracted great concerns from academic sectors and local governments, but also United Nations.

Examples
- ➤ Southwest China
2006, 2009-2010, 2011, 2014, 2019
- ➤ Mongolia
2017
- ➤ Southeast Asia
2015-2017, 2018-2020



Motivation and Key scientific issues

- ➤ Previous efforts are dealing with the following two aspects separately
  - Extremely cases in the recent decade
  - Long-term changes

Extremely cases recently | Long-term context

Key scientific issues

- How has super drought changed since 1960 over East Asia and how was the super drought in the last two decades compared to the preceding decades?
- Where are the hotspots frequently struck by super drought?
- What are the climatic driving factors? To what extent is the super drought governed by internal decadal variability or long-term trend associated with global warming?

Outline

- Background and Motivation
- **Data and Methods**
- Super Drought Hotspots identification
- Attribution Analysis
- Conclusions

Data

- Observational Data

Data	Variables	resolution	periods	Notes
CRU TS4.04	Precipitation, PET	0.5°	1950-2019	Used for drought index calculation
GLDAS-2.1 GLDAS-2.2	Soil Moisture	1°	1948–1999 2000–2019	Four levels: 0–10cm, 10–40cm, 40–100cm 和100–200cm

- CMIP6 model data

Experiments	Variables	periods	Notes
PiControl	Precipitation and other 10 variables for calculating PET	No less than 500 years	To derive internal variability range
Historical		1850–2019	To derived MME as external forcing 2015–2019 data are obtained from SSP2-4.5 experiments

Methods–SPEI

The SPEI at multiple time scales is used to construct super drought indicator

(1) Calculation of the climatic balance：

$$D_i = P_i - PET_i$$

(2) Creation of cumulative series at the desired time scale

$$D_n^k = \sum_{i=0}^{k-1}(P_{n-i} - PET_{n-i}), \quad n \geq k$$

where k(months) is the time scale of the aggregation and n is calculation number

(3) Fitting the D_n^k (during calibration period) to a probability distribution function

$$\int_{-\infty}^{D_i} f(x)\mathrm{d}x = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{Z} e^{-x^2/2}\mathrm{d}x$$

Calculation Specification

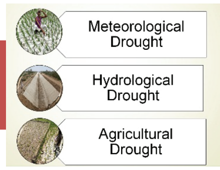
- Time scales: 3, 6, 12, 24
- Fitting distribution：Log-logistic
- Reference period：1960-1999（40 year)
- PET： Penman-Monteith

Methods–Super drought indicator

- **Wang and Chen et al. (2016) proposed the concept of super drought**

Wang, L., W. Chen, W. Zhou, G. Huang, 2016: Understanding and detecting super-extreme droughts in Southwest China through an integrated approach and index. Q.J.R. Meteorol. Soc., 142, 529–535, doi: 10.1002/qj.2593.

Super drought
combination of severe/extreme dry states in multiple components of water resources



Reinforce the damage

- **To detect whether the severe/extreme droughts at multiple time-scales occur alone or in concert.**

Super drought: occurs when the SPEI at timescales of 3, 6, 12, 24 months is all below –1.5

Outline

- Background and Motivation
- Data and Methods
- **Super Drought Hotspots identification**
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- Conclusions

Super Drought Hotspots identification

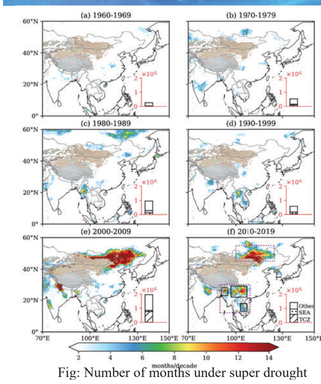


Fig: Number of months under super drought

Two super drought hotspots stand out in the last decade

region		domain
Transitional Climate Zone (TCZ)		45-55° N,100-125° E
Southeast Asian Region (SEA)	Southwest China (SWC)	22-29° N，97-107° E
	Indo-China Peninsula (ICP)	13-18° N，103-107° E
	Northeast India (NEI)	23-23° N，91-95° E

During 2010-2019, TCZ and SEA contribute 40% and 27% of the total amount, respectively, together accounting for 2/3 of the total.

Super Drought Hotspots identification

The results based on GLDAS soil moisture at 10-40cm confirm the two super drought hotspots

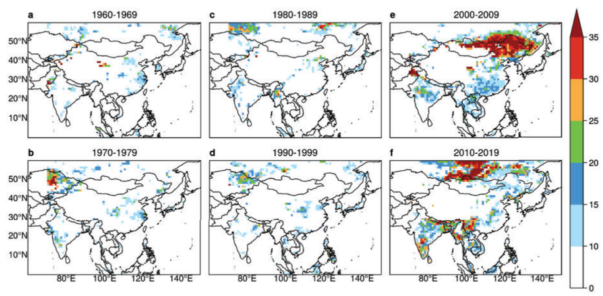


Fig: Number of months under severe soil moisture drought

Temporal and Seasonal features

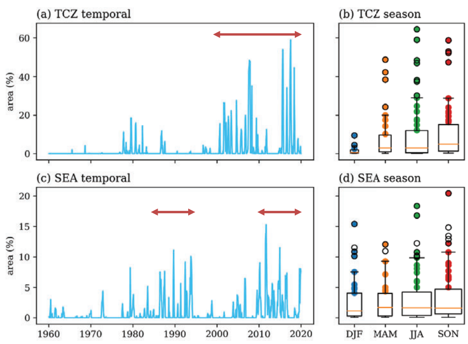


Fig: Temporal evolutions of the percentage area and seasonal distribution

TCZ

- Enhanced super drought after 2000
- 67% in summer and autumn, while only 13% in winter

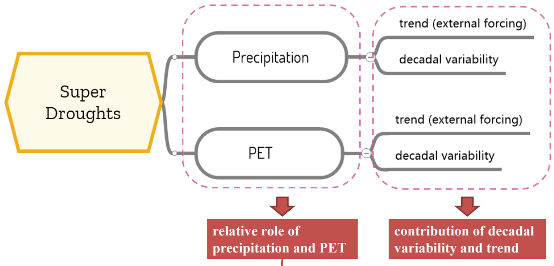
SEA

- Recent decade and the period around 1990 saw the most widespread super droughts
- Largest contribution from summer (34%) followed by autumn (32%) and then spring (17%) and winter (17%)

Outline

- Background and Motivation
- Data and Methods
- Super Drought Hotspots identification
- **Attribution Analysis**
- Conclusions

Attribution Analysis



- **The contribution of precipitation:** calculated by hold PET as its climatological annual cycle
- **The contribution of PET:** total effects minus the contribution of precipitation

Relative Role of precipitation and PET

TCZ：
- PET plays dramatic role, contributing 41% and 80% in 2000–2009 and 2010–2019, respectively

SEA (SWC, ICP and NEI)：
- PET makes an overall small contribution of less than 20%
- Precipitation rather than PET is the most influential
- The only exception is noted in SWC for the last decade, with PET making a half contribution

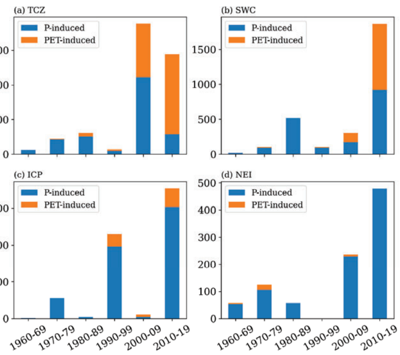
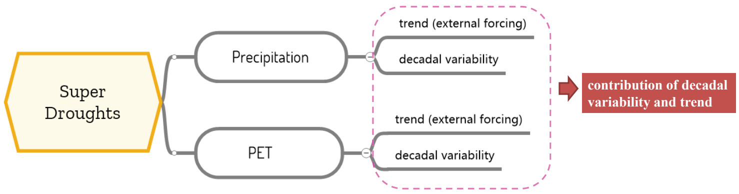


Fig: Contribution of precipitation (blue) and PET (orange)

Contribution of decadal variability and trend

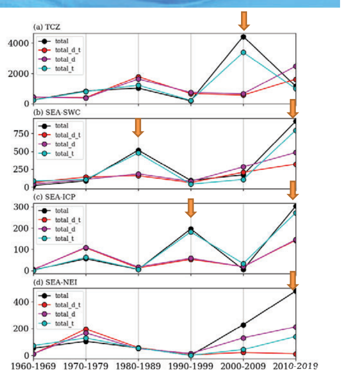


Statistical-based Method (Primary)
CEEMDAN (Complete Empirical Mode Decomposition with Adaptive Noise): to separate the long-term trends and internal decadal variability
Model-based simulations (For validation purpose)
External forcing: Multimodel ensemble mean for Hist simulation **Internal decadal variability:** the range between the maximum and minimum values across the entire piControl runs

precipitation-induced super drought: contribution of trend and decadal variability

- Four sets of calculation by removing specific EMD modes
  - benchmark
  - decadal oscillation and trend removed
  - decadal oscillation removed
  - trend removed

Region	Leading mode	contribution
TCZ	decadal	2000-2009：85%
SEA-SWC	decadal	1980-1989：64% 2010-2019：47%
SEA-ICP	decadal	1990-1999：70% 2010-2019：51.9%
SEA-NEI	decadal and trend	2010-2019：97%



precipitation-induced super drought: contribution of trend and decadal variability

Linear trends in most parts of East Asia failed statistical test

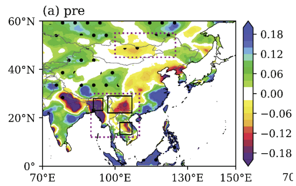


Fig: Linear trends of precipitation from 1960–2019

The external forcing induced anomalies in the recent decade is –0.81, only 15% of the unforced amplitude

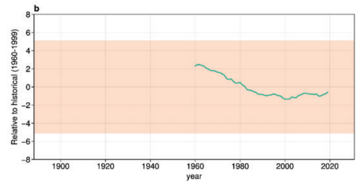
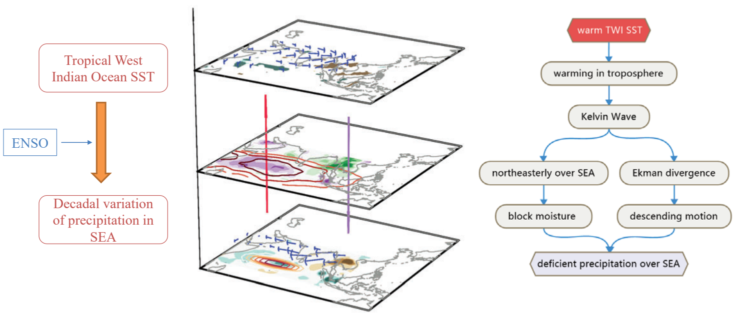


Fig: green line for Hist MME, shaded area for internal variability range

Out of the total variability in precipitation, more than half of the super droughts in the recent decade is caused by decadal variability, while the trend mode has marginal influence

What causes the internal decadal variability of precipitation in SEA?



Wang Lin, Huang Gang, Chen Wen, Wang Ting, Chakrit Chotamonsak, Atsamon Limsakul, 2022: Decadal background for active extreme drought episode in the decade of 2010–2019 over southeastern mainland Asia. *Journal of Climate*.

PET-induced super drought: contribution of trend and decadal variability

- For PET, the trend component is dominant, while the overall effect of decadal component is weak
- Global warming signal can explain 90% of the local PET upward trend

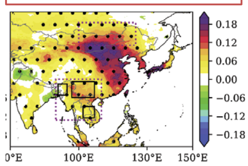


Fig: Linear trends of PET from 1960–2019

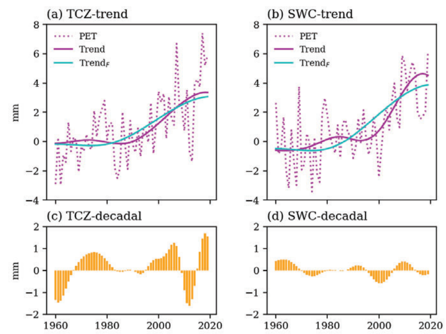


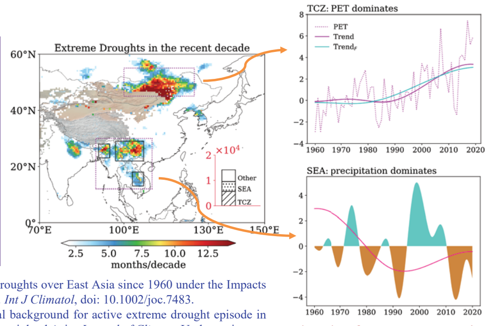
Fig: Upper: The PET (dotted pink), the trend component (solid pink) and forced trend component (solid blue). Bottom: The decadal component of PET

Outline

- ➢ Background and Motivation
- ➢ Data and Methods
- ➢ Super Drought Hotspots identification
- ➢ Attribution Analysis
- ➢ **Conclusions**

Conclusions

- **Super drought hotspots in the last decade: TCZ and SEA**
- **TCZ: primarily driven by global warming induced PET increase**
- **SEA: mainly caused by decadal variability of precipitation**



Wang Lin, Chen Wen, et al., 2021. Super Droughts over East Asia since 1960 under the Impacts of Global Warming and Decadal Variability. *Int J Climatol*, doi: 10.1002/joc.7483.
Wang Lin, Chen Wen, et al., 2022: Decadal background for active extreme drought episode in the decade of 2010–2019 over southeastern mainland Asia. *Journal of Climate*. Under review

Thanks for your attention!

Sejong University Advanced Hydrology Resources Lab.

A novel spatial downscaling approach for climate change assessment in regions with sparse ground data networks

Professor, Hyun-Han Kwon

SEJONG UNIVERSITY

27 January, 2022

A novel spatial downscaling approach for climate change assessment in regions with sparse ground data networks

CONTENTS

Sejong University Advanced Hydrology Resources Lab.
A novel spatial downscaling approach for climate change assessment in regions with sparse ground data networks

TOPIC to discuss

3

Sejong University Advanced Hydrology Resources Lab.
A novel spatial downscaling approach for climate change assessment in regions with sparse ground data networks

01. Research Background

Research Background

- A flavor of today's climate model results
  - ✓ Much better than 20 years ago in many respects
    - Much valuable work has been done in the entire modeling chain from climate to hydrology to impacts assessment
  - ✓ However, how well do models reproduce seasonal/monthly/extreme precipitation?
    - Moments/Interannual Variability, Response to CO2?
- Why We Need Downscaling- Some Justifications
  - ✓ Even if GCM in the future are run at high resolution there will remain the need to "downscale" the results from such models to individual sites or localities for impact studies
  - ✓ SD are commonly used to address the scale mismatch between coarse resolution GCM output and the regional or local catchment scales required for hydrological modeling

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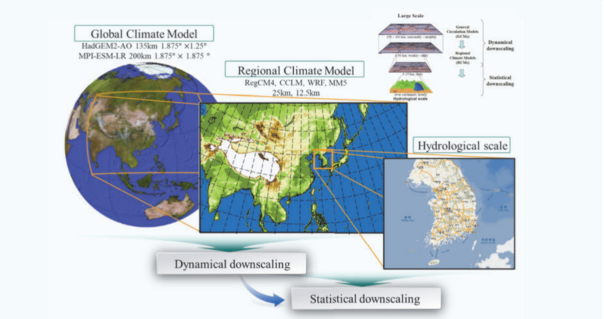
Sejong University Advanced Hydrology Resources Lab.
A novel spatial downscaling approach for climate change assessment in regions with sparse ground data networks

01. Research Background

Research Background



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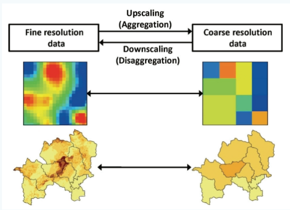
Sejong University Advanced Hydrology Resources Lab.
A novel spatial downscaling approach for climate change assessment in regions with sparse ground data networks

01. Research Background

Research Background

Global Models → Re-gridding → Bias Correction → Spatial Downscaling



Quantile Mapping (QM)

Constructed Analogs
(CA; Hidalgo et al. 2008)

Bias Correction and Constructed Analogs
(BCCA; Maurer et al. 2010)

Multivariate Adapted Constructed analogs
(MACA; Abatzoglou & Brown 2012)

Bias Correction with Spatial Disaggregation
(BCSD; Wood et al. 2004)

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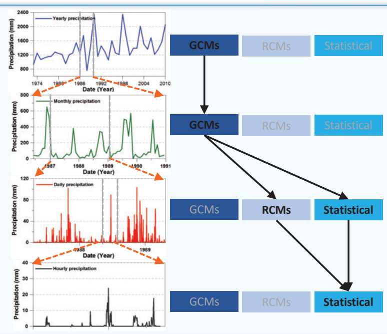
Sejong University Advanced Hydrology Resources Lab.
A novel spatial downscaling approach for climate change assessment in regions with sparse ground data networks

01. Research Background

Research Background

Annual scale
Monthly scale
Daily scale
Hourly scale



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Sejong University Advanced Hydrology Resources Lab.
A novel spatial downscaling approach for climate change assessment in regions with sparse ground data networks

TOPIC to discuss

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02. Methodologies

Quantile Delta Mapping (QDM) Approach

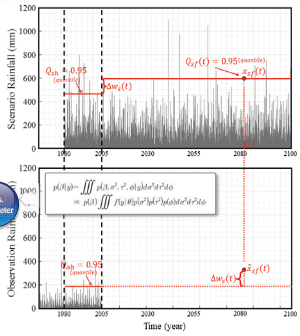
- QM does not preserve model-predicted changes (Maurer and Pierce, HESS, 2014)
- QDM has been widely adopted for bias-correction of the climate change scenarios due to its ability to preserve relative changes in quantiles over historical/future simulations.

Eq. 1
$$\tau_{s.f}(t) = F_{s.f}^{(t)}[x_{s.f}(t)] \quad \tau_{s.f}(t) \in \{0,1\}$$

Eq. 2
$$\Delta w_s(t) = \frac{x_{s.f}(t)}{F_{s.h}^{-1}[\tau_{s.f}(t)]}$$

Eq. 3
$$\hat{x}_{o.s.h.f}(t) = F_{o.h}^{-1}[\tau_{s.f}(t)]$$

Eq. 4
$$\hat{x}_{s.f}(t) = \hat{x}_{o.s.h.f}(t) * \Delta(t)$$



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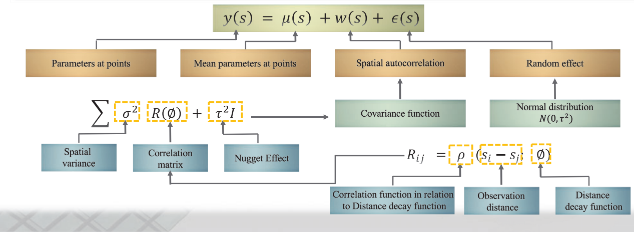
02. Methodologies

Bayesian Kriging based SD-QDM (Quantile Delta Mapping)

- Kriging is a field of geostatistics that can be applied to geophysical data
- There are various types of Kriging such as Simple Kriging, Ordinary Kriging, Co-Kriging
- We have used the OK, which minimizes the error variance without biasing Kriging estimation equation.



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02. Methodologies

Bayesian Kriging based SD-QDM (Quantile Delta Mapping)

- Kriging can be estimated with approaches such as Generalized Least Squares(GLS), Maximum Likelihood Estimation(MLE), and Bayesian inference.
- Bayesian inference was applied to quantify the uncertainty of spatial downscaling.
- If the Kriging parameter vector is $\theta = (\beta, \sigma^2, \tau^2, \phi)^T$, the likelihood function based on Bayes' theorem according to the prior probability distribution $p(\theta)$ can be calculated as $p(\theta) = p(\beta)p(\sigma^2)p(\tau^2)p(\phi)$.
- The posterior distribution $p(\beta|y)$ requires integral calculation using a computer and can be estimated using the Markov Chain Monte Carlo.

Bayesian Inference

$$p(\theta|y) \propto p(y|\theta) \cdot p(\theta)$$

- θ : Full parameter set
- y : Observed data
- $p(\theta)$: prior distribution of parameters
- $p(y|\theta)$: likelihood function of y

$$p(\beta|y) = \iiint p(\beta, \sigma^2, \tau^2, \phi|y) d\sigma^2 d\tau^2 d\phi$$
$$\propto p(\beta) \iiint f(y|\theta)p(\sigma^2)p(\tau^2)p(\phi) d\sigma^2 d\tau^2 d\phi$$

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02. Methodologies

Bayesian Kriging based SD-QDM Flowchart

- *Can all parameters associated with the spatial downscaling and bias-correction be simultaneously estimated and interpolated at the desired points?*
- *Can the interpolation of the bias-correction parameters be more effective than the interpolation of the daily precipitation in the context of spatial downscaling and bias-correction?*
- *Can a Bayesian Kriging based bias-correction approach effectively reproduce spatial dependency over a network of weather stations in the interpolated parameters associated with bias-correction?*

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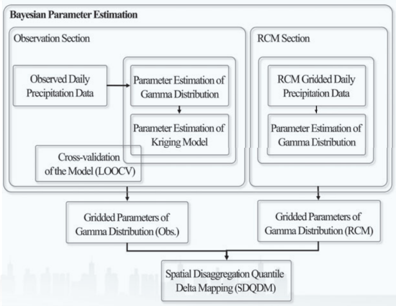
02. Methodologies

Bayesian Kriging based SD-QDM Flowchart



$$F(x|k_{oh}, \theta_{oh}) = \frac{1}{\theta^k \Gamma(k)} \int_0^x t^{k-1} e^{-t/\theta} dt$$

$$S \sim MVN(\mu, \tau^2 \Sigma)$$

$$\Sigma_{ij} = f(d_{ij}|\theta)$$

$$f(d_{ij}|\phi, \kappa) = exp\left[-(\phi \cdot d_{ij})^{\delta}\right]$$

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TOPIC to discuss

Ⅰ Research Background

Ⅱ. Methodologies

Ⅲ. Data (Obs. / CC Scenario)

Ⅳ. Results & Discussion

Ⅴ. Conclusion & Future Works

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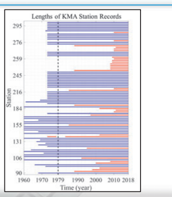
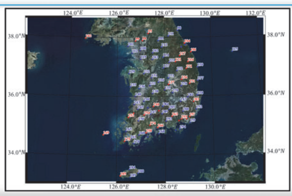
03. Data (Obs. / CC Scenario)

Historical Data - KMA

- The daily precipitation data was compiled from over 92 Automatic Synoptic Observation System (ASOS) across South Korea, operated by the KMA.
- Here, daily precipitation data at 60 weather stations with more than 45 years, ranging from 1973 to 2018, were finally selected for the subsequent analysis.
- In the present work, we explore a seasonal-varying model under the circumstances of high rainfall variability, without focusing on an annual basis model, in a more general context.





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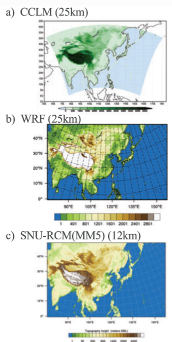
03. Data (Obs. / CC Scenario)

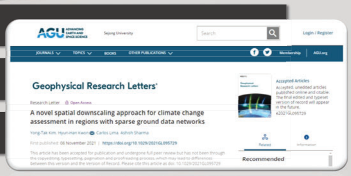
Climate Change scenario– CORDEX-RCMs

- The proposed model is applied to climate change scenarios simulated by three different RCMs employed in the Coordinated Regional Climate Downscaling Experiment-East Asia (CORDEX-EA), covering the entire East Asian areas, including South Korea.
- CORDEX is an internationally coordinated framework with the use of multiple RCMs for providing high-resolution climate change projections.
- In this study, the future precipitation simulation for 2006-2100 under the representative concentration pathways (RCP) 4.5 and 8.5 was used with the historical precipitation simulation for 1979-2005.
- The Bayesian Kriging based SD-QDM approach was applied to provide downscaled precipitation at finer scales of about 6.25km, 12.5km and 12.5km resolution for SNURCM, WRF, and CCLM, respectively, which is typically more relevant as input for hydrological model applications.



16

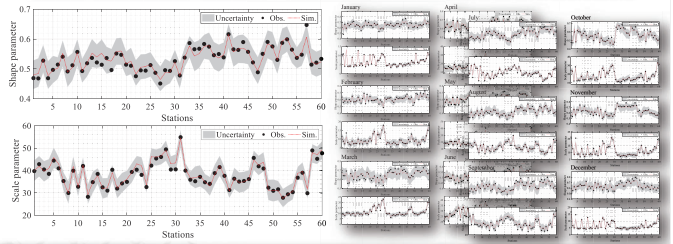
TOPIC to discuss



04. Results & Discussion

Parameter Estimation and Cross Validation

- The cross-validated results and their 95% credible intervals (shaded region) of the Gamma parameters within a LOOCV assessment in August.
- The black-filled circles are the parameters estimated from observed precipitation, while the red-dotted lines represent the median values estimated from the predictive posterior distribution.
- The number on the X-axis represents the gauge code, summarized in the supplementary information.



04. Results & Discussion

Parameter Estimation and Cross Validation

- A seasonal-varying model under the LOOCV scheme is investigated, and the model performance
- Model performance of the proposed prediction model for both shape and scale parameters in terms of Nash–Sutcliffe Efficiency (NSE), Index-of-Agreement (IoA), correlation coefficient (CC) and Root Mean Square Error (RMSE)
- For the shape parameter, the model showed slightly lower performance in the spring season from February to April in terms of the NSE
- Still, the model predictability can be regarded as "Very good: NSE ≥ 0.7" according to the given criteria suggested by Kalin et al. (2010), and other performance measures are largely comparable to that of different seasons. For the scale parameter, the predicted parameters appear to be almost identical to that of the observed, confirming the efficacy of the model.

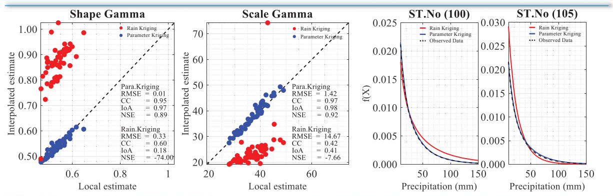
Mon	Shape Parameter				Mon	Scale Parameter			
	NSE	IoA	CC	RMSE		NSE	IoA	CC	RMSE
Jan	0.81	0.93	0.95	0.02	Jan	0.99	1.00	0.99	0.32
Feb	0.86	0.95	0.97	0.02	Feb	0.96	0.99	0.98	0.49
Mar	0.82	0.94	0.94	0.02	Mar	0.98	0.99	0.99	0.46
Apr	0.87	0.96	0.95	0.02	Apr	0.94	0.98	0.99	1.35
May	0.91	0.97	0.97	0.02	May	0.97	0.99	0.99	1.14
Jun	0.88	0.97	0.95	0.01	Jun	0.94	0.98	0.97	1.19
Jul	0.91	0.97	0.96	0.01	Jul	0.95	0.99	0.99	1.28
Aug	0.89	0.97	0.95	0.01	Aug	0.92	0.98	0.97	1.42
Sep	0.83	0.95	0.94	0.01	Sep	0.87	0.97	0.98	1.84
Oct	0.90	0.97	0.95	0.02	Oct	0.97	0.99	0.99	0.94
Nov	0.93	0.98	0.97	0.02	Nov	0.96	0.99	0.99	0.69
Dec	0.86	0.95	0.95	0.02	Dec	0.96	0.99	0.98	0.55

Statistics	Formula
Nash Sutcliffe efficiency (NSE)	$NSE = 1 - \frac{\sum_{i=1}^{N}(Obs_i - Sim_i)^2}{\sum_{i=1}^{N}(Obs_i - \overline{Obs})^2}$
Index of Agreement (IoA)	$IoA = 1 - \frac{\sum_{i=1}^{N}(Obs_i - Sim_i)^2}{\sum_{i=1}^{N}(\lvert Obs_i - \overline{Obs}\rvert + \lvert Sim_i - \overline{Obs}\rvert)^2}$
Correlation Coefficient (CC)	$CC = 1 - \frac{\sum_{i=1}^{N}(Obs_i - \overline{Obs})(Sim_i - \overline{Sim})}{\sqrt{\sum_{i=1}^{N}(Obs_i - \overline{Obs})^2}\sqrt{\sum_{i=1}^{N}(Sim_i - \overline{Sim})^2}}$
Root Mean Square Error (RMSE)	$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(Sim_i - Obs_i)^2}$

04. Results & Discussion

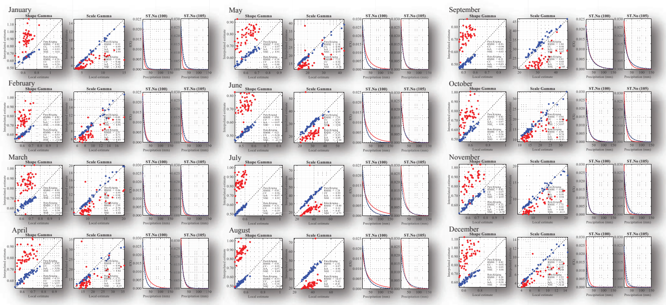
Parameter Estimation and Cross Validation

- Following the previous step, we investigated whether the grid generated by direct interpolating the gamma parameters can be more reliable than the grid obtained by first interpolating the observed daily precipitation onto the grid and thereafter estimating the gamma parameters over these points
- The directly interpolated gamma distribution parameters through the proposed Bayesian Kriging approach were then compared to the parameters obtained from the interpolated daily precipitation that will serve as a baseline model
- Note that daily precipitation was also interpolated by the Bayesian Kriging approach and all the results presented here were achieved under the LOOCV scheme
- It is clear that the proposed model outperformed the baseline model, which is based on the interpolated daily rainfall series



04. Results & Discussion

Parameter Estimation and Cross Validation

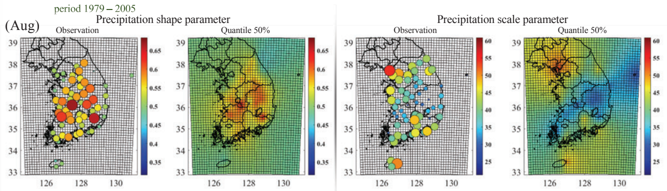


04. Results & Discussion

Interpolation of Parameters Using Bayesian Kriging Approach

- The relatively large shape parameters are identified in the southeastern regions, while relatively large scale parameter values are concentrated in the southern coastal area.
- On the other hand, the smaller shape parameters are mainly distributed in the mid-western region, while the lower scale parameter values are largely seen in the southern part of South Korea.
- Overall, the proposed Bayesian Kriging approach is capable of reproducing the main spatial patterns seen in the direct point estimates of both shape and scale parameters.

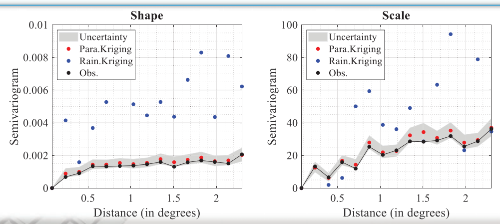
➢ Gamma parameters estimated from observed precipitation at weather stations (left panel) and gridded parameters (12.5km × 12.5km) obtained from the Bayesian Kriging approach (median estimates from the predictive posterior distribution). The estimates refer to the period 1979 – 2005



04. Results & Discussion

Interpolation of Parameters Using Bayesian Kriging Approach

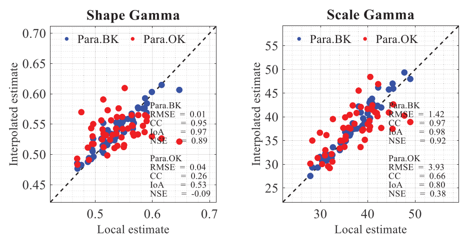
- This study further tested the efficacy of the model in effectively reproducing spatial dependency over a network of weather stations in the interpolated gamma parameters
- The semi-variogram of gamma parameters estimated from the posterior distributions obtained from the Bayesian Kriging approach was then compared to that obtained from local estimates based on gauged rainfall data.
- For August, the efficacy of the proposed model to reproduce the bias-correction parameters while preserving the spatial variability observed in the historical data-based estimates, where both semi-variograms are almost identical.
- The semi-variogram directly obtained from the interpolated precipitation is significantly biased from the observed one

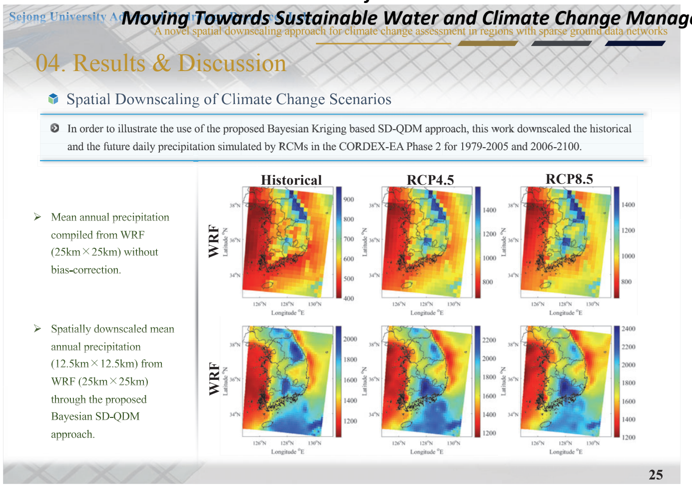


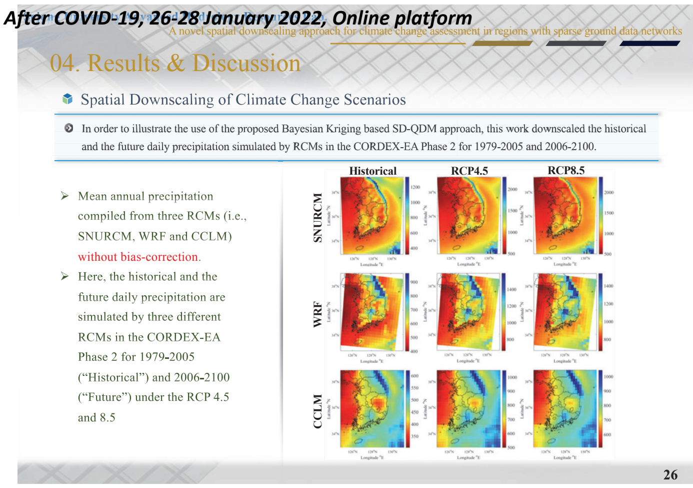
04. Results & Discussion

Interpolation of Parameters Using Bayesian Kriging Approach

- Moreover, the Bayesian Kriging based SD-QDM model was compared with the ordinary Kriging approach, which is widely adopted in spatial interpolation.
- The results confirmed that the proposed approach showed better performance to estimate the Gamma distribution parameters in the context of cross-validation.




A novel spatial downscaling approach for climate change assessment in regions with sparse ground data networks
04. Results & Discussion
Spatial Downscaling of Climate Change Scenarios
In order to illustrate the use of the proposed Bayesian Kriging based SD-QDM approach, this work downscaled the historical and the future daily precipitation simulated by RCMs in the CORDEX-EA Phase 2 for 1979-2005 and 2006-2100.
Historical
RCP4.5
RCP8.5
Mean annual precipitation compiled from WRF (25km×25km) without bias-correction.
WRF
Spatially downscaled mean annual precipitation (12.5km×12.5km) from WRF (25km×25km) through the proposed Bayesian SD-QDM approach.
WRF
25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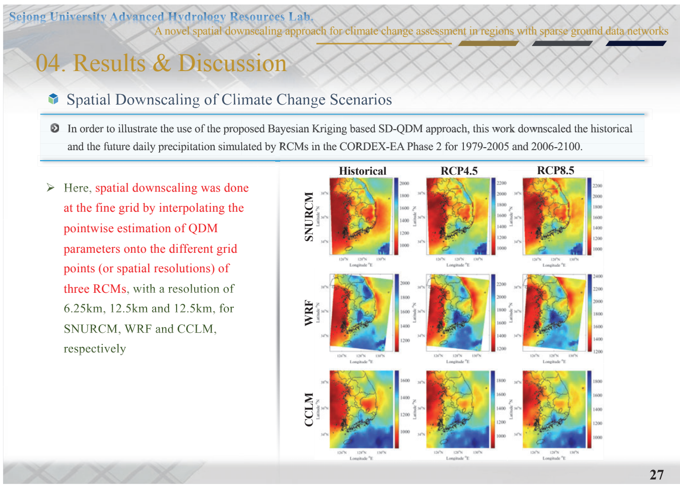
In order to illustrate the use of the proposed Bayesian Kriging based SD-QDM approach, this work downscaled the historical and the future daily precipitation simulated by RCMs in the CORDEX-EA Phase 2 for 1979-2005 and 2006-2100.
Mean annual precipitation compiled from three RCMs (i.e., SNURCM, WRF and CCLM) without bias-correction.
Here, the historical and the future daily precipitation are simulated by three different RCMs in the CORDEX-EA Phase 2 for 1979-2005 ("Historical") and 2006-2100 ("Future") under the RCP 4.5 and 8.5
Historical
RCP4.5
RCP8.5
SNURCM
WRF
CCLM
26


Sejong University Advanced Hydrology Resources Lab.
A novel spatial downscaling approach for climate change assessment in regions with sparse ground data networks
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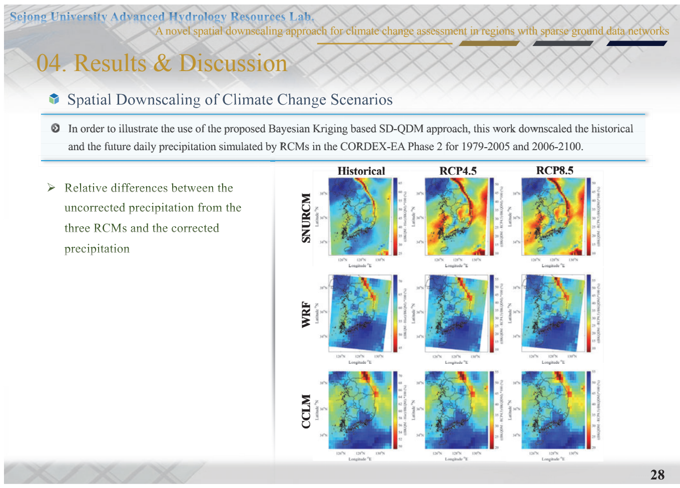
Here, spatial downscaling was done at the fine grid by interpolating the pointwise estimation of QDM parameters onto the different grid points (or spatial resolutions) of three RCMs, with a resolution of 6.25km, 12.5km and 12.5km, for SNURCM, WRF and CCLM, respectively
Historical
RCP4.5
RCP8.5
SNURCM
WRF
CCLM
27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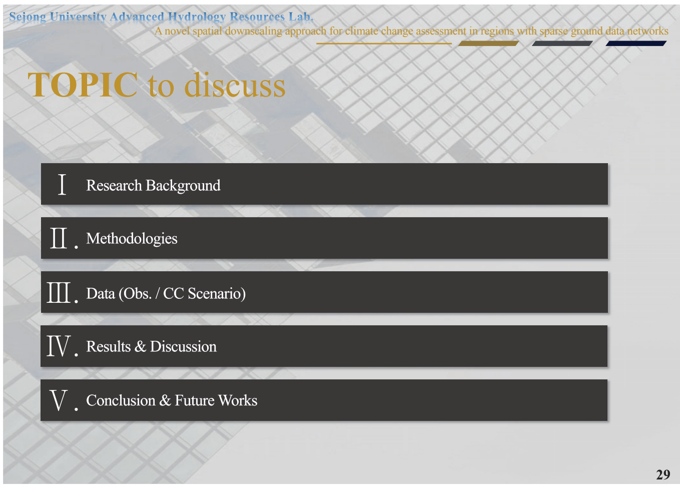
Relative differences between the uncorrected precipitation from the three RCMs and the corrected precipitation
Historical
RCP4.5
RCP8.5
SNURCM
WRF
CCLM
28


Sejong University Advanced Hydrology Resources Lab.
A novel spatial downscaling approach for climate change assessment in regions with sparse ground data networks
TOPIC to discuss
Ⅰ Research Background
Ⅱ. Methodologies
Ⅲ. Data (Obs. / CC Scenario)
Ⅳ. Results & Discussion
Ⅴ. Conclusion & Future Works
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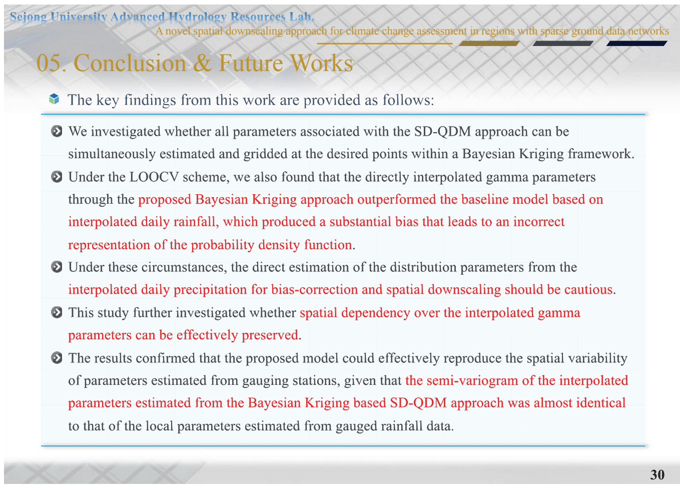
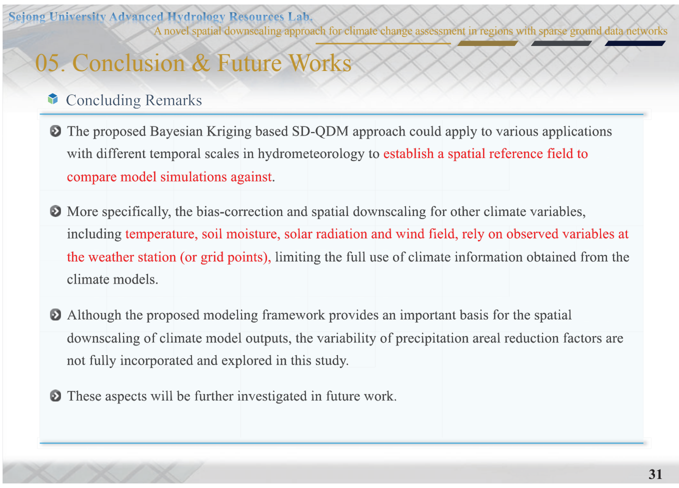

Sejong University Advanced Hydrology Resources Lab.
A novel spatial downscaling approach for climate change assessment in regions with sparse ground data networks
05. Conclusion & Future Works
The key findings from this work are provided as follows:
We investigated whether all parameters associated with the SD-QDM approach can be simultaneously estimated and gridded at the desired points within a Bayesian Kriging framework.
Under the LOOCV scheme, we also found that the directly interpolated gamma parameters through the proposed Bayesian Kriging approach outperformed the baseline model based on interpolated daily rainfall, which produced a substantial bias that leads to an incorrect representation of the probability density function.
Under these circumstances, the direct estimation of the distribution parameters from the interpolated daily precipitation for bias-correction and spatial downscaling should be cautious.
This study further investigated whether spatial dependency over the interpolated gamma parameters can be effectively preserved.
The results confirmed that the proposed model could effectively reproduce the spatial variability of parameters estimated from gauging stations, given that the semi-variogram of the interpolated parameters estimated from the Bayesian Kriging based SD-QDM approach was almost identical to that of the local parameters estimated from gauged rainfall data.
30


Sejong University Advanced Hydrology Resources Lab.
A novel spatial downscaling approach for climate change assessment in regions with sparse ground data networks
05. Conclusion & Future Works
Concluding Remarks
The proposed Bayesian Kriging based SD-QDM approach could apply to various applications with different temporal scales in hydrometeorology to establish a spatial reference field to compare model simulations against.
More specifically, the bias-correction and spatial downscaling for other climate variables, including temperature, soil moisture, solar radiation and wind field, rely on observed variables at the weather station (or grid points), limiting the full use of climate information obtained from the climate models.
Although the proposed modeling framework provides an important basis for the spatial downscaling of climate model outputs, the variability of precipitation areal reduction factors are not fully incorporated and explored in this study.
These aspects will be further investigated in future work.
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A novel spatial downscaling approach for climate change assessment in regions with sparse ground data networks
THANK YOU

SESSION B:
NEW TECHNOLOGY IN WATER AND IRRIGATION MANAGEMENT

THA 2022 International Conference on
Moving Towards Sustainable Water and Climate Change Management After COVID-19, 26-28 January 2022, Online platform

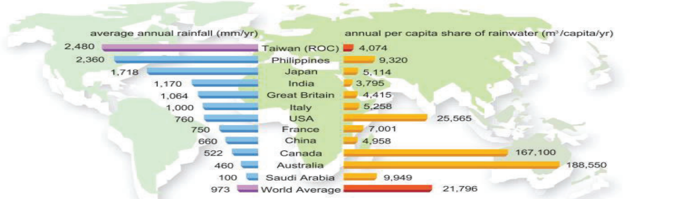
Responses of Agricultural Water Management to Climate Change in Taiwan

Min-der Hung
Director
Irrigation Management Division
Irrigation Agency, COA

Chih-hung Tan
Technology Director
Agricultural Engineering
Research Center

Climate and Rainfall

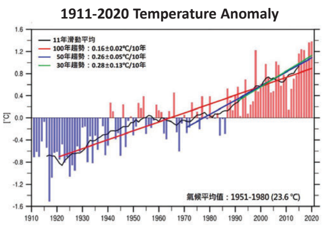
- The rainfall in Taiwan is approximately 2,500 mm/yr, which is about 2.6 times of the world average.
- Average per capita share of rainwater amounts to only 4,074 m3 per year, which is less than one fifth of the world average.

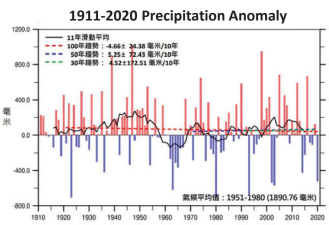


The Japanese Institute of Irrigation and Drainage, 「A Message from Japan and Asia to the World Water Discussion —prepared for the 3rd World Water Forum」, 2003

Climate Change in Taiwan

- Temperature increased 1.6℃ in the past 110 years (1911-2020) in Taiwan , and in recent 30 years, the trend accelerating
- Trend of annual rainfall did not change significantly in the past 110 years. However, less rainfall years increased between 1961-2020.



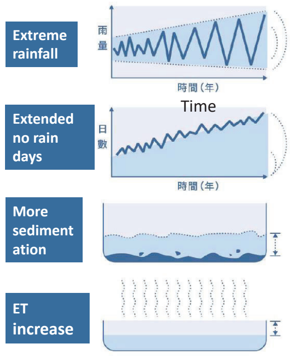


Source: IPCC 6th Analysis Report, MOST / TCCIP，2021

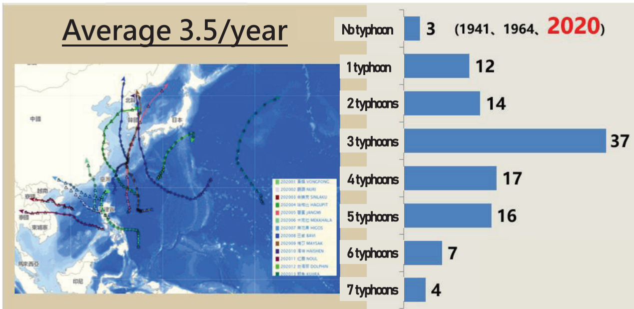
貳 氣候變遷對農業水資源之衝擊

◆Impact of Climate Change to Water Resource

- Extreme rainfall causes more floods and droughts
- Extended no rainfall days is harmful to agriculture
- Heavy rain increases the amount of sand transportation in rivers and the accumulation in reservoirs
- Evapotranspiration increases as the temperature rises



First NO typhoon year since 1964

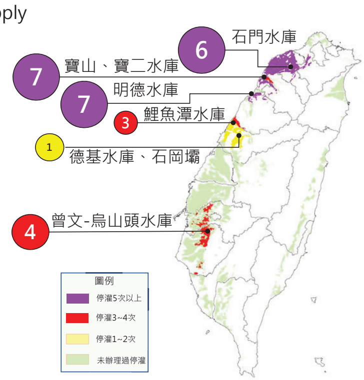


Source: CWB (data from 1911-2020)

◆ Cessation of irrigation in recent 20 years

- 9 times large scale cessation of irrigation
- Occurred in reservoir water supply areas, totally 300 thousands ha

Year	Crop	Cessation of irrigation (management office)	Area (ha)
2002	1st	SM, HC	14,778
2003	1st	TY, HC	27,646
2004	1st	TY, SM, HC, ML, CN	65,385
2006	1st	TY, HC, ML	30,828
2010	1st	ML, CN	22,366
2015	1st	TY, HC, ML, TC, CN	43,659
2018	1st	ML	1,175
2020	2nd	TY, SM, HC, ML, TC	19,000
2021	1st	TY, SM, HC, ML, TC, CN	74,375
		Total	299,212



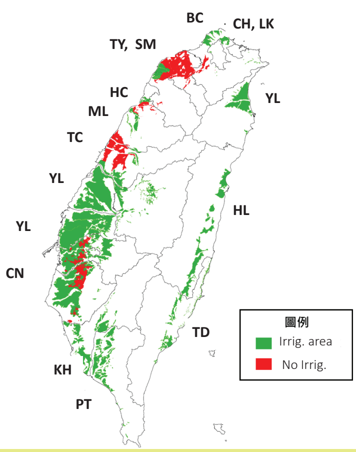
◆ 2021 First crop season water supply conditions

76% area maintain irrigation service

- 236K ha using multiple source water supply to maintain irrigation

Terminate irrigation service in reservoir-supplied areas

- 74K ha terminate irrigation in TY, SM, HC, ML, TC and CN Management Districts

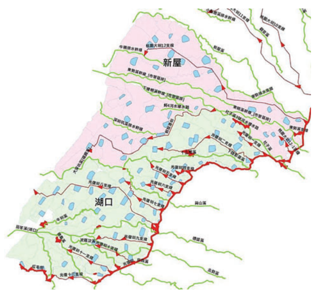


◆2021 Taoyuan 3rd District drought response during first crop season

TY Ⅲ Area
- 2020 1st crop grow upland crop
- 2020 2nd crop fallow

Supply irrigation water to avoid 3 consecutive seasons without irrigation

- TY III Irrigation district, 2700ha, about 1/3 of TY irrigation management area.
- Located at end of TY main canal, 56% water from Shihmen Reservoir, 44% from river, (25% return use)
- There are 100 ponds in the area, total storage of 1.527 million tons



Response to Climate Change

1. Pond Storage
2. Staggered tillage period
3. Dry ploughing
4. Use Return water
5. Use groundwater

Response to Climate Change

Pond Storage

- Actively store rainwater and surrounding streams to adjust agricultural water resources.
- Before the reservoir is released, give priority to the use of water storage in the pond for irrigation

Response to Climate Change

Staggered tillage period

- Staggered tillage period to avoid water consumption at same time, rotational supply water to each farm.
- Reduce ploughing from 2 to 1 time.
- Reduce tillage water depth.

Response to Climate Change

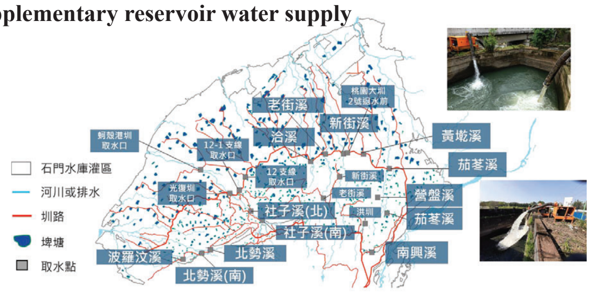
Dry ploughing

- Adopt dry ploughing with minimum amount of water
- Transplanting immediately after ploughing

Response to Climate Change

Use Return water

- Inventory of rivers and regional drainage water sources (21 locations), pumping water to irrigation canals
- Supplementary reservoir water supply

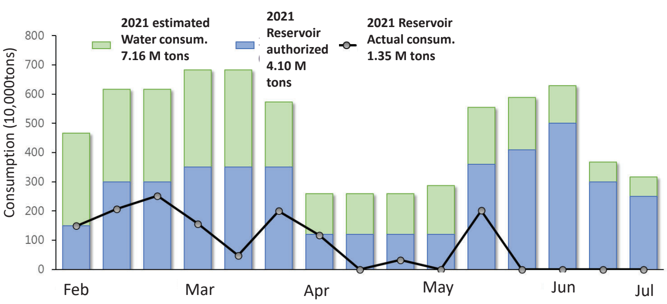


Response to Climate Change

Use groundwater

- Activate drought-relief wells adjacent to canals for irrigation
- Use groundwater only at lack of reservoir, pond and river water

- Those strategies reduced 2.75 M tons water consumption in 2021 1st crop season, and produced rice crop value up to NT$1.34 billion.



AERC 財團法人農業工程研究中心 Agricultural Engineering Research Center

Participatory Water Diversion Project in Bang Rakam Flood-prone Field

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The Royal Irrigation Department: RID, Thailand
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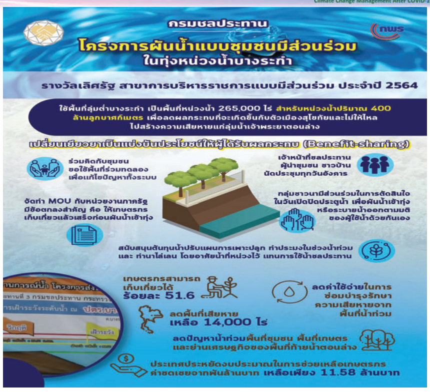
Keywords—benefit- sharing; mutual agreement; retardant area

Public Service Award

The Best of Participatory Governance in 2021



Introduction

Dimension 1: Problems and Organizational Capabilities
- 1.1 Background and Problems
- 1.2 Potential of RID to respond to the problems

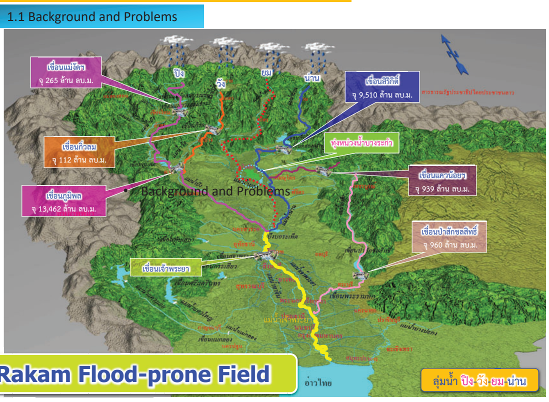
Dimension 2: Participatory Process
- 2.1 Implementation of Community-based Project
- 2.2 Participation Model (Collaborate)
- 2.3 Roles of Each Sector
- 2.4 Mechanisms to Drive Integration

Dimension 3: Productivity/Results/Impact
- 3.1 Results of the Project
- 3.2 Benefits to the stakeholders

Dimension 4: Sustainability
- 4.1 Lessons
- 4.2 Policy to Sustainability

Dimension 1: Problems and Organizational Capabilities

1.1 Background and Problems



Participatory Water Diversion Project in Bang Rakam Flood-prone Field

"Bang Rakam" means "Frustrated community", mostly paddy field in a lowland between the Yom and Nan River basins.



Before the project initiated in 2017, harvesting rice in flood was seen frequently almost every year. Compensation of more than 3 million dollars per year was paid to affected farmers.



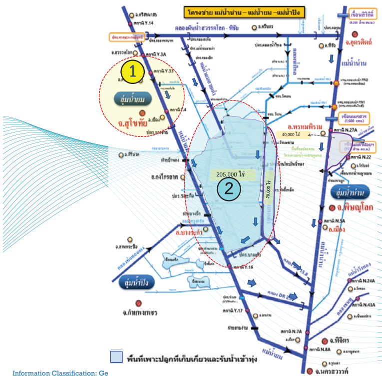
Problems in Bang Rakam Flood-prone Field

- lowland area between the Yom River Basin and the Nan River Basin that converge in the lower area.
- Bang Rakam is a repetitive flooded area. The water will come every year around August.
- 400 million m3 of water, equivalent to half the amount of water stored in the Khwae Noi Dam, flooded for 3-4 months between August and November.

Assumption

If it can be slowed down, the risk of flooding in the Chao Phraya River Basin will be reduced.

1.2 Potential of RID to respond to the problems

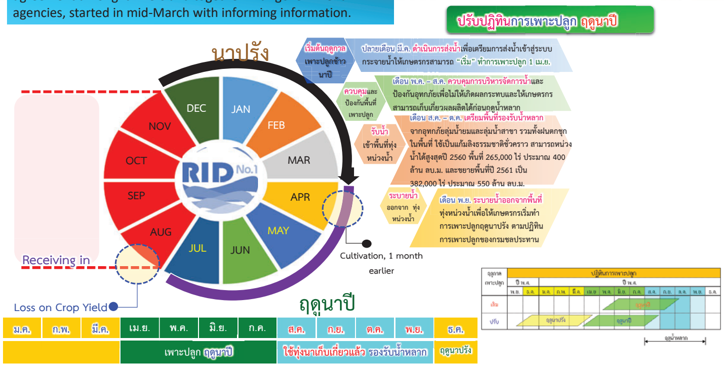


Implementing the concept into practices, RID firstly transformed Bang Rakam field as a water retardant area of 42,400 ha (265,000 rai) for holding massive 400 million m^3 of water.

RID prepares water storage about 310 million m^3 to supply for the project

65 Million m^3 for **April**
245 Million m^3 for **May-July**

RID then adjusted the cropping calendar based on a mutual agreement among farmers and together with government agencies, started in mid-March with informing information.



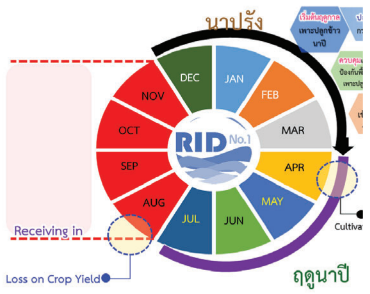
Dimension 2: Participatory Process

2.1 Implementation of Community-based Project

- to adjust the cultivation calendar requiring the integration on the cooperation of farmers to have rules and to follow
- In 2017, 400 million m3

Objectives:

1. Agreement to hold water in the harvested fields: (Community - RID)
2. Agreement of a new crop calendar and water allocation: (water users - water users)
3. Agreement regarding the new crop calendar: (Other government agencies - RID- Community)



2.2 Participation Model (Collaborate)

1) relying on local knowledge

- **In 2015, a trial of 30,000 rai in 7 villages of 1,467 households**
- **In 2016, it proposed to adjust the cultivation calendar**
- **In 2017, operating in an area of 265,000 rai**

2) Participate in consultation by understanding the way of life

- **Discussion on adjusting planting calendars and water delivery plans.**
- **Meetings to clarify, and to understand**
- **Consultations required before the implementation**

3) Provide opportunities for farmers to participate in decision-making.

- **The day of diversion water determined by the community**
- **The agreements decided by the community.**

2.3 Roles of Each Sector

1) Farmers affected by the project

- **to sacrifice their farming land as a water retardation area,**
- **To participate in proposing solutions**
- **Set rules and enforce through resolutions at the meeting**

2) Community leaders

- **To propose rules**
- **To help organizing participatory meeting**

help clarify the relationship From the community's lack of confidence

3) Reginal RID

- **responsible for planning and participation among the governmental sectors and community representatives.**

4) Other government agencies (more than 20 agencies)

- **to adjust the rules and policies tailoring with the project through MOU**

5) The 3rd Army Area

- **to integrate cooperation between the central, provincial and local governments in the area during the project start-up in 2017 to 2018**

6) RID provides

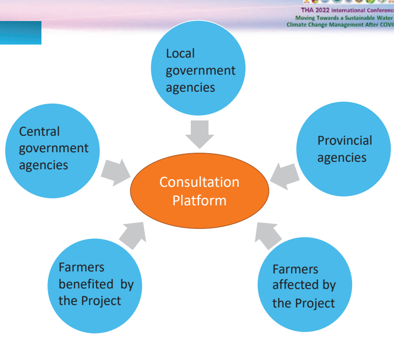
- **Concept of benefit sharing for solving flood problems**
- **Participatory power to Community**

7) The Ministry of Agriculture and Cooperatives provides

- **policies and supervision.**
- **Pushing the project into a national policy in managing water disasters effectively**

2.4 Mechanisms to Drive Integration

1) Adjusting the cultivation calendar to shift from affected to beneficiary (Benefit-sharing) through consultation,



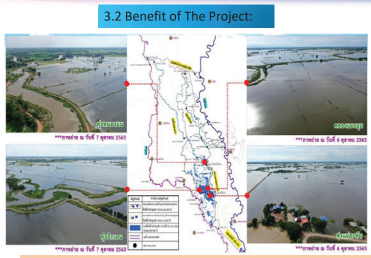
2) MOU of the "Bang Rakam Model Year 2017" project with government agencies on February 22, 2017.

Dimension 3: Productivity/Results/Impact

3.1 Results of the Project

1) **an agreement accepted by the community in diverting water into the farmer's fields**
2) **rules to adjust the cultivation calendar**
3) **"Bang Rakam Memorandum of Understanding (MOU)**

3.2 Benefit of The Project:



to the community:

- **farmers can harvest 51.61%**
- **damaged area and compensation decreased since 2018 onwards.**

to the country:

- **Save economic areas of the lower downstream areas**

Dimension 4: Sustainability

4.1 Lessons

Obstacles

Lack of Trust

- failed to comply with the agreed planting plans.
- disputes to pump water in dry season
- In 2017 mount of rainfall was similar to 2011, some people misunderstand as a result of the Bang Rakam model

RID has systematically operated:

1) building trust and correcting misunderstandings by
- PR
- community leaders
- All agreements operated by RID

2) Consultation with the community to adjust the cultivation

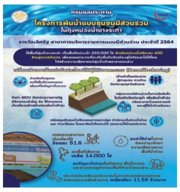
Participatory Water Diversion Project in Bang Rakam Flood-prone Field

1) Sharing-benefit concept to those affected leads to effective change

2) Community leaders helps to
- initiative the policy
- coordinate information and clarification
- build confidence

Three factors of success

3) Water storage to supply for the new crop calendar



4.2 Policy to Sustainability

- benefit sharing, which can alleviate the flooding of the Chao Phraya River Basin.
- Bang Rakam water retardation area solve the problem at a macro level
- plans accepted by communities

Participatory Water Diversion Project in Bang Rakam Flood-prone Field

Extension the success

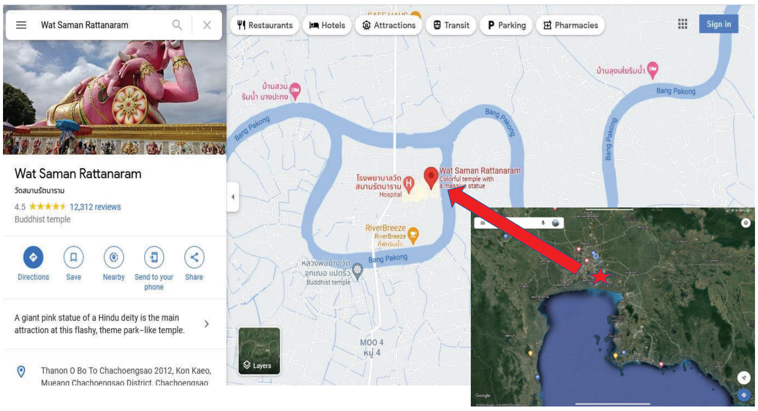
12 Lower fields in Chao Phraya River Basin

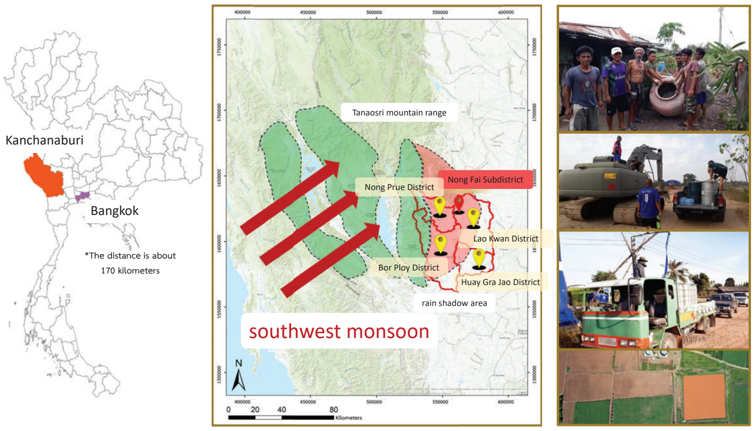
RID plans to expand to other areas with similar problems throughout the country.

Thank You for Your Attention

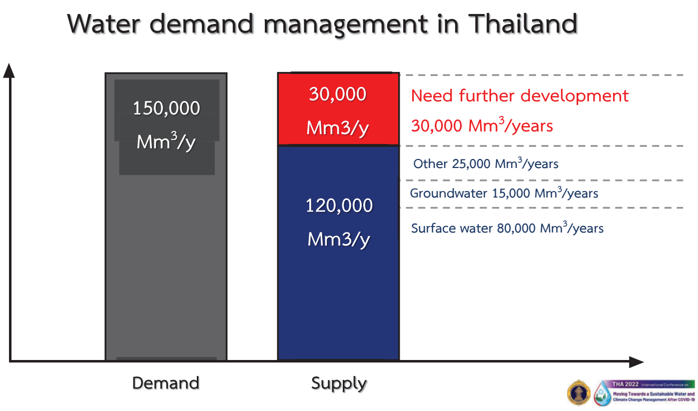
SESSION C:
WATER MANAGEMENT TOWARDS SDGS


Innovation for Groundwater Management
towards SDGs in Thailand
INNOVATION
Surin Worakijthamrong , Ph.D.
Director of Groundwater Development Bureau,
Department of Groundwater Resources
Technical Presentation
THA2022
27th January 2022

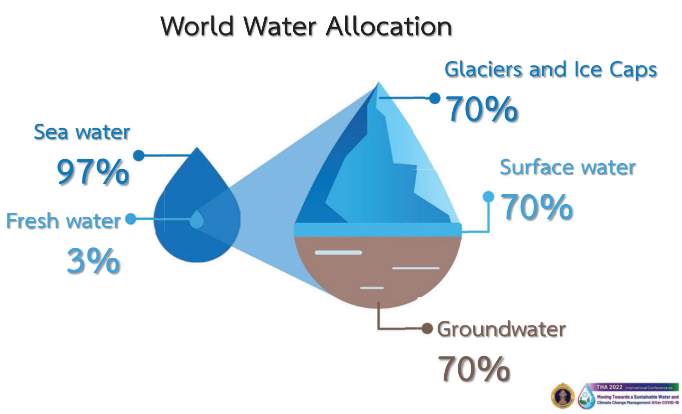

Wat Saman Rattanaram
Restaurants
Hotels
Attractions
Transit
Parking
Pharmacies
Sign in
4.5 12,312 reviews
Buddhist temple
Directions
Save
Nearby
Send to your phone
Share
A giant pink statue of a Hindu deity is the main attraction at this flashy, theme park-like temple.
Bang Pakong
Wat Saman Rattanaram
Colorful temple with a massive statue
RiverBreeze
Layers


Kanchanaburi
Bangkok
*The distance is about
170 kilometers
Tanaosri mountain range
Nong Prue District
Nong Fai Subdistrict
Lao Kwan District
Bor Ploy District
Huay Gra Jao District
rain shadow area
southwest monsoon
Kilometers


The Sustainable Development Goals
THE GLOBAL GOALS
Clean water and sanitation
Challenges
Solutions
SDGs 6
Ensure availability and sustainable management of water
and sanitation for all


Water demand management in Thailand
150,000
Mm3/y
30,000
Mm3/y
120,000
Mm3/y
Need further development
30,000 Mm3/years
Other 25,000 Mm3/years
Groundwater 15,000 Mm3/years
Surface water 80,000 Mm3/years
Demand
Supply


Water demand management in Thailand
30,000
Mm3/years
Option 1
Option 2


World Water Allocation
Glaciers and Ice Caps
70%
Sea water
97%
Surface water
70%
Fresh water
3%
Groundwater
70%

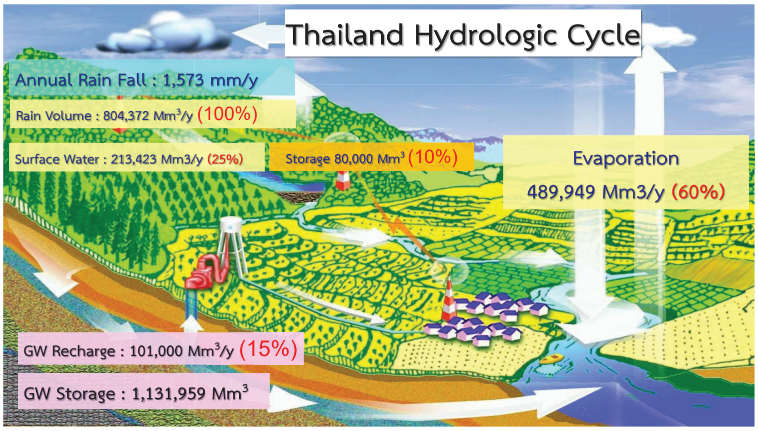
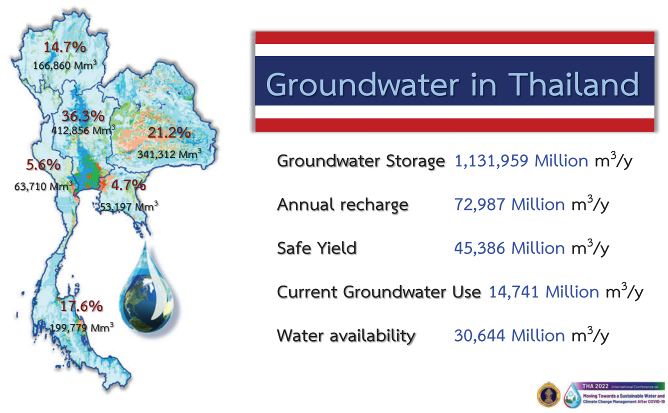
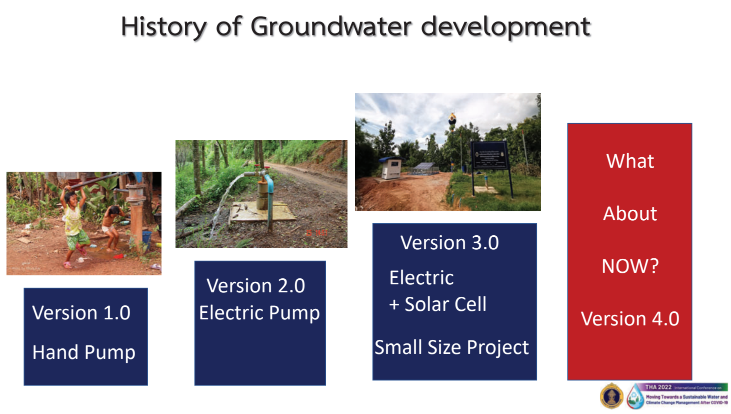

Thailand Hydrologic Cycle
Annual Rain Fall : 1,573 mm/y
Rain Volume : 804,372 Mm³/y (100%)
Surface Water : 213,423 Mm3/y (25%)
Storage 80,000 Mm³ (10%)
Evaporation
489,949 Mm3/y (60%)
GW Recharge : 101,000 Mm³/y (15%)
GW Storage : 1,131,959 Mm³


Photo by Khunphai


MILL WATER SYSTEM
CLEAR WELL
2559 m³
CLEAR WELL
2559 M³


Groundwater in Thailand
14.7%
166,860 Mm³
36.3%
412,856 Mm³
21.2%
341,312 Mm³
5.6%
63,710 Mm³
4.7%
53,197 Mm³
17.6%
199,779 Mm³
Groundwater Storage 1,131,959 Million m³/y
Annual recharge 72,987 Million m³/y
Safe Yield 45,386 Million m³/y
Current Groundwater Use 14,741 Million m³/y
Water availability 30,644 Million m³/y

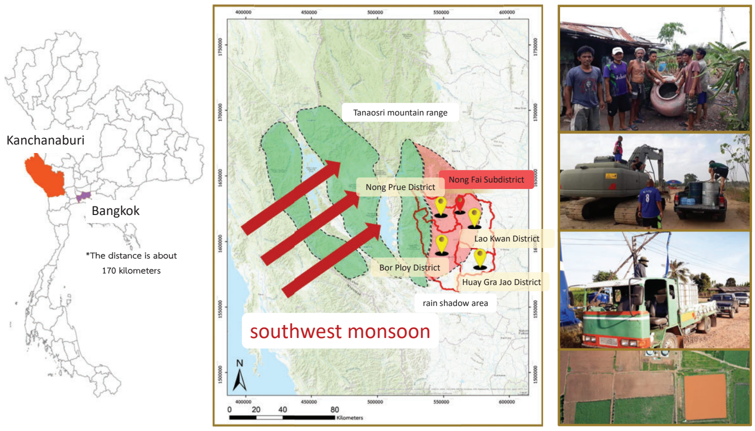

Water demand management in Thailand
30,000
Mm³/years
Option 1
Option 2


History of Groundwater development
Version 1.0
Hand Pump
Version 2.0
Electric Pump
Version 3.0
Electric
+ Solar Cell
Small Size Project
What
About
NOW?
Version 4.0

Ground Water Development

Past | Present

Challenge in Ground Water Management



Large-Scale Groundwater Supply for Drought Relief

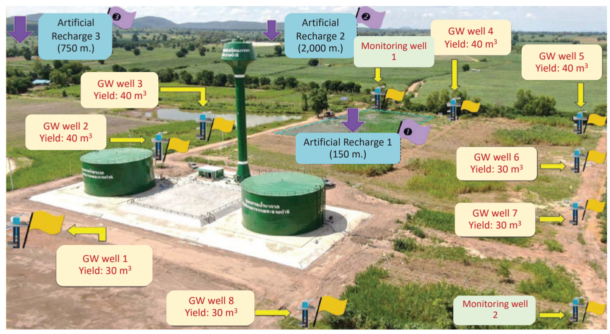
Nong Fai, Lao Khwan, Kanchanaburi

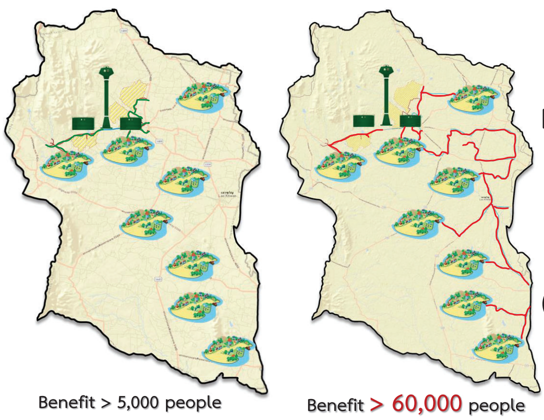
GW yield from 6 wells (m^3/hr)	Estimated GW yield (m^3/year)
300	1,752,000

Benefit	
Individuals	5,786
Households	1,856
Agriculture (rai)	3,000

Large-Scale Groundwater Supply for Drought Relief

Nong Fai, Lao Khwan, Kanchanaburi





Benefitted area
3,000 Rais

5,786
beneficiaries
(1,856 households)

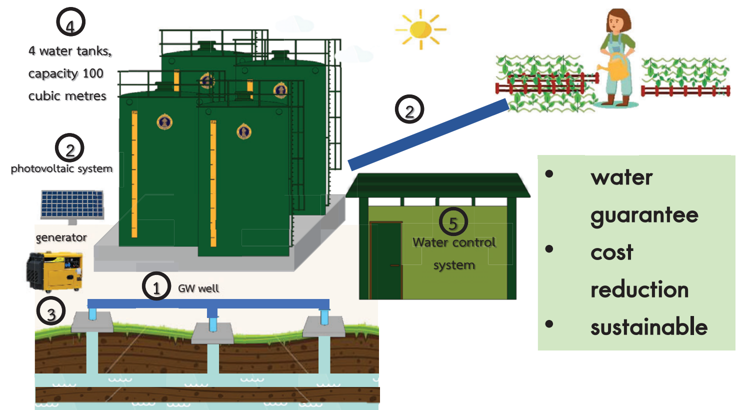
Mineral Water

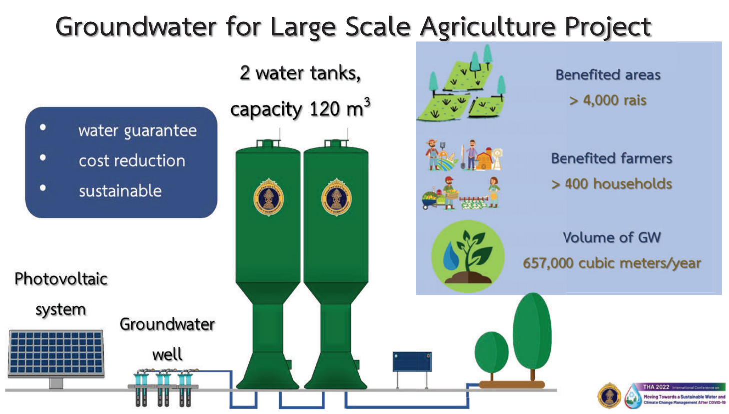
Quality
=

Huai Krachao Water

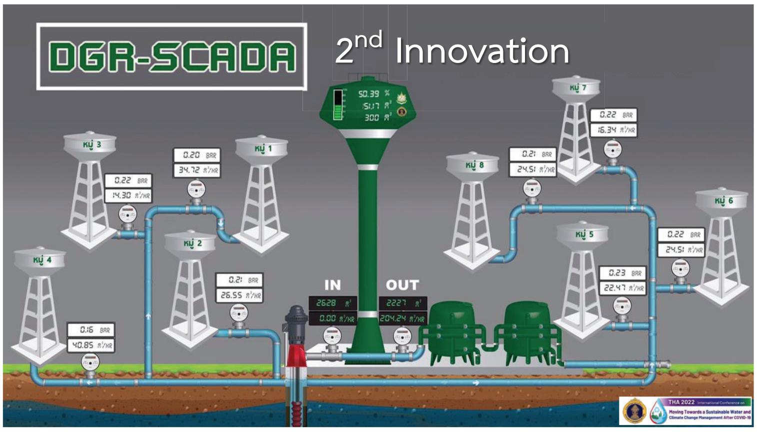

Daily drinking water cost $0.5 per person
Monthly drinking water cost $45 per months
Yearly drinking water cost $540k per years
Return on investment 4 years

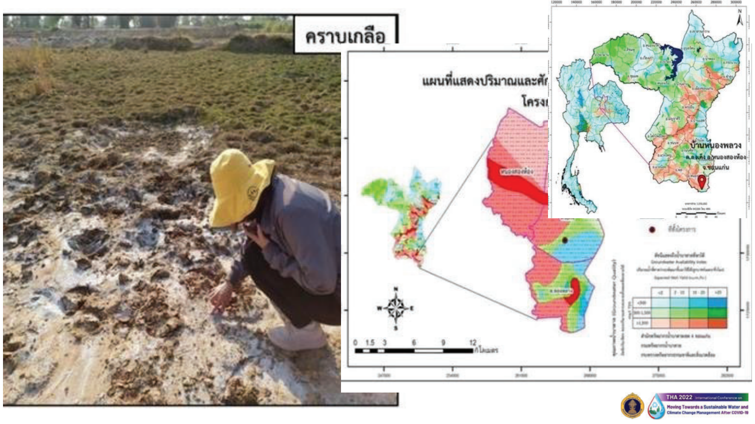

3 water tanks can fully fill to their capacity of 400,000 litres in 5 hours
6-inch pipe can fill water at 1,000 litre within less than 30 seconds


4
4 water tanks, capacity 100 cubic metres
2
photovoltaic system
generator
3
1 GW well
2
5 Water control system
water guarantee
cost reduction
sustainable


Groundwater for Large Scale Agriculture Project
2 water tanks, capacity 120 m3
water guarantee
cost reduction
sustainable
Benefited areas
> 4,000 rais
Benefited farmers
> 400 households
Volume of GW
657,000 cubic meters/year
Photovoltaic system
Groundwater well


Groundwater for Large Scale Agriculture Project


DGR-SCADA
2nd Innovation
IN
OUT



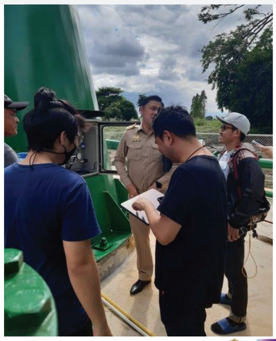
2nd Innovation : DGR SCADA

Website

Application

DGR SCADA : RBF, CHAI NART Province

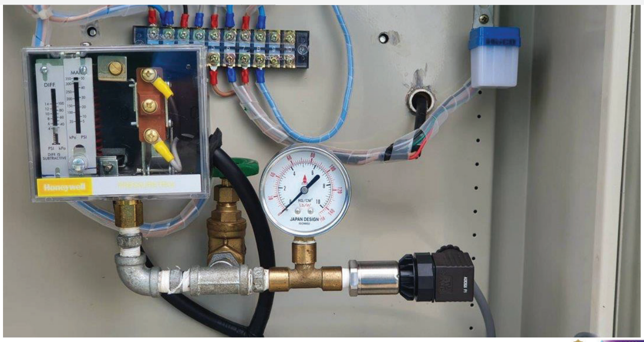
DGR SCADA : RBF, CHAI NART Province



DGR SCADA : RBF, CHAI NART Province

DGR SCADA : RBF, CHAI NART Province

DGR SCADA : RBF, CHAI NART Province



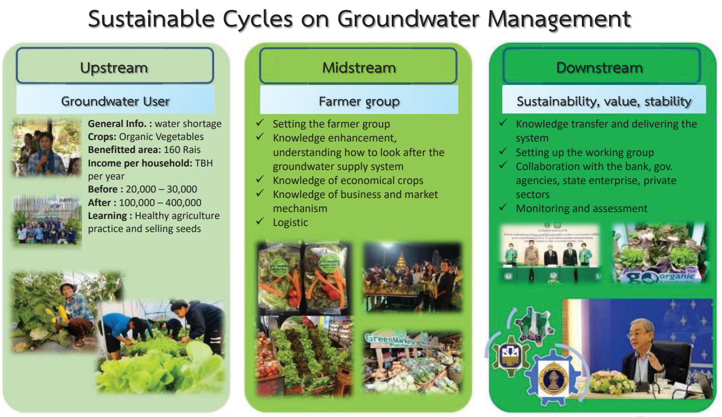
3rd Innovation : Groundwater conservation management

Past

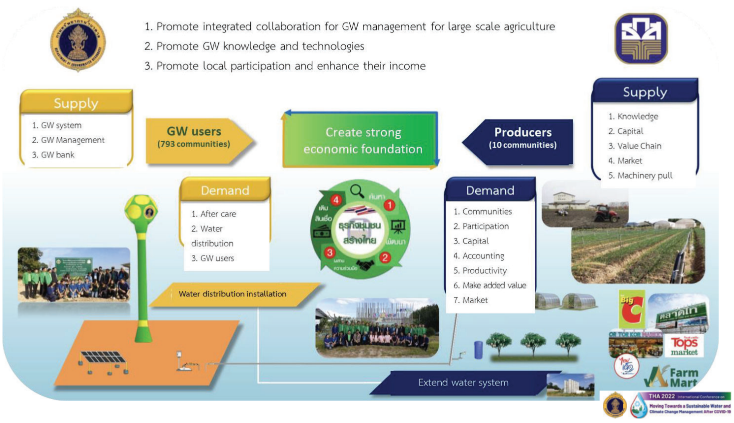
Present

Average household oncome : $12,124 per years

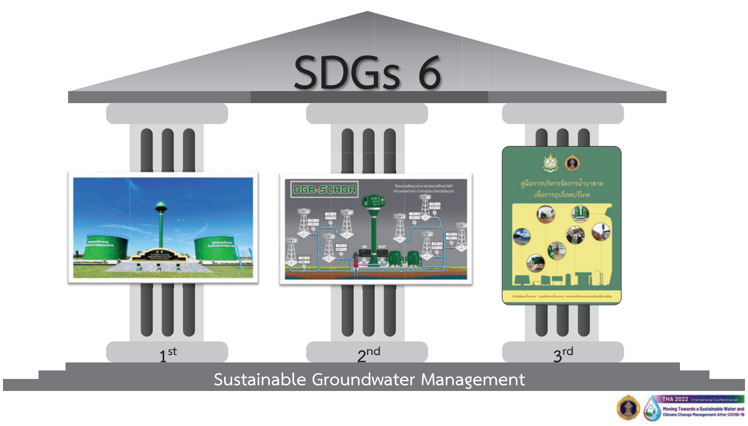
Future


Sustainable Cycles on Groundwater Management
Upstream
Groundwater User
General Info. : water shortage
Crops: Organic Vegetables
Benefitted area: 160 Rais
Income per household: TBH per year
Before : 20,000 – 30,000
After : 100,000 – 400,000
Learning : Healthy agriculture practice and selling seeds
Midstream
Farmer group
✓ Setting the farmer group
✓ Knowledge enhancement, understanding how to look after the groundwater supply system
✓ Knowledge of economical crops
✓ Knowledge of business and market mechanism
✓ Logistic
Downstream
Sustainability, value, stability
✓ Knowledge transfer and delivering the system
✓ Setting up the working group
✓ Collaboration with the bank, gov. agencies, state enterprise, private sectors
✓ Monitoring and assessment


Collaboration with other organizations
Promote public participation in agricultural groundwater management
by working with the Bank for Agriculture and Agricultural Cooperatives (BAAC)

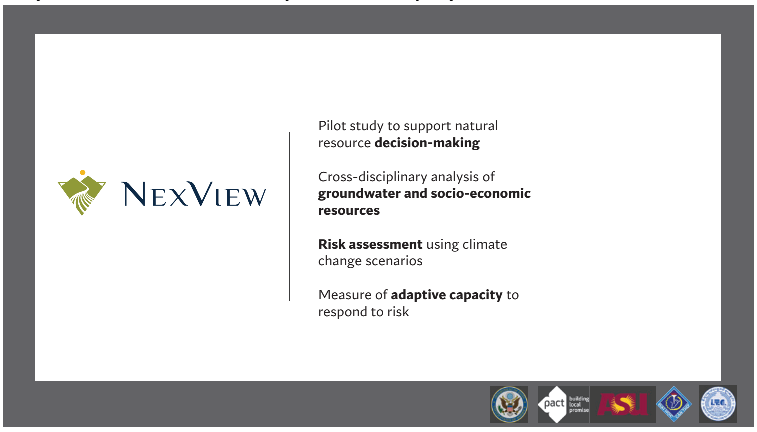

1. Promote integrated collaboration for GW management for large scale agriculture
2. Promote GW knowledge and technologies
3. Promote local participation and enhance their income
Supply
1. GW system
2. GW Management
3. GW bank
GW users
(793 communities)
Create strong economic foundation
Producers
(10 communities)
Supply
1. Knowledge
2. Capital
3. Value Chain
4. Market
5. Machinery pull
Demand
1. After care
2. Water distribution
3. GW users
Demand
1. Communities
2. Participation
3. Capital
4. Accounting
5. Productivity
6. Make added value
7. Market
Water distribution installation
Extend water system

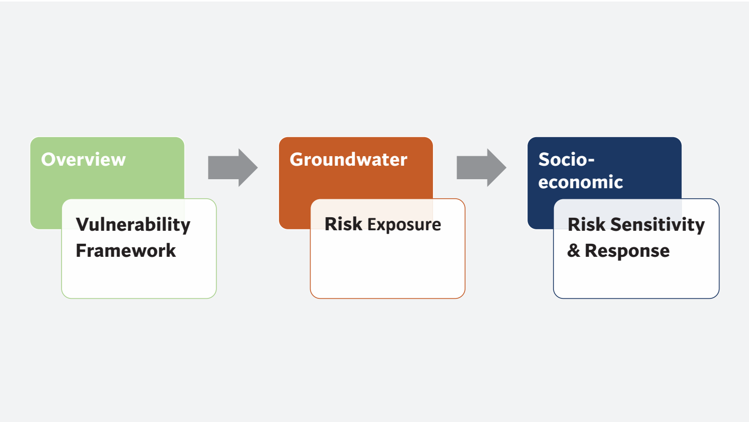

Groundwater Management Manual
Domestic Consumption Manual
Water for Agriculture Manual
คู่มือการบริหารจัดการน้ำบาดาล
เพื่อการอุปโภคบริโภค
คู่มือ
การบริหารจัดการน้ำบาดาล
โครงการพัฒนาน้ำบาดาล
เพื่อเกษตรแปลงใหญ่

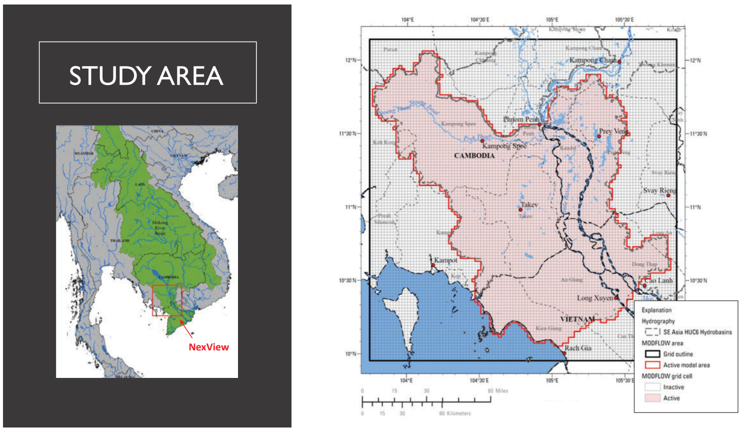

SDGs 6
1st
2nd
3rd
Sustainable Groundwater Management


SUSTAINABLE DEVELOPMENT GOALS
Thank you for your attention
Surin Worakijthamrong,Ph.D.
Director of Groundwater Development Bureau
Department of Groundwater Resources

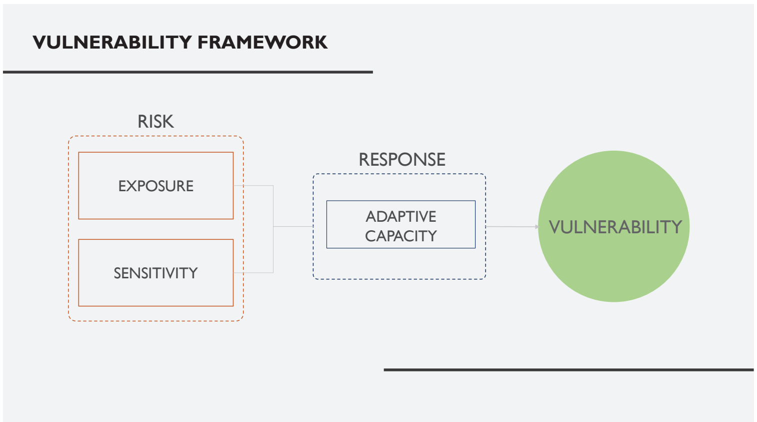

THA 2022 26-28/01/2022
Integrated Groundwater and Socio-Economic Vulnerability Analysis to Identify Potential Risk of Water Stress
Saira Haider – Wetland and Aquatic Research Center, Fort Lauderdale, Florida
Kathryn Powlen – Oklahoma-Texas Water Science Center, Austin, Texas
Kyle Davis – Nevada Water Science Center, USGS, Carson City, Nevada
USGS
science for a changing world


NEXVIEW
Pilot study to support natural resource **decision-making**
Cross-disciplinary analysis of **groundwater and socio-economic resources**
Risk assessment using climate change scenarios
Measure of **adaptive capacity** to respond to risk

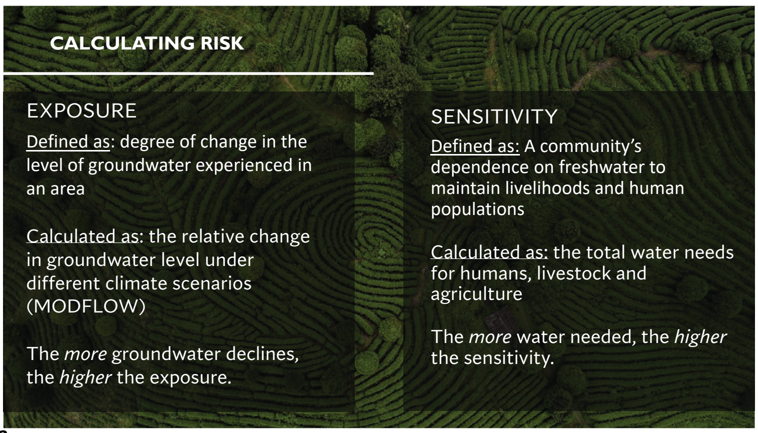

Overview
Vulnerability Framework
Groundwater
Risk Exposure
Socio-economic
Risk Sensitivity & Response

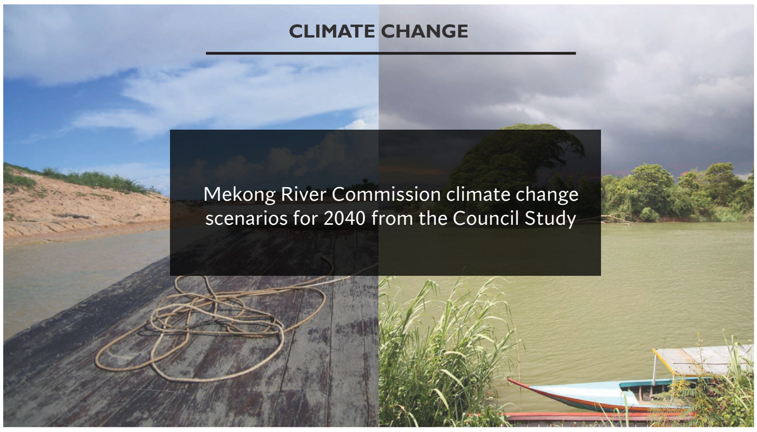

STUDY AREA
NexView
CAMBODIA
VIETNAM

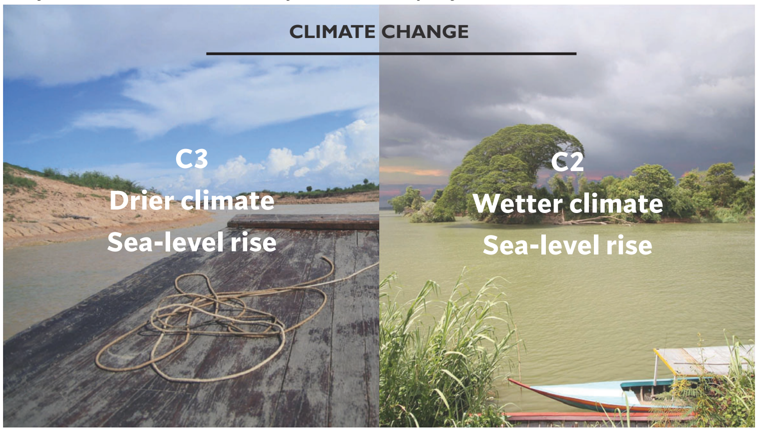

GOALS
GROUNDWATER MODEL
+
SOCIO-ECONOMIC MODEL


VULNERABILITY FRAMEWORK
RISK
EXPOSURE
SENSITIVITY
RESPONSE
ADAPTIVE CAPACITY
VULNERABILITY

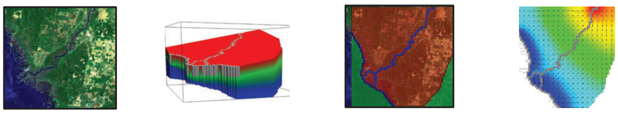

CALCULATING RISK
EXPOSURE
Defined as: degree of change in the level of groundwater experienced in an area
Calculated as: the relative change in groundwater level under different climate scenarios (MODFLOW)
The *more* groundwater declines, the *higher* the exposure.


CALCULATING RISK
EXPOSURE
Defined as: degree of change in the level of groundwater experienced in an area
Calculated as: the relative change in groundwater level under different climate scenarios (MODFLOW)
The *more* groundwater declines, the *higher* the exposure.
SENSITIVITY
Defined as: A community's dependence on freshwater to maintain livelihoods and human populations
Calculated as: the total water needs for humans, livestock and agriculture
The *more* water needed, the *higher* the sensitivity.





A Numerical Groundwater Flow Model



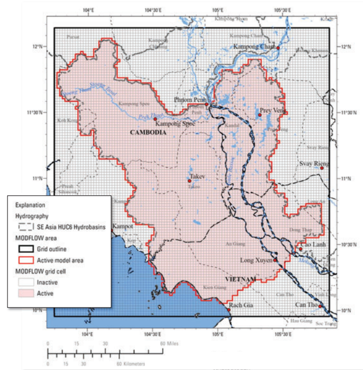
Real-world system → Hydrogeologic and conceptual models → Model input → Model output

- **Real-world system**
  - How will the model be used?
  - What processes are most important?
- **Hydrogeologic and conceptual models**
  - Hydrogeologic understanding
  - Understand and describe important groundwater processes
- **Model input**
  - Spatial extent and time period
  - Hydrogeologic properties
  - Representation of aquifer stress
- **Model output**
  - Simulation of system behavior in space and time
  - Simulation of potential future scenarios

USGS science for a changing world

Model Design

- USGS MODFLOW-6
- Spatial extent and time period
  - Mekong River Basin between Phnom Penh, Cambodia and Cao Lanh, Vietnam
  - Predevelopment (steady-state)
  - Time-varying conditions (1991-2010):
    - Historical
    - Future scenarios (20 years)
  - Stress periods: three months long
    - Two per dry season (Nov. – Apr.)
    - Two per wet season (May – Oct.)

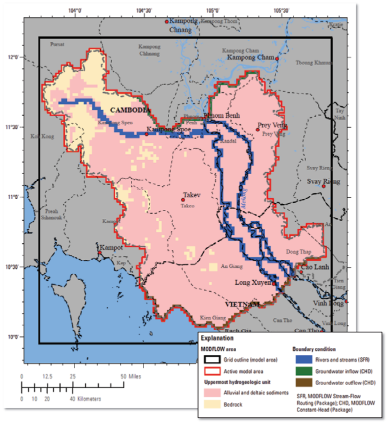


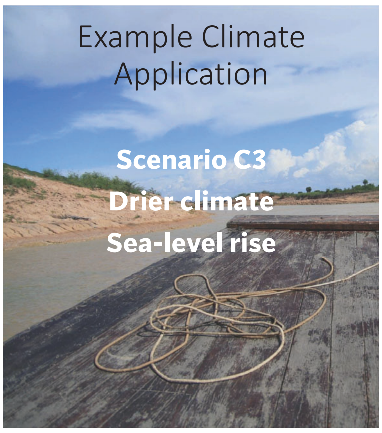
Conceptual Understanding

- Hydrogeologic understanding
  - Layers 1–5: delta aquifer and confining units
  - Layers 6: bedrock aquifers
  - Used geologic maps define initial layering and extent
  - Uniform hydrogeologic properties
- Understand and describe important groundwater processes
  - Streamflow
  - Connection between rivers and aquifers
  - Recharge
  - Evapotranspiration
  - Groundwater pumping*
  - Salt-water intrusion*
  - Land subsidence*

Model Input

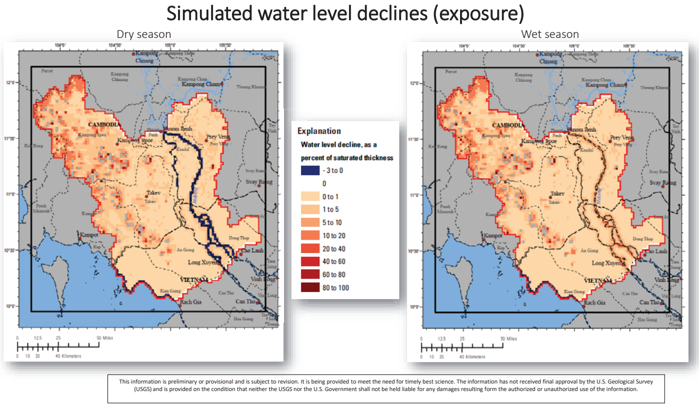
- Representation of aquifer stress
  - Interaction with streams
    - Time variable streamflow
  - Spatially uniform recharge:
    - Time variable
    - Approximately 16 percent of precipitation
  - Spatially uniform maximum potential evapotranspiration:
    - About 1.5 meters per year
  - Groundwater inflow and outflow

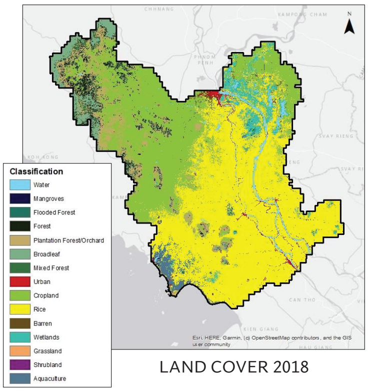




- Changes applied to model
  - Adjusted monthly recharge
  - Adjusted monthly streamflow at Phnom Penh
  - Sea-level rise
- Example analyses of model results
  - Calculate relative water level change

Simulated water level declines (exposure)





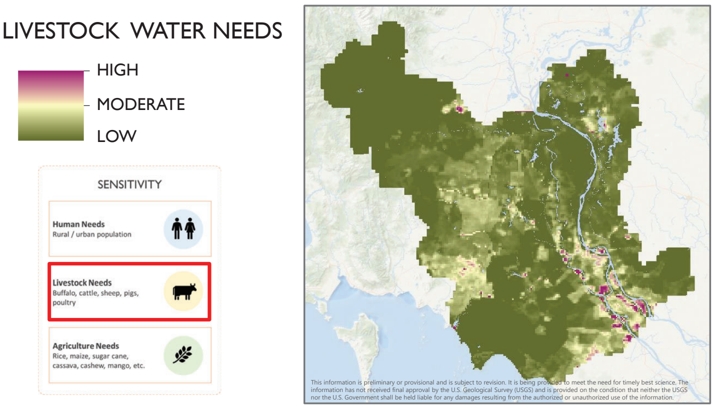
LAND COVER 2018

DATA USED

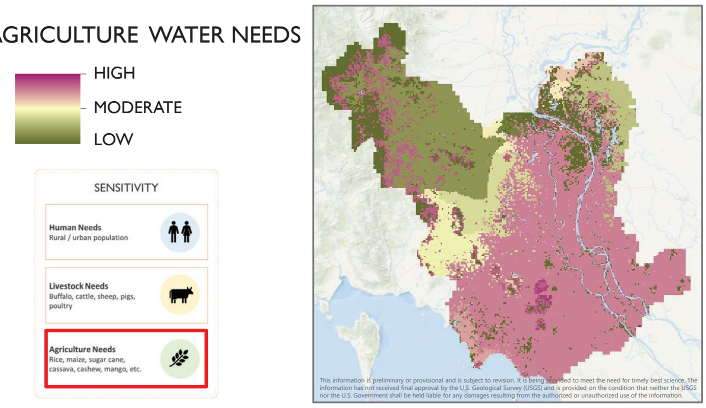
- SERVIR-Mekong Land Cover Maps
- WorldPop - Human population distribution raster
- GeomWiki – Livestock distribution raster
- Census Reports (Human Population and Agricultural) from KHM and VN

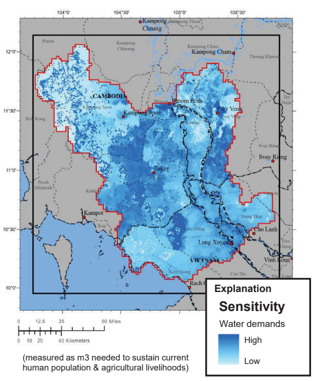
HUMAN WATER NEEDS

LIVESTOCK WATER NEEDS



AGRICULTURE WATER NEEDS





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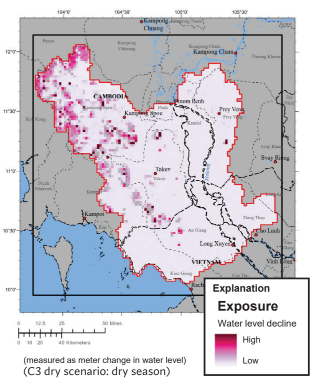

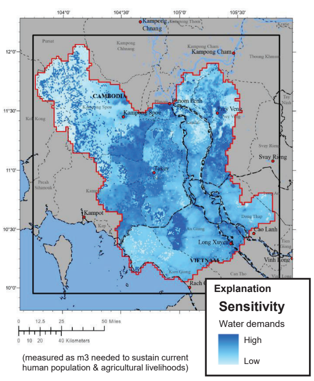

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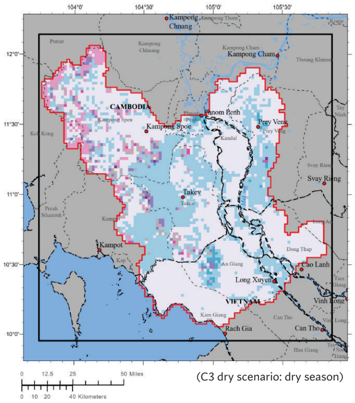
IDENTIFYING RISK

Risk = Exposure + Sensitivity

- Areas with **high** exposure and **high** sensitivity are most at risk (**dark purple**)
- Areas with **high** exposure and **low** sensitivity (**pink**) *or* **low** exposure and **high** sensitivity (**blue**) have moderate risk
- Areas with **low** exposure and **low** sensitivity have low risk levels (white)

Explanation
Exposure
Sensitivity
High
Low
Low High



(C3 dry scenario: dry season)

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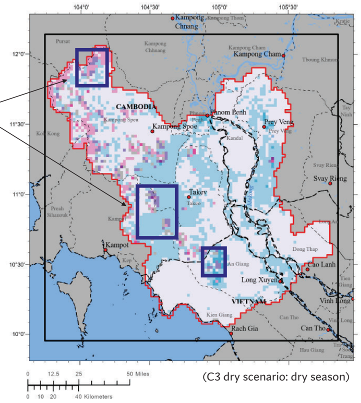

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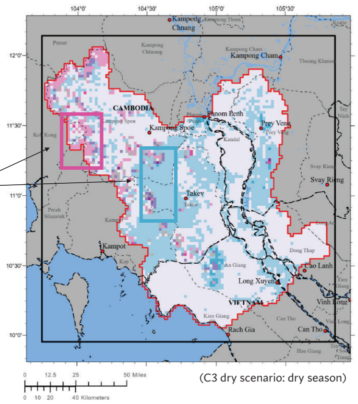

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VULNERABILITY FRAMEWORK

RISK
EXPOSURE
SENSITIVITY
RESPONSE
ADAPTIVE CAPACITY
VULNERABILITY

5 COMPONENTS OF ADAPTIVE CAPACITY

ADAPTIVE CAPACITY
Assets
Information
Institutions
Flexibility
Agency

Framework adapted from Brooks et al 2003 and Cinner et al 2019

1. ASSETS
The financial, technological, and service resources that people have access to

2. INFORMATION & LEARNING
The ability to generate, absorb, and process new information

3. FLEXIBILITY
The opportunities available to adapt or change

4. INSTITUTIONS & SOCIAL ORGANIZATION
The way society is organized, including formal and informal relationships, and existence of appropriate institutions that enable cooperation, collective action, knowledge sharing and fair access and entitlements to key assets and capital

5. AGENCY
The power and freedom to leverage and mobilize the other aspects of adaptive capacity

ADAPTIVE CAPACITY INDICATORS & THE SDGS

SUSTAINABLE DEVELOPMENT GOALS

1.4.1
1.4.1
4.3.1
4.6.1
5.1.1
5.2.1
6.1.1
6.2.1
8.5.2
8.10.2

AC: Assets
- Clean drinking water
- Sanitation
- Electricity

AC: Information & Learning
- % population with secondary education
- % population as trained workers
- Literacy rate

AC: Agency
- Gender inequality index

AC: Assets
- % population with centrally managed drinking source
- % population with flush toilets

AC: Flexibility & Institutions
- Employment rate
- Access to bank account

CHALLENGES + FUTURE STEPS

Integrating multiple spatial scales
- Combining risk & adaptive capacity

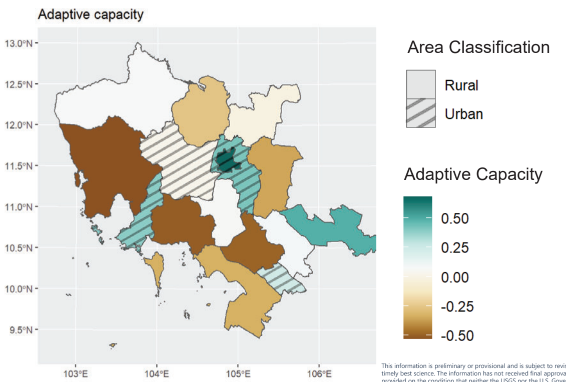
Inability to collect field data due to COVID-19
- Socio-economic data
- Limits to collaboration

Improvements to groundwater model
- Include groundwater pumping
- Update hydrogeology
- Simulate surface and groundwater management scenarios

EXTRA SLIDES

Adaptive Capacity Component (# indicators)	Specific Indicator
Asset Base (7)	Labor force as % of population
	Employment rate
	Malnutrition under 5 years
	Birth life expectancy
	Electrification rate
	Sanitation services
	Water provider
Information & Learning (4)	Literacy rate
	Secondary education
	Trained worker rate
	Access to information (internet)
Flexibility (3)	% income from agriculture
	Number of markets per person
	Net migration
Institutions/Social organization (3)	% membership in cooperative, farmer assoc.
	Access to extension agents
	Access to bank
Agency (1)	Gender equality index*

(Disclaimer: This is an example. Figure does not represent real data.)



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WORKSHOP

Workshop A

THA 2022 Training courses for hydrologic analysis using GCM climate projection outputs

Purpose of the training

In this training workshop, you will learn about climate change downscaled data for Southeast Asia and water resource impact assessment using it. In addition, you will learn how to use climate change data through exercises. At first, dynamically downscaled high-resolution climate projection outputs in Southeast Asia using a regional climate model (RCM) are introduced. Next, a large ensemble of climate simulations (d4PDF) developed by using a 60 km atmospheric general circulation model (AGCM) and dynamical downscaling with a 20 km RCM is explained. Then, a 150-year continuous simulation using a GCM is introduced. After the introduction of climate change scenario data, an impact assessment of climate change on water resources in Southeast Asia is introduced. After these lectures, a training excessive will be provided to study how to access the climate projection data and how handle the data through a simple application of the usage of d4PDF at the selected river basin in Southeast Asia.

Training schedule: 28th January 2022 in the morning

No.	Agenda	Speaker	Time (tentative)
1	Dynamical downscaling of climate data for Southeast Asia at Meteorological Research Institute in Japan	**Dr. Akihiko MURATA**, Meteorological Research Institute, Japan	09:00-09:20 AM
2	Evaluation of MRI-AGCM and 150-year continuous simulation in Southeast Asia	**Dr. Toshiyuki NAKAEGAWA**, Meteorological Research Institute, Japan	09:20-09:40 AM
3	Impact assessment of climate change on water resources in Japan Southeast Asia using d4PDF	**Prof. Yasuto Tachikawa**, Graduate School of Engineering, Kyoto University, Japan	09:40-10:00 AM
4	3.1- Introduction of the exercise (uncertainty assessment of reservoir operation using d4PDF), How to access d4PDF and data format	**Dr. Thatkiat Meema**, Graduate School of Engineering, Kyoto University, Japan	10:00-10:30 AM
	Break		10:30-10:40 AM
	3.2- Hand-on the exercise (precipitation analysis using d4PDF)		10:40-11:30 AM
4	**Q&A**		11:30-12:00 AM

Workshop B

THA 2022 Training courses for water security index

Purpose of the training

During RIO+20 meeting, the sustainable green economy for protecting environmental health via income increasing and poor eradication were discussed. The successful countries for sustainable green economy depend on efficiency of integrated water management 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.

In this training workshop, you will learn about water security status data and calculation method in case of Thailand. In addition, you will learn how to use water security index data through exercises. The example of application and implementation of water security index in Thailand is illustrated. The strength and weakness of Thailand water management status were discussed.

Training schedule: 28th January 2022 in the afternoon

No.	Agenda	Speaker	Time
1	Introduction of Water security index.	**Asst. Prof. Piyatida Ruangrassamee** Faculty of Engineering, Chulalongkorn University, Thailand	13.00-13.20
2	Example of mainstreaming water security index in national water resources management in Thailand.	Office of the National Water Resources, Thailand	13.20-13.40
3	Linkage of water security index and water operation in Thailand: framework and system.	**Asst. Prof. Pongsak Suttinon** Faculty of Engineering, Chulalongkorn University, Thailand	13.40-14.00
4	4.1- Introductions of exercise.	**Asst. Prof. Piyatida Ruangrassamee** **Asst. Prof. Pongsak Suttinon** Faculty of Engineering, Chulalongkorn University, Thailand	14.00-14.30
	Break		14.30-14.40
	4.2- Hand-on the exercise		14.40-15.30
4	**Q&A**		15.30-16.00

Workshop C

Science-Policy Interface Dialogue on Water and Climate Change

Friday 28th January 2022, at 13.00-16.00 GMT+7
(Online via ZOOM)

Background:

While the strengthening of the Science-Policy Interface (SPI) was collectively committed by the ministers at the United Nations High-level Political Forum in 2020 with a high amount of investment being put into research, science, technology and innovation, it is found that promoting only these areas are not enough anymore. This is because the SPI is not simply the relation between science and public policy. Rather, it is a dynamic ecosystem of processes, actors and organizational arrangements, intended to facilitate the exchange of scientific evidence and place it in the context of social values so that it can inform the most complex policy problems and mobilize forward.

Additional to the urgency of climate change and environmental challenges we are facing, Intergovernmental Panel on Climate Change (IPCC) and Inter-Panel on Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) have identified the need of transformational change, in which technology is identified as one of the vital drivers, will accelerate actions towards the goals of limiting temperature rise to 1.5 degrees C by 2030 and living in harmony with nature by 2050.

Therefore, to strengthen the linkages between science and policy, as well as enable ecosystem for driving climate action, 'Science-Policy Interface Dialogue on Water and Climate Change' is organized to create a space for discussion and drive action on Science-Policy Interface among young professionals from various background and take forward with youth networks and relevant stakeholders for implementing change across different sectors.

Objectives:

1. Familiarize participants with the concept of Science-Policy Interface
2. Explore challenges and opportunities for Science-Policy Interface
3. Network and build community of action for continuing activities towards achieving SDGs

Target: 40 young professionals, focus but not limited to 18-35 years old
(Background Covering: Researcher, NGO, Science-Policy Interface, Policy, Youth Network working on the following issues related to climate change/biodiversity i.e. Indigenous/Ethic groups, Gender, People with Disability, Economic, Finance, Media, Others that is relevant to climate change and water issues)

Time	Minutes	Programme	Note
13.00-13.15	15	Warm-up	Menti
13.15-13.30	15	Introduction to Science-Policy Platform	Presentation
13.30-13.45	15	Getting to know each other & Locating where we are	Round of Self-Introduction
13.45-14.05	20	Inputting to the Quadrant and Identify 3 key functions	Small breakout groups of 3-4 people and fill the output into the consolidated sheet of 9 quadrant
14.05-14.20	15	Break	
14.20-15.20	60	Open Discussion on Challenges and Solutions	Group of max 5. Sharing & Mapping Exercise on

			Challenges and Solutions through 5 topics (Free to choose topic(s) of interest) 1. Financing 2. Capacity Building 3. Data 4. Innovation 5. Governance
15.20-15.50	30	Next Step	Suggestions for next step & Allocate working groups for taking consultation to action
15.50-16.00	10	Summary and Reflection	Menti & Photo

Community of Action (Potential Partners for taking outputs forward into action)
- Asian University Network
- YECAP
- Movers Programme

Follow up activities
- Report the result to relevant government agencies
- Continued activities in action with Community of Action
- University network updates progress and collaboration (If any)

Timeline

20 December 2021 – 10 January 2022	Call for Application
14 January 2022	Initial List of Announcement
21 January 2022	Finalists and final details to participants
28 January 2022	SPI Dialogue

Reference
Science-Policy Interface addressed by the United Nations Committee of Experts on Public Administration (CEPA)

Summary of Online Workshop of Status of Water Conservation, Climate Change and Ecosystem-based Adaptation in ASEAN

Date: Friday 28 January 2022 (10.00-12.00)
Under collaboration of: (1) ASEAN Working Group on Water Resources Management: AWGWRM, (2) Association of Southeast Asian Nations, (3) Department of Water Resources, Ministry of Natural Resources and Environment, Thailand and (4) Department of Water Resources Engineering, Faculty of Engineering, Chulalongkorn University, Thailand

Participants: 64 participants from 6 ASEAN member countries

Summary

In this online workshop, the participants discussed about status of water conservation, climate change and ecosystem-based adaptation in ASEAN. The example of status index of ASEAN member countries is illustrated. The gap of this issue is discussed.

The outputs of online workshop are sharing indicators of socio-economic, environment and governance issues. This links with the open data from the World Bank, United Nation and ASEAN. The data shows how the pandemic changed the world and ASEAN economy.

The discussion results show that ASEAN still has gap in various issues such as:

(1) **The gap of available data:** Mr. Dwight Jason Magro Ronan Senior Officer of ASEAN Secretariat, Indonesia informed that limited data is one of challenging issues in ASEAN. ASEAN Secretariat tried to provide information through ASEAN Biodiversity Dashboard (http://dashboard.aseanbiodiversity.org). However, only 2 country-reports are presented now.

(2) **The gap of knowledge:** There is limitation of responsible organization and knowledge for Ecosystem-based Adaptation in ASEAN. Now, only some pilot projects from international support such as Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH are implemented and illustrated (https://www.thai-german-cooperation.info/th/thai-german-climate-programme-water/)

The recommendations from the workshop show that ASEAN still need the capacity building process to address the data and knowledge gaps. We should keep and continue the training program or workshop for strengthening the Water Conservation, Climate Change and Ecosystem-based Adaptation in ASEAN together.

News Clipping

No.	Link
1	https://www.facebook.com/radioam1467/videos/186438407015430/
2	https://www.facebook.com/radioam1467/videos/778476620213228/
3	https://www.tnnthailand.com/news/social/103063/
4	https://www.matichon.co.th/publicize/news_3152096
5	https://www.prachachat.net/public-relations/news-851351
6	https://www.mojothainews.com/2022/01/19_26.html
7	https://aec-tv-online1.com/?p=230705
8	www.5forcenews.com/?p=230989
9	https://mgronline.com/onlinesection/detail/9650000008574
10	http://www.restmetalk.com/17329239/-tha-2022-international-conference-
11	http://www.innewsthailand.com/?p=17701
12	https://th.postupnews.com/2022/01/chula-tha-2022.html
13	https://www.asiannewschannel1.com/?p=4607
14	http://www.leadertoday.net/2022/01/19-tha-2022-international-conference-on.html
15	https://www.khaokrom.com/2022/01/19.html
16	http://www.vateekhao.com/2022/01/19-tha-2022-international-conference-on.html
17	https://www.chadthukkrasae.com/2022/01/blog-post_239.html
18	https://aec-tv-online2.com/?p=813290
19	https://siamrath.co.th/n/317061
20	http://www.stageonleader.com/2022/01/19-tha-2022-international-conference-on.html
21	https://www.facebook.com/100031018435007/posts/598379861205956/?d=n
22	https://www.facebook.com/1416823535235926/posts/3022510928000504/?d=n
23	https://mgronline.com/science/detail/9650000008594
24	https://www.pimthai.co.th/99005
25	https://www.thaikufanews.com/ราชการ/27997/
26	http://thanjainews2017.blogspot.com/2022/01/blog-post_213.html
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28	https://internewsonline.com/?p=22745
29	https://thainews.prd.go.th/th/news/detail/TCATG220126203447901
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32	https://www.lokkhaosanonline.com/28459/
33	https://www.mojothainews.com/2022/01/tha2022.html
34	https://aec-tv-online1.com/?p=231450
35	https://th.postupnews.com/2022/01/tha2022.html
36	https://www.khaokrom.com/2022/01/tha2022.html
37	https://aec-tv-online2.com/?p=815274
38	https://www.chadthukkrasae.com/2022/01/tha2022.html
39	https://www.blockdit.com/posts/61f20d1ec1f60e4fc9a6d952
40	http://www.leadertoday.net/2022/01/tha2022.html
41	https://www.mojothainews.com/2022/01/tha2022_31.html

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