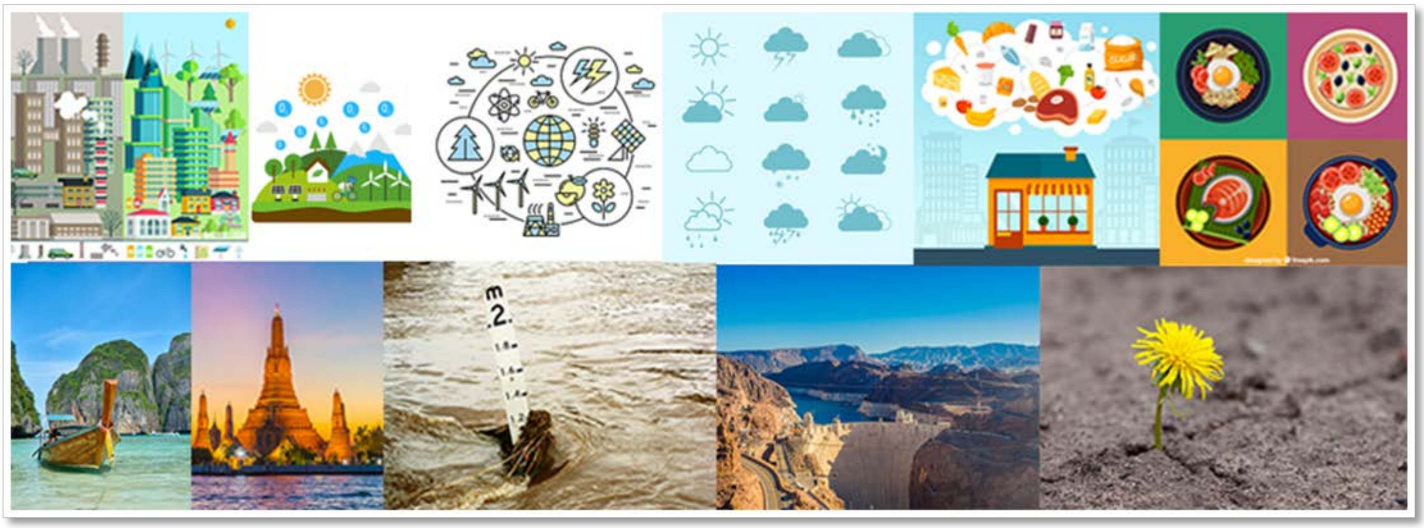
THA 2017 International Conference on "Water Management and climate Change Towards Asia's Water-Energy-Food Nexus"



THA 2017

25-27 January 2017 | Swissôtel Le Concorde,

www.tha2017.org | Bangkok, Thailand

Executive Summary Report

Organized by

THA 2017
International Conference on
Water Management and climate Change
Towards Asia's Water-Energy-Food Nexus

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25-27 January 2017

Swissôtel Le Concorde,

Bangkok, Thailand

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Preface

The THA 2017 International Conference on "Water Management and Climate Change towards Asia's Water-Energy-Food Nexus" was organized from January 25th to 27th, 2017 at Swissôtel Le Concorde, Bangkok. The event was co-organized by 9 national and 16 international institutions. The national institutions included Faculty of Engineering Chulalongkorn University, the Thai Hydrologist Association, Kasetsart University, Asian Institute of Technology, Royal Irrigation Department, Department of Water Resources, Department of Groundwater Resources, National Economics and Social Development Board, and Thailand Research Fund. The international institutions were International Society of Paddy and Water Environment Engineering (PAWEES), International Centre of Excellence for Water Hazard and Risk Management (ICHARM), Department of Civil and Earth Resources Engineering, Kyoto University, Japan-ASEAN Science, Technology and Innovation Platform (JUSTIP), Japan Society of Hydrology and Water Resources (JSHWR), Department of Hydraulic and Ocean Engineering, National Cheng Kung University, National Taiwan University, K-Water, Chungnam National University, Korea Water Resources Association (KWRA), International Water Resources Research Institute (IWRRI), AUN/SEEDNet, Japan International Cooperation Agency (JICA), Regional Office for Asia and Pacific, Food and Agriculture Organization (FAO), UNESCO Asia and Pacific Regional Bureau for Education, and Danish Hydraulic Institute (DHI), Thailand. The main objective of the THA 2017 was to provide a platform for researchers, scientists, practitioners, and policy makers to share and present new advances, research findings, perspectives, and experiences in disaster, irrigation and water management. Special attentions were given to developing certain skills or competence, or general upgrading of capacity for climate change adaptation, participatory water management, disaster and environmental management, sustainable development in irrigation and drainage, and WEF Nexus. The conference brought together leading researchers, engineers, scientists, and officials in the domain of interest from around the world.

The THA 2017 international conference was successful according to the main objective of serving as the public assembly. Report on the background of the THA 2017 international conference and the role of the university in this water and disaster issues were given in the opening speech by Prof. Dr. Bundhit Eua-arporn, President of Chulalongkorn University and followed by the congratulation speech given by Dr. Gwang-Jo Kim, Director, UNESCO Asia and Pacific Regional Bureau for Education

(UNESCO Bangkok). The opening remarks was given by Prof. Emeritus Khunying Suchada Kiranandana, Chairman of the University Council. At this conference we had three keynote speakers, 8 invited speakers, 302 Thai participants, 50 foreign participants from 12 countries including Denmark, India, Indonesia, Japan, Korea, Lao PDR, Malaysia, Myanmar, Philippines, Taiwan, US, and Vietnam. The three keynote presentations given by distinguished speakers who were invited to participate in the conference emphasized the connection between water security and Sustainable Development Goals (SDGs), key issues of WEF Nexus in Asia-Pacific area, and water planning strategies under SDGs and WEF Nexus. There were 8 invited paper and 69 selected papers to present under 4 subthemes and special session. In detail 18 papers on climate change and hydrology, 6 papers on participatory irrigation management (PIM), 11 papers on emerging technologies in water resources, 22 papers on disaster and groundwater management, and 12 papers on a special session on groundwater under changing world.

The first subtheme on climate change covers the topic of climatic and rainfall change including climate change adaptation. In hydrology and meteorology, the topic covers a broad range of areas such as storm prediction, river flow, sedimentation, and drainage. Some research papers discuss about the impact of climate change on flooding, reservoir management, ocean wave, and water quality.

The second subtheme on Participatory Irrigation Management covers PIM experiences in Thailand and Japan and water use efficiency for crop and water-food nexus.

The third subtheme on emerging technologies covers many issues of water-energy-food nexus. The technologies on urban water supply, application of irrigation, water quality management, downscale of rainfall prediction, and water footprint were discussed.

The last subtheme on disaster management covers many issues about policy on disaster management, assessment of extreme events including flood, drought and landslide. In addition for groundwater issue, the papers cover groundwater modeling, assessment of groundwater under climate change, groundwater yield estimation, effect of land use change on groundwater, etc.

Apart from the presentations based on the above-mentioned themes, the ASEAN Academic Networking in Water & Disaster Management and Climate Change was organized in parallel to the THA 2017 international conference. The aim of the ASEAN Academic networking was to encourage further collaboration in research, to exchange knowledge and technology pertaining to disaster warning, management and recovery and to suggest appropriate policies that correspond to the increased severity of the climate change and natural disasters as well as the interconnection among WEF Nexus. The ASEAN Academic networking was divided into four sessions including country report, academic presentations, roundtable discussion, and technical training. There were 14 invited presentations from ASEAN countries; 7 of which were for the country report and the other 7 were for the academic sessions. Suggestion, recommendations, opportunities for further research direction and collaboration were discussed among ASEAN representatives and also shared from the views of 6 invited speakers from countries including Japan, Korea, Taiwan, Thailand, US, and international organizations which are UNESCO-IHP.

At the end of the THA 2017 International Conference, a summary plenary session presentation was given by Assoc. Prof. Dr. Bancha Kwanyuen, Dean of Faculty of Engineering, Kasetsart University, Kampaengsaen Campus followed by the formal announcement of Bangkok Statement 2017 made by Asst. Prof. Dr. Anurak Sriariyawat, Head of the Department of Water Resources Engineering, Chulalongkorn University and Dr. Jayakumar Ramasamy, Programme Specialist & Chief of Natural Science Sector, UNESCO Bangkok. The closing remarks were given by Dr. Sucharit Koontanakulvong, Conference Secretariat.

Major outputs obtained from the THA 2017 can be summarized below:

- Knowledge dissemination and exchange from the presentations. At this conference and workshop we had 3 keynote speakers, 8 invited speakers, 302 Thai participants, 50 foreign participants from 12 countries: Denmark, India, Indonesia, Japan, Korea, Lao PDR, Malaysia, Myanmar, Philippines, Taiwan, US, and Vietnam, 8 invited papers, 69 technical papers participated.
- Formal announcement of Bangkok Statement 2017 for collaboration in the ASEAN Academic Networking in Water & Disaster Management and Climate Change.
- A technical training on "CHRS Remote Sensing Precipitation & Bias Adjustment of PERSIANN-CCS Estimation for Water and Disaster Management"

- Poster 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 ASEAN and other countries outside ASEAN.
- Strengthening collaboration among ASEAN countries in the area of water and climate change and bringing it towards WEF Nexus.

This document presents main conclusions from the THA 2017 International Conference on "Water Management and Climate Change towards Asia's Water-Energy-Food Nexus". Related materials that will be issued separately are the THA 2017 proceedings titled "Water Management and Climate Change towards Asia's Water-Energy-Food Nexus", and the Special Issue of THA2017 in Engineering Journal (EJ) (http://www.engj.org/index.php/ej/; ISSN: 0125-8281, Faculty of Engineering, Chulalongkorn University.

Lastly, we would like to take this opportunity to express our sincere gratitude to all participants for their contributions and support that driving the THA 2017 International Conference toward the desired objectives and achievement.

The organizers of the THA 2017 International Conference on "Water Management and Climate Change towards Asia's Water-Energy-Food Nexus" and the coordinator of the ASEAN Academic Networking in Water and Disaster Management and Climate Change

May 2017

Activity Summary
THA2017International Conference on
"Water Management and Climate Change towards Asia's Water-Energy-Food Nexus"
25-27January 2017, Thailand

Assoc. Prof. Dr. Sucharit Koontanakulvong
Conference Secretariat of THA 2017

The conferencehad brought together leading researchers, engineers, scientists, and officials with the overall aims:

- To present innovative knowledge and technology in water management for security and sustainability under the threats of climate change
- To provide a forum for researchers, engineers, scientists, academics from public and private institutions internationally to present and discuss their research
- To facilitate knowledge transfer, experience sharing, and further development of the research for public benefit

The THA 2017 covers the domain of interest from around the world which can be categorized into four main areas including:

- Uncertainty in Hydrology and Meteorology
- Participatory Management for Water and Irrigation Project
- Emerging Technologies in Water Management and Environment Towards W-E-F Nexus
- Disaster Management/ Groundwater Management

For the opening ceremony of the THA 2017, it is our honour to have distinguished guests at our conference. The report speech was given by Prof. Dr. Bundhit Eua-arporn, President of Chulalongkorn University. The congratulation speech was delivered by Dr. Gwang-Jo Kim, Director, UNESCO Asia and Pacific Regional Bureau for Education(UNESCO Bangkok). The opening remarks was given by Prof. Emeritus Khunying Suchada Kiranandana, Chairman of the University Council.

Following the opening ceremony, we had three keynotes presentations. The first keynote presentation on "The water-food-energy nexus: future challenges and opportunities in Asia" was given by Ms. Louise Whiting, Regional Office for Asia and the Pacific Food and Agriculture Organization of the United Nations (FAO). The second keynote presentation focusing on Water Planning Strategies under SDG and WEF

Nexus was presented by Dr. Porametee Vimolsiri, Secretary General of Office of National Economic and Social Development Board, Thailand. The final keynote on Water management under climate change and WEF approach was delivered by Dr.Ramasamy Jayakumar, UNESCO, Bangkok Thailand.

Several activities had been done in the THA 2017 including:

- Oral presentation
- Poster presentation and exhibition
- Technical Workshops
- Executive/technical meeting in ASEAN session
- Roundtable discussion in ASEAN session
- Technical tour

Oral presentations were presented by invited 8 speakers, 69 presenters in plenary session and 12 presenters in the special groundwater session. The total number of the participants is 352. About 302 participants are Thai and the rest are from 12 countries including Denmark, India, Indonesia, Japan, Korea, Lao PDR, Malaysia, Myanmar, Philippines, Taiwan, USA, and Vietnam.

Plenary session summary

THA2017 is a continuing from THA2015 as biannual conference under the theme of "water management and climate change towards Asia Water-Energy-Food Nexus". We have discussed about climate change and uncertainty in hydrology and meteorology, participatory management for water and irrigation project, emerging technologies in water management and environment, disaster management and groundwater management.

The presentations include eight guest speakers from Malaysia, Vietnam, Korea, Japan, Denmark, and USA, 69 papers on 4 subthemes. In detail 18 papers on climate change and hydrology, 6 papers on participatory irrigation management (PIM), 11 papers on emerging technologies in water resources, and 22 papers on disaster and groundwater management were presented. In addition there are 12 papers on a special session on groundwater under changing world.

The first subtheme on climate change covers the topic of climatic and rainfall change including climate change adaptation. In hydrology and meteorology, the topic covers a broad range of areas such as storm prediction, river flow, sedimentation, and drainage.

Some research papers discuss about the impact of climate change on flooding, reservoir management, ocean wave, and water quality.

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The third subtheme on emerging technologies covers many issues of water-energy-food nexus. The technologies on urban water supply, application of irrigation, water quality management, downscale of rainfall prediction, and water footprint were discussed.

The last subtheme on disaster management covers many issues about policy on disaster management, assessment of extreme events including flood, drought and landslide. In addition for groundwater issue, the papers cover groundwater modeling, assessment of groundwater under climate change, groundwater yield estimation, effect of land use change on groundwater, etc.

In conclusion, this conference gave opportunities for researchers, practitioners and people who are interested in climate change and water-energy-food nexus to gain knowledge and share ideas on the topic. Information and knowledge contributed from this conference can be further investigated, studied, and applied for sustainable development goals (SDG).

ASEAN Forum Summary

ASEAN Forum on Water Management and Climate Change towards Asia's Water-Energy-Food Nexus was organized as a session in the THA2017. The ASEAN Forum consisted of four main parts including country report presentation by management executives, academic presentation by senior researchers, and roundtable discussion.
The planning session in which country reports were presented was on January 25, 2017. The presentations include seven guest speakers from ASEAN Secretariat, Malaysia, Myanmar, Thailand, and Vietnam. The presentation from ASEAN Secretariat highlighted on ASEAN cooperation on water resources management. Other countries' presentations focused on water resources strategy to deal with climate change and nexus approach.

The academic presentation session on January 26, 2017 was participated by seven senior researchers from Cambodia, Lao PDR, Malaysia, Philippines, Thailand, and Vietnam. The presentations aimed at sharing research status on water resources management under climate change. The studies covered the area of hydrologic and hydraulics modeling, natural disaster prevention and mitigation, climate change impact assessment, climate change strategy, and Nexus.

The ASEAN forum was ended with roundtable discussion on January 26, 2017. ASEAN participants and distinguished guests from UNESCO and collaborative countries including Japan, Korea, Taiwan, and USA were invited. The session started by the presentations from collaborative countries which attempted to address the challenges in preventing natural disaster and managing water resources under climate change followed by the presentation from UNESCO and Thailand Research Fund (TRF) about possible collaboration among the region. Future collaborative research, training, and education were discussed at the end of the session. Potential proposals for further collaborative actions were satellite application (for drought monitoring) and WEF Nexus planning and the near future workshops will be prepared among members interested.

Bangkok Statement 2017

The conference seemed to run smoothly and the participants were very active in the fruitful discussions in each session. We are very glad to see such an active participation. As a co-host in this conference, Faculty of Engineering at Chulalongkorn University, Kasertsart University, Asian Institute of Technology (AIT), Royal Irrigation Department (RID), Department of Water Resources (DWR), Department of Groundwater Resources (DGR), National Economic and Social Development Board (NESDB), Thai Hydrologist Association (THA), and the Thailand Research Fund (TRF),we would like to thank all the chairs, repretures, moderators, speakers, and of course, participants for your contributions which made this Conference a success. Who could have imagined a better exchange than seeing representatives from the several countries represented here discuss and share their knowledge in the Plenary session so effectively.

An important conclusion after conferences is that the participants are on a very steep curve in increasing the level of understanding on Water Management and Climate Change towards Asia's Water-Energy-Food Nexus. During this conference, we have built frameworks of knowledge, documents with a wealth of useful. We must use this momentum to carry the knowledge, expertise, and regional networks to an even more effective level. This will be an important goal for the next conference, as will be the further development and broadening of these networks (as attached document).

Thailand Hydrologists Association (THA) and ASEAN Academic Network in Water, Disaster Management and Climate Change –Bangkok Statement January 2017

We, faculty members, researchers and planners, working in the fields of water, the environment and disaster management from nine ASEAN countries –the Kingdom of Cambodia, the Republic of Indonesia, the Lao People's Democratic Republic, Malaysia, the Republic of the Union of Myanmar, the Republic of the Philippines, the Republic of Singapore, the Kingdom of Thailand and the Socialist Republic of Viet Nam–as well as the Environmental Division of ASEAN, met during the THA 2017 international conference on "Water Management and Climate Change: Towards Asia's Water-Energy-Food Nexus (WEF)" as well as participated in an ASEAN Academic Network parallel session on how countries in the sub-region can develop a WEF Nexus.

Following an intensive and interactive process, the participants decided on the following actions:

Thank the ASEAN Academic Network, Chulalongkorn University, UNESCO and Center for Hydrometeorology & Remote Sensing, University of California (Irvine) for organizing training on the remote sensing-based satellite data application for near real time rainfall estimation; a common training manual will be available for network members

Agree to continue capacity-building training on the remote sensing-based satellite data application for flood and drought warning system in ASEAN for another two years (2017-2018) both online and through in-person sessions.

Request that the ASEAN Network, Chulalongkorn University and UNESCO coordinate with ASEAN Members to explore the possibility of a water-energy-food nexus capacity-building training programme.

Explore the possibilities of exchanges of faculty members and students among ASEAN universities to benefit from the sharing of information and experience.

Request that the ASEAN Network formulate a working group to discuss an action plan for the development of collaborative research projects of mutual interest and discuss related proposals in the next THA meeting.

Thank the Thai Hydrologists Association for providing a platform during the biannual THA International Conference. The ASEAN Network also would like to organize a session during THA 2019 based on the theme identified.

Thailand Research Fund (TRF)agree upon the Bangkok Statement from THA2017. We are happy to be a member of the Academic Networking in water, disaster management and climate change, water-energy-food nexus for ASEAN Countries. We sincerely hope that the network will bring significant impacts to society from the collaborative research and capacity building to address our future challenges regarding the above issues.

Conference Organizing Institutes:

Chulalongkorn University (CU), Thailand

Faculty of Engineering at Kamphaengsaen, Kasetsart University (KU), Thailand

Asian Institute of Technology, Thailand

Royal Irrigation Department (RID), Thailand

General of Department of Water Resources (DWR), Thailand

Department of Groundwater Resources, Thailand

National Economic and Social Development Board, Thailand

Thai Hydrologist Association, Thailand

Thailand Research Fund, Thailand

Advisory Committees:

1	Prof. Dr. Bundhit Eua-arporn	Chulalongkorn University
2	Assoc. Prof. Dr. Chongrak Watcharinrat	Kasetsart University
3	Prof. Dr. Worsak Kanok-Nukulchai	Asian Institute of Technology
4	Mr. Sanchai Ketwonrachai	Director General of Royal Irrigation Department
5	Mr. Worasart Apaipong	Director General of Department of Water Resources
6	Mr. Suphot Towichakchaikun	Director General of Department of Groundwater Resources
7	Dr. PorameteeVimolsiri	Secretary General of Office of National Economic and Social Development Board
8	Dr. Subin Pinkayan	President of Thai Hydrologist Association
9	Prof. Suthipun Jitpimolmard, M.D.	Director General of Thailand Research Fund
10	Mr. Li He	Food and Agriculture Organization of the United Nations (FAO)
11	Prof. Dr.Toshio Koike	ICHARM, Japan
12	Prof. Dr. Yasuto TACHIKAWA	Kyoto University, Japan
13	Prof. Tsugihiro WATANABE	President of PAWEES, Japan
14	Prof. Wei Cheng Lo	NCKU, Taiwan
15	Prof. Kwansue Jung	KWRA, Korea
16	Dr. Ramasamy Jayakumar	UNESCO-IHP

Organizing Chair:

1	Assoc.Prof. Dr. Supot Teachavorasinskun	Chulalongkorn University

Organizing Co-Chair:

2	Assoc.Prof. Dr. Bancha Kwanyuen	Dean of Engineering Faculty, Kasetsart University
3	Assoc.Prof. Dr. Chanatip Pharino	Thailand Research Fund

International Scientific Committees:

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4	Dr. Kimihito Nakamura	Kyoto University, Kyoto, Japan
5	Dr. Andrew Whitaker	Niigata University, Niigata, Japan
6	Dr. Shinji Fukuda	Tokyo University of Agriculture and Technology, Japan
7	Dr. Takanori Nagano	Kobe University, Hyogo, Japan
8	Assoc. Prof., Dr. Kenji Tanaka	Department of Civil and Earth Resources Eng., Kyoto University, Japan
9	Prof. Koike Toshio	ICHARM, Japan
10	Dr. Hirodata Matsuki	Director of International Affairs Office, River Planning Division, Water and Disaster Management
11	Prof. K.S. Cheng	National Taiwan University, Taiwan
12	Dr. WT Feng	National Taiwan University, Taiwan
13	Prof. Jian-Ping Suen	NCKU, Taiwan
14	Dr. Meng-Hsuan Wu	NCKU, Taiwan

15	Dr. Byung Man Choi	K-water Institute, Korea
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22	Dr.Yeonsu Kim	K-water, Korea
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28	Assoc. Prof. Dr. Tuantan Kitpaisalsakul	Chulalongkorn University
29	Dr. Piyatida Ruangrassamee	Chulalongkorn University
30	Dr. Pongsak Suttinon	Chulalongkorn University
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34	Assoc.Prof.Dr. Avishek Datta	Asian Institute of Technology
35	Asst.Prof.Dr. Sarawut Ninsawat	Asian Institute of Technology
36	Assoc. Prof. Amnat Chidthaisong	King Mongkut's University of Technology Thonburi, TRF
37	Dr. Oranuj Lophensi	Department of Groundwater Resources, Thailand

Working Committees:

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2	Miss Daunpen Punayangkool	Chulalongkorn University
3	Miss Napaporn Noppakhun	Chulalongkorn University
4	Miss Marayart Petcharat	Thai Hydrologist Association

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1st day
THA 2017 International Conference (Wednesday- 25 January 2017)
Venue: Le Concorde Ballroom, 2nd floor

08.00		**Registration**	
Opening Session			
09.00	Exhibition	Report Speech:	**Prof. Dr. Bundhit Eua-arporn** President of Chulalongkorn University
09.10		Introduction Speech:	**Dr. Gwang- Jo Kim** Director, UNESCO Asia and Pacific Regional Bureau for Education (UNESCO Bangkok)
09.20		Congratulation Speech:	**Mr. Vongthep Arthakaivalvatee** Deputy Secretary-General of ASEAN Socio-Cultural Community Department ASEAN Secretariat
09.30		Opening Remarks:	**Prof. Emeritus Khunying Suchada Kiranandana** Chairman of the University Council
09.40		Group Photo Tour for Exhibition on Green and Smart Technology for Water Managemen and Press conference	
10.10			**Coffee Break**
		Scope Session	
10.30		**Keynote Speakers I** **The water-food-energy nexus: future challenges and opportunities in Asia**	**Ms. Louise Whiting** Regional Office for Asia and the Pacific Food and Agriculture Organization of the United Nations (FAO)
11.00		**Keynote Speakers II** **Water Planning Strategies under SDG and WEF Nexus (tentative)**	**Dr. Porametee Vimolsiri** Secretary General of Office of National Economic and Social Development Board, Thailand
11.30		**Keynote Speakers III** **Water management under climate change and WEF approach (tentative)**	**Dr. Gwang- Jo Kim** Director, UNESCO Asia and Pacific Regional Bureau for Education UNESCO Bangkok
12.00			**Lunch Break**

DAY 1 (Wednesday- 25 January 2017) THA 2017 Plenary session presentation

Scope		Plenary session presentation Venue: Salon A		Plenary session presentation Venue: Salon B		Plenary session presentation Venue: Krisana
Chair		Assoc. Prof. Dr. Ekasit Kositsakulchai		Dr. Sangam Shrestha		Assoc. Prof. Chaiyuth Sukhsri
Briefing		Dr. Saisunee Budhakooncharoen		Ass.Prof.Dr. Uma Seeboonruang		Dr. Patama Singhruck
13.00		**Invited A: Projected changes in mean precipitation, temperature and extremes over Southeast Asia region based on the multi-model simulations of SEACLID/CORDEX Southeast Asia** **Prof. Fredolin Tangang, PhD,** School of Environmental and Natural Resource Sciences, Malaysia		**Invited C: Water-Energy-Food Nexus: the roadmap in Korea** **Dr. Byung Man Choi** Project manager of Water-Energy-Food Nexus in Korea, Former Head of K-water Institute, Korea		**Invited D: Japan's Rivers Policies and Technical Works for Disaster Risk Reduction under climate change** **Mr. Takafumi Nakui,** International Affairs Office, River Planning Division, Water and Disaster Management Bureau, Ministry of Land, Infrastructure, Transport and Tourism(MLIT), Japan
13.30	**TA016**	**Development of Design Storm Pattern with Climate Change in Monsoon Asia** Dr. Sutat Weesakul, Hydro and Agro Informatics Institute, Thailand	**TB001**	**Water-Food Nexus: Water Use Efficiency in Central Asia** Dr. Younghun Jung, K-water, Korea	**TD020**	**SWAT and MODFLOW Modeling of Spatio-Temporal Runoff and Groundwater Recharge Distribution** Dr. AKSARA Putthividhya, Chulalongkorn University, Thailand
13.55	**TA002**	**Probabilistic Flood Forecasting using Ensemble Numerical Weather Prediction rainfalls during the 2011 Largest Flood Event in Japan** Dr. Wansik YU, Chungnam National University, Korea	**TA017**	**Correlation Analysis Between Tsengwen-Wushantou Reservoirs Operation and Environmental Factors** Yi-Lung YehSheng, National Pingtung University of Science and Technology, Taiwan	**TD001**	**Groundwater balance and river interaction analysis in Pleistocene aquifer of the Saigon River basin, South of Vietnam by stable isotope analysis and groundwater modeling** Mr. Tran Thanh Long, Chulalongkorn University, Thailand
14.20	**TA024**	**Land Cover/Use Scenario Building and its Impact on Flooding inside the Iligan River Basin** Mr. ALAN MILANO, MSU- Iligan, Institute of Technology, Philippines	**TC016**	**The Roles of virtual water for assessing the impacts of food security and global food trade on Water-Energy-Food Nexus** Dr. Sang-Hyun Lee, Texas A&M, USA	**TD003**	**Estimation of Hydrological Parameter Distribution by Geostatistical methods in the Upper Central Plain, Thailand** Ms.Pwint Phyu Aye, Chulalongkorn University, Thailand
14.45		**Coffee Break (15 Minute)**				

DAY 1 (Wednesday- 25 January 2017) THA 2017 Plenary session presentation						
Scope	**Plenary session presentation** Venue: Salon A		**Plenary session presentation** Venue: Salon B		**Plenary session presentation** Venue: Krisana	
Chair	Assoc. Prof. Dr. Ekasit Kositsakulchai		Dr. Sangam Shrestha		Assoc. Prof. Chaiyuth Sukhsri	
Briefing	Dr. Saisunee Budhakooncharoen		Ass.Prof.Dr. Uma Seeboonruang		Dr. Patama Singhruck	
15.00	**TD025**	**Evaluation of Near-Real-Time Satellite-based Rainfalls over Thailand** Mr. Teerawat Ram-Indra, Chulalongkorn University,	**TC001**	**Achieving Sustainable Resource Security through the Water-Energy-Food Nexus** Dr. Eul Rae Lee, K-water ,Korea	**TD021**	**Groundwater Vulnerability and Risk Assessment in Thailand using GIS-Based Modified DRASTIC Approach** Dr. AKSARA Putthividhya, Chulalongkorn University, Thailand
15.25	**TB002**	**Improving Crop Water Use with The use of Efficient Irrigation Technologies and Coconut Mulch Husk: A study on long-bean production.** Mr. Iep., National University of Lao,Lao	**TC007**	**Water Energy Carbon Nexus in Urban Water Supply System of Kathmandu Valley** Mimansha Joshi, AIT, Nepal	**TD005**	**Flow budget of groundwater systemand conjunctive use pattern under climate change in Upper Central Plain, Thailand** Mr. Chokchai Suthidhummajit, Chulalongkorn University, Thailand
15.50	**TB005**	**Water Quality Profiles And The Reservoir Utilization With Special References To Jatiluhur, Cirata And Saguling Reservoirs** Dr. Luki Subehi, Indonesian Institute of Sciences	**TA018**	**Spatial heterogeneity and trans-boundary pollution: A case study on the 3S River Basin** Mr. Manish Shrestha, AIT, Thailand	**TD010**	**An Assessment of Saltwater Intrusion in Cebu City Aquifers** Mr. Nelson Stephen L. Ventura, De La Salle University, Philippines
16.15	**TA026**	**Assessment of Water Resources During the 21st Century in Northern Thailand with Focus on Ping River Basin** Miss. Srisunee Wuthiwongyothin ,Thailand	**TC013**	**Developing food-energy-water (FEW) nexus indicators with DPSIR framework: Experience from Taiwan** Shang-Lien Lo, National Taiwan University,Taiwan	**TD026**	**Input-Output Analysis of Water Deficits in Nan River Basin, Thailand** Mr.PavisornChuenchum Chulalongkorn University, Thailand
18.00	**Reception Dinner (For registration participant) Venue: Le Lotus 1**					

1st day, ASEAN FORUM PROGRAMME (Wednesday- 25 January 2017)
Venue: Jamjuree Room, 2nd floor

13.00 – 16.00	**Session 1: Planning presentation** Objectives: To present national water management status, to share strategies to deal with the issue of climate change and WEF Nexus and propose research/training needs. (15 minutes each)
13.00	**Opening speech** **Mr. Saroj Srisai** Assistant Director/ Head of Environment Division Sustainable Development Directorate ASEAN Socio-Cultural Community Department
13.15	**Thailand Country Report 1** **Dr. Somkiat Prajamwong** Deputy Director General for Engineering Royal Irrigation Department, Thailand
13.30	**Myanmar Country Report** **Ms. Htay Htay Than** Department of Meteorology and Hydrology, Ministry of Transportation, Myanmar
13.45	**Lao PDR Country Report** **Dr. Mayphou Mahachalern** Department of Meteorology and Hydrology Ministry of Natural Resouces and Environment, Lao PDR
14.00	**Vietnam Country Report** **Dr. Le Minh Nhat** Head of the Climate Change Adaptation Department of Meteorology, Hydrology and Climate Change
14.15	**Cambodia Country Report** **HE Ponh Sachak** Director General Technical Affairs of Ministry of Water Resources and Meteorology of Cambodia
14.30	**Coffee Break**
14.45	**Thailand Country Report 2** **Mr. Worasart Apaipong** Director-General Department of Water Resources, Thailand
15.00	**Indonesia Country Report** **Assoc. Prof. Dr. Zainal Arifin** Deputy Chairman of Earth Sciences of Indonesian Institute of Sciences/ Chairman of Indonesia National Committee of UNESCO-IHP
15.15	**Philippines Country Report** **Dr. Sevillo D. David Jr.** Executive Director, National Water Resources Board Philippines
15.30	**Malaysia Country Report** **Datuk Mohd Adnan Mohd Nor** Academy Science of Malaysia (ASM), Malaysia
15.45	**Thailand Country Report3** Mr.Suphot Tovichakchaikul Director-General Department of Groundwater Resources, Thailand
18.00	**Reception Dinner**

DAY 2 (Thursday- 26 January 2017) THA 2017 Plenary session presentation						
Scope	**Plenary session presentation** Venue: Salon A		**Plenary session presentation** Venue: Salon B		**Plenary session presentation** Venue: Krisana	
Chair	Dr. Duc H. Nguyen		Assoc. Prof. Dr. Suwatthana Chitladakon		Assoc. Prof. Chaiyuth Sukhsri, CU	
Briefing	Dr. Saisunee Budhakooncharoen				Dr. Praphawadee Otarawanna	
09.00		**Invited C: Smart Urban Water systems – in practice** **Mr. Sten Lindberg,** DHI, Denmark		**Invited B: Principles and Methods for PIM in Action -Is the Japan's model exceptional?** **Dr. Masayoshi Satoh ,** Prof. Emeritus, University of Tsukuba		**Invited D: Extreme flood frequency analysis and risk curve development under a changing climate** **Prof. Dr. Yasuto Tachikawa,** Kyoto University, Japan
09.30	**TC008**	**Satellite based sub-daily downscaling of daily gauged rainfall for flood analysisvia fully distributed hydrological model** Mr. Pallav Kumar Shrestha, AIT, Nepal	**TB004**	**Participatory Water Management in the Specific Locale of Sub-watershed: Negotiation Process and Institutionalization.** Mr. Man Purotaganon, Thai Water Partnership, Thailand		**Invited D: Assessment of the impacts of groundwater abstraction and climate change on groundwater resources in Mekong Delta, Viet Nam** **Mr. Nguyen Tien Tung,** Division of Water Resources Planning and Investigation for the South of Vietnam, Vietnam.
09.55	**TC003**	**Characteristics of CH4 flux from paddy field adopting the intermitted irrigation technique Duringthe winter-spring and summer-autumn seasonsin the Red River Delta, Vietnam** Mr. Fumiya Inagaki, Kyoto University, Japan	**TA004**	**Determination of Extreme Design Waves under Climate Change in the Gulf of Thailand** Dr. Sutat Weesakul, Hydro and Agro Informatics Institute, Thailand		**Invited D: The PhEDEX Model: Anomalous (nonlocal) solute transport in groundwater modeled by keeping track of age of sorbate** **Prof Dr. Tim Ginn** Ph.D., Civil and Environmental Enginerring, WSU, 2016- Present
10.20	**TC009**	**A Case Study on Industrial Mismanagement of Tanneries in Hazaribagh: Water Pollution and Chromium Poisoning in Dhaka, Bangladesh** Mrs. Nilay Kumar Sarker, AIT,Thailand	**TB006**	**Proposal of a reservoir management method based on the observed accumulated areal mean rainfall for the Sirikit reservoir in the Chao Phraya River basin, Thailand** Dr. Kentaro Dotani, Toyama Prefectural University, Japan	**TD009**	**Assessment of rainfall-runoff models for stream flow and flood predictions in the Nam Song River Basin** Mr. Bounhome Kimmany Chulalongkorn University Thailand
10.45	**Coffee Break (15 Minute)**					

11.00	**TA022**	**Stochastic Simulation and Frequency Analysis of the Concurrent Occurrences of Multisite Extreme Rainfalls** Prof. Ke-Sheng Cheng, National Taiwan University, Taiwan	**TA005**	**Analysis of Farmers' Choice of Adaptations to Climate Change at NongSua District,Rangsit Canal, Thailand** Dr. Sutat Weesakul, Hydro and Agro Informatics Institute,Thailand	**Ground Water under Changing Word**	**The Possibility of Using Solute Age to Evaluate the Effectiveness of Riverbank Filtration (RBF)** Dr. Warangkana Larbkich, SystemPlan and Policy Analyst, Practioner Level
11.25	**TA011**	**Assessment of Satellite Rainfall Estimates as a Pre-Analysis for Water Environment Analytical Tools: A Case Study for Tonle Sap Lake in Cambodia** Arun. Chan. Phoeurn,Institute of Technology of Cambodia	**TC014**	**Effect of water management on growth of malabar chestnut** Dr.Yung-Liang Peng,National Taiwan University, Taiwan		**Simulation and optimization methodologies to estimate groundwater sustainable yield in the Central Chi River Basin, Northeast Thailand** Dr. Tussanee Nettasana, Geologist, Senior Professional Level
11.50	**TD012**	**Flood Risk Maps and Its Applications** Prof. Ming Daw SU, National Taiwan University, Taiwan	**TD006**	**Flood Modelling in Lower Mekong River in Cambodia** Dr. Sarann Ly, Institute of Technology of Cambodia, Combodia.		**Roles of Groundwater in the FED Triangle Water Resources Management Model in Thailand.** Mr. Chaiporn Siripornpibul, Former Inspector of Ministry of Natural Resources and Environment
12.00			**Lunch Break**			
Chair	Dr. Avishek Datta		Prof. Tawatchai Tingsan chali			Asst. Prof. Dr. Aksara Putthividhya
Briefing	Dr. Saisunee Budhakooncharoen		Assoc. Prof. Dr. Tuantan Kitpaisalsakul			Dr.Warangkana Larbkich
13.00	**TA023**	**Climate Extremes, People's Perception and Adaptation in Lower Songkhram River Basin, Thailand,** Miss. Pisinee Bariboon, AIT,Thailand	**TD023**	**Impact of decreasing percentage of imperviousness area with flooding in urban area at Sukhumvit, Bangkok, Thailand.** Mr. Detchphol Chitwatkulsir, Valaya Alongkorn Rajabhat University under the Royal Patronage,Thailand		**Assessing and Characterizing the Efficacy of the Constructed Wetland for Treating Pollutants in Landfill Leachate** Miss Chadaporn Busarakum, Geologist
13.25	**TC010**	**Quantifying climate change impact on rice production in Northeast of Thailand: a critical review through water footprint concept** Miss. Ranju Chapagain, AIT,Thailand	**TA006**	**Change of the Probability Distribution of Annual Maximum River Discharges derived from the d4PDF datasets at the Indochinese Peninsula** Mr. Patinya Hanittinan, Kyoto University , Japan		**Application of the Precipitation-Runoff Modeling System (PRMS) to the Investigation of the Effects of Land-use Changes on the Runoff Coefficient in the Prachinburi River Basin, Thailand** Dr. Phatcharasak Arlai

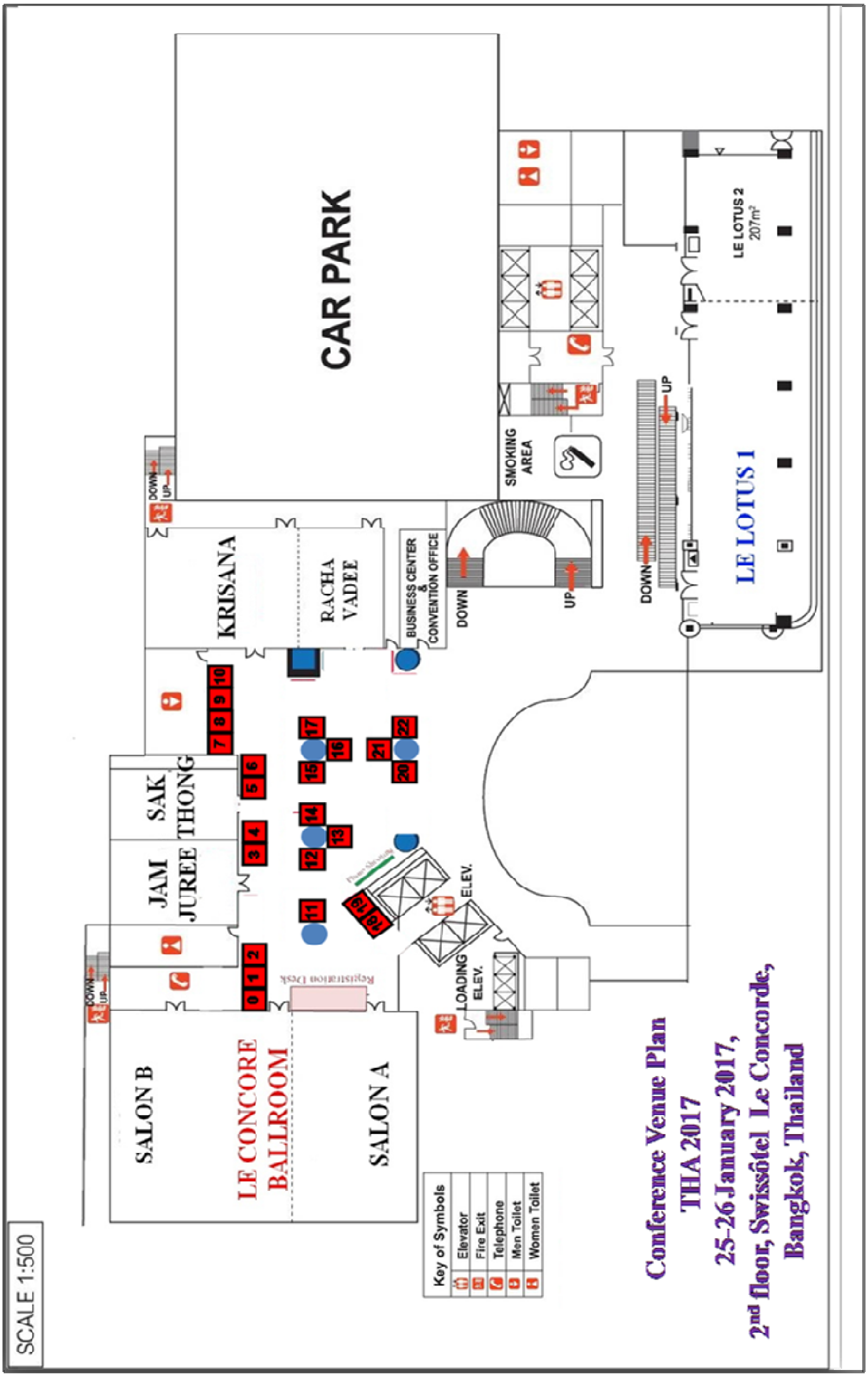
13.50	TA003	**River Discharge and Reservoir Operation Assessment under a Changing Climate at the Sirikit Reservoir** Mr. Donpapob Manee, Kyoto University, Japan	TA014	**Climate change and landslide risk assessment in Uttaradit Province** Miss Shotiros Protong, Department of Water Resources, Thailand		**Hydrological Assessment Using Stable Isotope Fingerprinting Technique In The Upper Chao Phraya River Basin** Asst.Prof.Dr. Aksara Putthividhya
14.15	TA009	**Comparison of the spatial rainfall in Khun Dan Prakan Chon Reservoir by spatial interpolation techniques.** Mr. Peerapong RattanaburiRID, Thailand	TD019	**Iron oxide coated activated carbons for arsenate adsorption from groundwater** Miss. Manavanh MUONGPAK, Chulalongkorn University, Thailand		**The Study on Groundwater Quality and Quantity Fluctuation near the Coastal Area Due To Climate Change, Thailand** Dr. Praphawadee Otarawanna, Geologist, Professional Level
14.40	TA008	**Effect of Land Cover Change to Annual Sedimentation in Nan Basin, Thailand** Dr. Kwanchai Pakoksung, Kochi University of Technology, Japan	TD002	**Estimation of river conductance values along Saigon River, Vietnam** Mr. Tuan Pham Van Chulalongkorn University,Thailand		**Assessment of Climate Change on Groundwater Vulnerability to Drought of Areas in Eastern Thailand** Ass.Prof.Dr. Uma Seeboonruang
15.05				**Coffee Break (15 Minute)**		
15.20	TA015	**Assessment of an Urban Drainage System in Phnom Penh Using Storm Water Management Model** Mr. Sokchhay Heng, Institute of Technology of Cambodia, Combodia	TD004	**Mechanism of land subsidence due to groundwater production.** Mr. P.,Phong prayoon, non-affiliated,Thailand		**Impact of Climate and Land Use Changes on Surface Water and Groundwater Potential in Huai Saibat Watershed, NE, Thailand** Dr. Phayom Saraphirom
15.45	TA021	**Change of water budged between 1960's and 2000's at the seasonal tropical forest in Northern Thailand** Dr. Katsushige Shiraki, Tokyo University of Agriculture and Technology, Japan	TD022	**Potential Impact and Risk Assessments of Future Climate Conditions on Salinisation in Central Huai Luang River Basin, Northeast, Thailand** Miss. Kewaree Pholkern , Khon Kaen University , Thailand		**Hydrogeochemical Features of Karst in the Western Thailand** Mr. Mahippong Worakul, Geologist, Senior Professional Level
16.10	TD016	**Analysis of Rainfall Induced Landslide Dam Geometries and Failures (Poster)** Prof. KWANSUE JUNG, Chungnam National University, South Korea, Korea	TD008	**Drought Risk Assessment of Irrigation Project Areas in a River Basin** Prof. Tawatchai Tingsanchali, AIT , Thailand		**Developing Policy Recommendations for the Water, Energy, and Food Security of Thailand** (Assoc. Prof. Dr. Lampang Manmat)

2nd day, ASEAN FORUM PROGRAMME (Thursday- 26 January 2017)
Venue: Jamjuree Room

09.00 – 12.00	**Session 2: Academic presentation** **Objective: To update research status and results on water management under climate change environmentand future research/training plan**
09.00	**Presentation on Cambodia research** **Dr. Sarann Ly** Head Department of Rural Engineering Institut de Technologie du Cambodge (ITC),Cambodia
09.20	**Presentation on Vietnam research** **Assoc. Prof. Dr. Hoang Minh Tuyen** Vice Director of IMHEN, Vitenam
09.40	**Presentation on Malaysia research** **Ir Mohd Zaki Mat Amin** National Hydraulic Research Institute of Malaysia (NAHRIM) Director of Research Centre for Water Resources
10.00	**Presentation on Lao PDR research** **Mr. Saykham Sithavong** Deputy Head of Irrigation Department Faculty of Water Resource,NUOL
10.20	**Presentation on Thailand research 1** **Dr. Piyatida Ruangrassamee** Department of Water Resources Engineering Faculty of Engineering, Chulalongkorn University, Thailand
10.40	**Coffee Break**
11.00	**Presentation on Indonesia research** **Dr. Fauzan Ali** Director of Research Centre for Limnology/Secretary of Indonesian National Committee of UNESCO-IHP
11.20	**Presentation on Philippines research** **Prof. Alan E. Milano** Civil Engineering Department MSU-Iligan Institute of Technology, Philippines
11.40	**Presentation on Thailand research 2** **Dr. Pongsak Suttinon** Department of Water Resources Engineering Faculty of Engineering, Chulalongkorn University, Thailand
12.00	**Summary of the session**
12.10	Lunch
13.00 – 16.00	**Session 3.2: Technical Training** (more details in separate training programme) Objective: To provide hands-on training and perform satellite bias correction for hydrological applications Introduction of satellite-based rainfall product and bias correction. Bias correction workshop for drought analysis. Coordinated by **Dr. Piyatida Ruangrassamee** Department of Water Resources Engineering Faculty of Engineering, Chulalongkorn University, Thailand
16.30-16.10	Closing Ceremony (Joint closing ceremony for the THA2017 and ASEAN Forum)
18.00	**Farewell Party Dinner** (For foreign and invited guests)

2nd day, ASEAN FORUM PROGRAMME (Thursday- 26 January 2017)
Venue: Sakthong Room

13.00 – 16.00	**Session 3.1: ASEAN Roundtable** **Objective: To present existing collaborative activities and discuss future collaborative activities/proposals on research/education**
13.00	**Sharing climate change projection data for impact assessment studies in ASEAN region** **Prof. Dr. Yasuto Tachikawa** Department of Civil and Earth Resources Engineering, Graduate School of Engineering Kyoto University, Japan
13.15	**Progressive Drought Monitoring and Risk Assessment Using SPI – Experiences of Taiwan** **Prof. K S Cheng** National Taiwan University, Taiwan
13.30	**Present and Future collaboration** **Prof. Dr. Kwansue Jung** KWRA, Korea
13.45	**Present and Future collaboration of International Organizations** **Dr. Ramasamy Jayakumar** UNESCO,Bangkok.
14.00	**"Recent Development of Precipitation Climate Dataset for Monitoring Hydroclimate Extremes."** **Prof. Dr. Kuolin Hsu** Center for Hydrometeorology and Remote Sensing, University of California - Irvine**,** UCIrvine
14.15	**Present and Future collaboration** **Assoc. Prof. Dr. Chanathip Pharino** Deputy Director Public Well-Being Division Thailand Research Fund
14.30	**Coffee Break**
14.45	**Research/training possibility of Philippines** **Prof. Alan E. Milano**
14.55	**Research/training possibility of Indonesia** **Assoc. Prof. Dr. Zainal Arifin**
15.05	**Research/training possibility of Lao PDR** **Mr. Saykham Sithavong**
15.15	**Research/training possibility of Malaysia** **Ir Mohd Zaki Mat Amin**
15.25	**Research/training possibility of Vietnam** **Assoc. Prof. Dr. Hoang Minh Tuyen**
15.35	**Research/training possibility of Cambodia** **Dr. Sarann Ly**
15.45	**Discussion on research/training/education of future research proposals (i.e. satellite application and WEF Nexus)**
16.00	**Conclusions**
16.10 – 16.30	Closing Ceremony (Joint closing ceremony for the THA2017 and ASEAN Forum)
18.00	**Farewell Party Dinner** (For foreign and invited guests)


CAR PARK
SMOKING AREA
LE LOTUS 2
207m²
LE LOTUS 1
DOWN
UP
KRISANA
RACHA VADEE
BUSINESS CENTER & CONVENTION OFFICE
SAK THONG
JAM JUREE
ELEV.
LOADING ELEV.
Registration Desk
SALON B
LE CONCORE BALLROOM
SALON A
SCALE 1:500
Key of Symbols
Elevator
Fire Exit
Telephone
Men Toilet
Women Toilet
Conference Venue Plan
THA 2017
25-26 January 2017,
2nd floor, Swissôtel Le Concorde,
Bangkok, Thailand

Opening Speech

Prof. Dr. BundhitEua-arporn

President of Chulalongkorn University

Dear Prof. Emeritus Khunying Suchada Kiranandana, the Chairman of the University Council; ASEAN secretariat delegate; the Director UNESCO Asia and Pacific Regional Bureau for Education; the chairman of the THA 2017 International Conference on Water Management and Climate Change Towards Asia's Water-Energy-Food Nexus; Regional Water Management Officer, FAO Regional Office for Asia and the Pacific; Secretary-General, Office of the National Economic and Social Development Board (NESDB), Thailand, management from water institutions, faculties from universities in ASEAN and in neighboring region and all honorable guests.

I, Prof. Dr. Bundhit Eua-arporn, the President of Chulalongkorn University would like to report on the background of the THA2017 International Conference as follows:

There has been the higher frequency of water disasters and water shortage in Asian region including Thailand over recent years. Each country has attempted to deal with the problems using various means depending on physical characteristics, economic and social conditions in the area. To address water-related problems at an international level, the dimensions of economy, society and environment must be taken into account together at the same time. Moreover, the dimensions of water, food and energy must also be considered as they are interconnected. Recently, the issue of climate change and WEF Nexus has become a crucial factor which needs to be integrated into planning to achieve sustainability. A forum for exchange knowledge, information and experience in planning is therefore important.

The THA International Conference was first initiated in 2015 under the theme of Climate Change and Water & Environment Management in Monsoon Area. The THA 2015 international conference was successful according to the main objective of serving as the public assembly. There were three keynote speakers, 268 Thai participants, 83 foreign participants from 15 countries. The ASEAN Academic network was formally formed. A hands-on technical training about “Satellite-based Rainfall (PERSIANN) for Planning and Management for Natural Disasters in Monsoon Asia” was conducted.

This year, 2017, Chulalongkorn University will celebrate its 100th anniversary of founding, we, in association with 8 national and 16 international collaborative agencies organize the THA 2017 International Conference on Water Management and Climate Change Towards Asia's Water-Energy-Food (WEF) Nexus during January 25-27, 2017. This conference serves as a public forum for researchers, scientists, practitioners and policy makers to present their research findings, share knowledge, experience and perspective, update new progress of relevance to the issue of disaster, irrigation and water management. The conference pays particular attention to developing the skills and ability to address the problems of climate change and WEF Nexus.

The conference consists mainly of five parts including oral presentation, poster exhibition, special training, and study tour. The presentations are categorized into four main themes including 1) Climate Change and Uncertainty in Hydrology and Meteorology, 2) Participatory Management for Water and Irrigation Project, 3) Emerging Technologies in Water Management and Environment Towards W-E-F Nexus, 4) Disaster Management/ Groundwater Management.

The THA 2017 International Conference is running in parallel to the workshop on ASEAN Academic Networking. This is to provide an opportunity for the management and Thai scholars to exchange knowledge and experience and prepare for the establishment of the ASEAN Academic Network which aims to promote collaboration in research and education in ASEAN that can be extended to other countries in the future.

The THA 2017 International Conference is therefore:

1) gathering scholars and combining the knowledge of climate and water and disaster management together to be able to identify the problem in a holistic manner through the view of planners, practitioners and academic researchers
2) gathering the management at DG level from ASEAN countries and Thailand to exchange perspectives on planning, addressing water problems and to propose key areas of future collaborative research to cope with global climate change and WEF Nexus issues especially in ASEAN region
3) providing an opportunity to meet distinguished scholars coming from ASEAN and international to exchange research concept and research findings as well as to seek for collaborative support for the establishment of the ASEAN Academic Network from countries outside ASEAN in the future.

The THA 2017 International Conference has received kind cooperation from a number of international organization for example, UNESCO; DHI, Denmark; ICHARM Japan; PAWEES, Japan; Kyoto University, Japan, National Taiwan University; Chungnam National University, Korea; K-Water, Korea; NCKU, Taiwan; and University of California – Irvine.

I hope that all participants of the THA 2017 International Conference will gain more knowledge and innovations regarding climate change, water and environmental resources management, water disaster management, new technology and operation of basin organization from the presentations given by scholars and experts from several countries in different regions of the world. This is believed to lead to the creation of a network for academic and professional research as well as cordial collaboration in this region.

Now it is good timing, I would like to open the THA 2017 International Conference and hope that the conference will proceed smoothly towards the objectives set.

Congratulation Speech

Dr. Gwang-Jo Kim

Director, UNESCO Asia and Pacific Regional Bureau for Education (UNESCO Bangkok)

Prof. Emeritus Khunying Suchada Kiranandana, Chairman of University Council

Prof. Bundhit Eua-arporn, President of Chulalongkorn University

Distinguished Guests,

Ladies and Gentleman,

It is my pleasure to join you for the opening of the 2017 Thailand Hydrologists Association International Conference. I'm pleased to note that that this international conference is being jointly organised by Chulalongkorn University, as part of its centenary celebration.

The Taoist Chuang-Tzu once said, "Water is the blood of the Earth, and flows through its muscles and veins."

And, indeed, it is the desire to keep that lifeblood strong – to ensure its flow sustains us now and for generations to come – that brings us here today. We are here to discuss issues of critical importance to the survival of our countries, this region and our planet – specifically the impacts of climate change and other pressing challenges on Asia's water-energy-food nexus.

Before we discuss the other sectors of this nexus, let's focus first on water. Freshwater is central to all aspects of life – from economic development to human health and sustainability and it cuts across all of UNESCO's fields of competence. Water – and the lack of it – is not simply an issue for innovative technology and science to address. The implications are far broader. It is about social equity and justice. It is about gender equality. It is about lasting peace and sustainable development.

Freshwater has been a priority for UNESCO since the Millennium Summit and the Millennium Development Goals, which focused in part on improving access to clean drinking water and basic sanitation. We worked towards those aims and have now refocused and renewed our efforts around the 2030 Agenda for Sustainable Development and specifically Goal 6: Ensure availability and sustainable management of water and sanitation for all. We pursue this important goal in concert with what we might call the UNESCO Water Family, comprising:

- our flagship International Hydrological Programme;
- the network of 26 water-related centres under UNESCO's auspices;

- the World Water Assessment Programme, the flagship UN-Water programme that brings together 30 UN agencies and produces the now-yearly World Water Development Reports;
- and the 39 water-related UNESCO Chairs and UNITWIN network, including the latest one at Chulalongkorn University on Water, Disaster Management and Climate Change.

The stakes are high. Freshwater is limited, unevenly distributed, poorly managed and under severe pressure.

Billions of people remain vulnerable to water scarcity, deterioration of water quality and water-related disasters, such as floods and droughts.

Water security is essential to sustainable development and vital to building inclusive, peaceful societies. This is UNESCO's position, and it is reflected in the strategic plan developed for the 8th Phase of the International Hydrological Programme on Water Security, which responds to local, regional, and global challenges.

This plan highlights six knowledge areas – water-related disasters, groundwater, water scarcity and water quality, water for human settlements, ecohydrology, and water education – each of which is critical for water security.

Ladies and Gentlemen,

The water-energy-food nexus, the main theme of this conference, offers a way of looking at our modern resource challenges that reframes these issues to emphasize their interconnectedness. It is a holistic concept and one that, if properly understood, can help societies around the world deliver on the SDGs.

The nexus is a forward-thinking way to identify pathways to a sustainable future. Water is essential to the nexus and it plays a primary role in climate change. The impacts of climate change are typically expressed through the water cycle, leading to undesirable outcomes, ranging from flooding to crop failure to climate migration.

Geopolitical tensions have the potential to pose grave threats to water security, although at present there are more examples of water scarcity leading to cooperation rather than conflict.

The close links between the different sectors of the water-energy-food nexus are also apparent – hydropower dams, for example, manage both water supply and generate electricity. The nexus indicates that a holistic approach is essential to a deeper understanding of the challenges ahead.

The need for an integrated and participatory approach focused on the water-energy-food nexus is essential to achieving the SDGs.

Policy-makers who want to address the water-energy-food nexus in a forward-looking and effective manner tend to approach these issues in a horizontal manner, with a mandate to develop a broader cross-cutting vision.

Ladies and Gentlemen,

Our efforts to expand our knowledge in these crucial areas and deepen and localize our focus takes a major step forward today. UNESCO and Chulalongkorn University would like to take this opportunity to launch the UNESCO Chair in Water, Disaster Management and Climate Change, which we have agreed to establish at Chulalongkorn University's Faculty of Engineering.

On behalf of UNESCO, I would like to congratulate Prof. Bundhit Eua-arporn, President of Chulalongkorn University, on the establishment of the new UNESCO Chair.

Prior to the establishment of the UNESCO Chair Programme in 1992, our organization ran a fellowship programme, and while it did facilitate technology transfer from developed to developing countries, some weaknesses were apparent. For example, the direct beneficiaries were few in number; costs were high and there was a risk of a brain-drain occurring.

Developing countries pointed out these weaknesses, which led to the establishment of the UNESCO Chair Programme. Under this unique programme, eminent specialists and professors are appointed UNESCO Chair at universities or institutions of higher education in developing countries. This approach means that more people can benefit from their shared expertise, and the risk of a brain drain is significantly lessened.

The UNESCO Chairs and UNITWIN Networks serve as think tanks and bridge-builders between academia, civil society and local communities as well as between research and policy-making.

They have proven useful in informing policy decisions, establishing new teaching initiatives, spurring innovation through research and enriching existing university programmes, while promoting cultural diversity.

In areas suffering from a dearth of expertise, these Chairs and Networks have become touchstones of excellence and innovation at the regional and sub-regional levels. They have also strengthened North-South-South cooperation.

This programme has attracted significant interest from developing countries, universities and donors. The UNESCO Chair Programme currently involves over 700 institutions in 128 countries.

The current UNESCO Chair on Water, Disaster Management and Climate Change hosted by Chulalongkorn University realizes the importance of collaboration on water and disaster management among ASEAN countries. To that end, UNESCO partnered with Chulalongkorn University to organize the first workshop on ASEAN Academic Networking in Water, Disaster Management and Climate Change in 2014 and the 2nd technical workshop in 2015. These initiatives brought academics from ASEAN countries together to promote and support collaborative research, discuss new technologies as well as share methods of preparation, warning and adaptation related to water and disaster management and climate change. This UNESCO Chair will serve as a platform for disseminating and sharing knowledge of water and disaster management and climate change in achieving related SDGs.

Under the auspices of the UNESCO Chair, Chulalongkorn formed the ASEAN Academic Network, inviting faculty members and researchers from ASEAN Universities and policymakers to share knowledge and experiences at the regional level. Joint research to address water-related disaster threats faced by several ASEAN member states – such as floods, droughts, and landslides – can improve the efficiency of resource utilization due to pooled resources. Such a collaboration can mean tremendous savings for countries thanks to reduced redundancies in infrastructure investment, technology and personnel. Technology transfer costs will also be reduced due to economies of scale across ASEAN countries.

Parallel to this conference, UNESCO and the UNESCO Chair are jointly organising the ASEAN Technical Workshop on the Satellite-based Rainfall Adjustment and Drought Monitoring System under UNESCO-IHP-GWADI, a global initiative with University of California, Irvine.

Experts from the Center for Hydrometeorology & Remote Sensing (CHRS), at the University of California Irvine, will provide hands-on training to experts from ASEAN on the use of PERSIANN – Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks. This system, which was developed at the University of California, Irvine's Center for Hydrometeorology & Remote Sensing (CHRS), is used to monitor and estimate precipitation through satellites, and is a contribution to the UNESCO-IHP-GWADI initiative.

The workshop brings together academics, scientists, policy-makers and researchers to share information and learn about the potential benefits of satellite-based rainfall applications in their countries.

Going forward, UNESCO expects the UNESCO Chair at Chulalongkorn to play an important role in facilitating technical knowledge dissemination within ASEAN as well as to enhance north-south partnerships in technology transfer.

The Chinese philosopher Lao Tzu once said: "The highest form of goodness is like water. Water knows how to benefit all things without striving with them." The partnerships that we aim to foster and strengthen here and the knowledge we share aspire to this ideal – to protecting and preserving water's life-giving benefits.

I wish the UNESCO Chair great success in advancing this mission and I hope you all a fruitful discussion over the next three days on the critical issues before you.

Thank you.

Opening Remarks

Prof. Emeritus Khunying Suchada Kiranandana

Chairman of the University Council

Distinguished delegates, ladies and gentlemen, it is my great pleasure to welcome you all to the THA 2017 International Conference on Water Management and Climate Change Towards Asia's Water-Energy-Food Nexus and the ASEAN Academic workshop which are organised by Chulalongkorn University, in association with 8 national and 16 international collaborative agencies. This event provides a forum for water planners and water professionals in academia coming from a number of countries including Thailand, other ASEAN countries, countries in ASIA, and USA to present academic findings, exchange knowledge and experience in water and disaster management to increase preparedness and capability to cope with climate change and Water-Energy-Food Nexus issues which are likely to be more intense. I have a great honour to attend the THA International Conference and the ASEAN Workshop today. I would like to take this opportunity to provide you information and philosphy of water management in Thailand that are applied to the royal projects. This could probably be of beneficial to encouraging collaboration on water, disaster management and climate change within the ASEAN region which could be extended to other regions in the foreseeing future.

Thailand has adopted the Philosophy of Sufficiency Economy into developing the 8th-10th (1997-2011) Economic and Social Development Plans.The Philosophy of Sufficiency Economy has been adapted to be used at various scales ranging from household, community and national as a whole. It has been well proved to increase resilience to a rapid change in climate between 2012 to 2016. The Philosophy of Sufficiency Economy in combination with knowledge, science, technology innovation and creativity are critical components to attain sustainable development and stability.

The philosophy of water resources management initiated by the late King Bhumibol Adulyadej focuses on the development for solving water problems in the country by considering infrastructure and management simultaneously. Also, His Majesty King Bhumibol attempted to address the problems of agriculture and soil. Examples of the royal projects area project for improving soil acidity (Klang Din), new theory agriculture and organic farming. His Majesty King Bhumibol established a cooperative system, SufficiencyEconomy and Suwannachart retail shop for the development of community. To improve education and literacy of Thai residents, His Majesty King Bhumibol established an education centre demonstrating how to deal with the problems of forest, soil and water. Distance learning is also used to disseminate knowledge to rural areas to increase the resistance and resilience of the local residents to various kinds of risks including land slide, flood and drought and to solve the problem of poverty directly at the community level.
The royal projects are undertaken based on the philosophy of His Majesty King Bhumibol covering three dimensions of conceptual principle, framework and technology.

Conceptual principle refers to self-reliance, comprehensive thinking and integrating, using natural means as solutions to natural problems. Everything has its own value and no waste. Solutions to the problems must be designed to comply with the surrounding context of the area and lead to sustainability. Also, there must not be unfavourable effects on other people. Solutions must be turned into actions for real demonstration.
Framework means the use of information, work diagram, mind map, integration of information and work diagram into actual site where the problem occurs, network of operation, experiment, monitoring, evaluation and extension of the results.
Technology includes handheld transceiver, computer, internet, GIS map, GPS, data from satellite, radar and tele-gauges. Appropriate technologies for specific site must be selected.

Examples of the royal projects that have been implemented are: the Rainmaking Project to expedite rainfall in the desired areas; the monitoring of storm data for the use of reservoir management; the application of satellite data for flood monitoring; using natural pond for waste water treatment such as the LaemPhakBia Project

Each royal project has adopted and applied the philosophy of Sufficiency Economy initiated by His Majesty King Bhumibol into resources management leading to sustainable development and improved shelter from future climate change.

I sincerely hope that water management under the philosophy of Sufficiency Economy initiated by His Majesty King Bhumibol as mentioned above will be beneficial to you as it provides information for discussion session on preparedness for climate change. Also it encourages further academic collaboration within the region which can subsequently be extended to other regions.

Now it is good timing to open our International Conference and ASEAN Workshop. I wish that the International conference and ASEAN Workshop proceed smoothly and achieve the desired objectives.

Session A

Climate Change and Uncertainty in Hydrology and Meteorology

INVITED PAPER A

PROJECTED CHANGES IN MEAN PRECIPITATION, TEMPERATURE AND EXTREMES OVER SOUTHEAST ASIA REGION BASED ON THE MULTI-MODEL SIMULATIONS OF SEACLID/CORDEX SOUTHEAST ASIA.

Fredolin Tangang

The Southeast Asia (SEA) region is one of the most vulnerable regions to climatic changes especially extreme weather events and sea level rise. However, gaps remain in understanding how climate change affects the region due to lack of robust regional climate change information (IPCC AR5 WGII). For sustainability and climate resilience, countries in the region need to implement evidence-based adaptation and mitigation measures, which require high-resolution regional climate change scenarios. Under the framework of WCRP Coordinated Regional Climate Downscaling Experiment (CORDEX, http://www.cordex.org/), Southeast Asia Regional Climate Downscaling (SEACLID)/CORDEX SEA has been established (2013-2017) and funded by the Asia-Pacific Network for Global Research (APN) to provide multi-model regional climate information (http://www.ukm.edu.my/seaclid-cordex). More than ten CMIP5 Global Climate Models (GCMs) have been successfully downscaled to 25 km resolution over the CORDEX SEA domain based on the collaboration of 18 institutions from 14 countries (Malaysia, Thailand, Vietnam, Indonesia, Philippines, Cambodia, Lao PDR, Australia, South Korea, UK, Sweden, Germany, Hong Kong, and Japan).This paper summarizes plenary findings on projected future changes based on these simulations. The magnitudes of projected temperature change depend on the emission. For RCP8.5, the projected mean temperature surface temperatures over the Southeast Asia region 0.56°C, 1.38°C, and 2.90°C, for near term, middle and end of the 21st century, respectively. Slightly lower projected means for the RCP4.5. For both RCP4.5 and 8.5 emission scenarios, the projected annual on-land rainfall over Southeast Asia consistently shows ~10 – ~15% drier than the current climate by end of the 21st century. The projections show some regional and seasonal variations. However, in all seasons, the Southeast Asia region appears to be heading for relatively drier condition. The drying tendency is also clearly projected from indicator of duration of extreme i.e. consecutive dry days (CDD) and the number of rainy days (WETDAYS). In the near-future, CDD is projected increase by 10% (10-20%) for RCP4.5 (RCP8.5) whereas in the end-of-century models simulate a change of 30-50% (>40%) for RCP4.5 (RCP8.5). In contrast, a tendency of wetting is identified from frequency indicators i.e. the R20mm and R50mm indices. The area north of equator show a signal of increasing of R20mm and R50mm for all time period (near, mid and end-of-century). In south of equator, these frequency indices tend to decrease in near-future but increase in mid and end-of-century. Also projected to increase is the annual maxima of daily rainfall (RX1day) and daily rainfall intenisty with 10 year return period (RV10yr). In general, we found that the annual rainfall is projected to decrease but dry spell and daily extreme intensity and frequency are projected to increase. The signals of both drying and wetting are more obvious in the end-of-century especially for RCP8.5. These findings suggest an intensification of both dry and wet episod over the region in future unmitigated climate.In this presentation, model performances, biases, uncertainty issues will also be discussed. Overall, SEACLID/CORDEX Southeast Asia does not only provide basic regional climate change information for the Southeast Asia region but also other required variables for Impact Vulberability Assessment (IAV) community. The simulation outputs from SEACLID/CORDEX Southeast Asia will be desimminated through the SEACLID/CORDEX Southeast Asia Earth System Grid Frederation (ESGF) Node which is generously hosted by the Ramkhamaheng University Center for Regional Climate Change and Renewable Energy (RU-CORE).

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PAPER ID: TA002

PROBABILISTIC FLOOD FORECASTING USING ENSEMBLE NUMERICAL WEATHER PREDICTION RAINFALLS DURING THE 2011 LARGEST FLOOD EVENT IN JAPAN

Wansik YU[1, a *], Kwansue JUNG[2,b]

In early September, 2011, local heavy rainfalls due to season's 12th typhoon, "Talas" caused large flooding and enormous landslide disasters over the Kinki, Chugoku, Shikoku, and Tokai regions in Japan. It also caused unprecedented human damages, resulting in 78 dead and 16 missing persons. In these types of extreme events, it is essential to be able to provide as much advance warning as possible. This advance warning requires both quantitative precipitation forecasting (QPF) and quantitative flood forecasting (QFF). Ensemble flood forecasting driven by ensemble NWP rainfall provides additional information to the deterministic flood forecast in the short forecast range (1~2days). Therefore, in this study, we assessed the ensemble NWP rainfall with 2km horizontal resolution and 30hr forecast time whether it can produce suitable rainfall or not during typhoon "TALAS", 2011. We also assessed the ensemble flood forecast based on ensemble NWP rainfall for hydrological application. It can be concluded from the study that ensemble NWP rainfall could improve the forecast accuracy compared with deterministic forecast in terms of quantitative precipitation forecast. Ensemble flood forecast driven by ensemble rainfall forecasts also could produce comparable results in comparison of observed data, even the maximum peak discharge value among ensemble was underestimated. For the improvement of this underestimation, we tried to utilize the spatial shift of NWP rainfall fields. Later, we also need to examine a variety of case studies of typhoon event in order to assess the performance of ensemble flood forecasts.

Keywords: Typhoon Talas, Ensemble NWP rainfall, Ensemble Hydrological Forecasting

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PAPER ID: TA003

RIVER DISCHARGE AND RESERVOIR OPERATION ASSESSMENT UNDER A CHANGING CLIMATE AT THE SIRIKIT RESERVOIR

MANEE Donpapob, [a *], TACHIKAWA Yasuto [2,b], ICHIKAWA Yutaka [3,c] and YOROZU Kazuaki[4,d]

The large scale reservoir plays an important role in modern water resources management by regulating the water to address severe flood and drought problems. Therefore, the proper planning of water resource availability based on uncertainty climate change impact is very necessary. The objective of this study is to evaluate the changes of water storage and outflow based on present and past operation with the different future reservoir inflow data by using Atmospheric General Circulation model (MRI-AGCM3.2S) forcing data which is jointly developed by Meteorological Research Institute of Japan and Japan Meteorological Agency. For each 20-km grid cell, the surface runoff generation of MRI-AGCM3.2S was used to simulated river discharge at the Sirikit reservoir by a distributed flow routing model (1K-FRM) based on the kinematic wave theory. In this study, distribution mapping methods are applied to raw daily river discharge simulated data for remove systematic bias between model and observed daTA After bias correction to daily discharge achievement, the future corrected reservoir inflow of different scenarios were given to reservoir operation model algorithms and using the Artificial Neural network (ANN) for calculation the future release flow and reservoir storage based on remain the downstream water requirement and amount of water losses in this reservoir same as present climate condition. The evaluation of future reservoir operation based on present rule curve will show the necessary decision way to revise or improve current operation to adapt to probably water resources availability.

Keywords: Artificial Neural Network, Flow Routing Model, Atmospheric General Circulation Model, Bias Correction

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PAPER ID: TA004

DETERMINATION OF EXTREME DESIGN WAVES UNDER CLIMATE CHANGE IN THE GULF OF THAILAND

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Chatlada Sriumpoldech[1,e] and Weerasinghe L.K.K[1,f]**

A number of studies showed that wave climate have been effected spatially from climate change in a global scale. Present study analyzes the extreme wave characteristics in a regional scale covering the Gulf of Thailand (GoT) and extended to Cambodia, Vietnam and Malaysia. Climate data from present days to future are NCEP, ECHAM 5 and GFDL CM2.1 under A2 scenario with 20 years' time window. There are six wave parameters have been computed and evaluated i.e. storm duration, storm frequency, mean intensity of significant wave height of 1% highest wave, wave height at 99th percentile, wave directions and design wave height. The designed wave height corresponding to 2 to 100 years return period was calculated based on Generalized Extreme Value Distribution, in serving structures design. Mike 21 SW is used as an analysis tool for wave generation and their propagation. Model calibration and validation are conducted with good results. It is found that the general trend of design wave height increase at every locations from near future to far future climate, especially the locations in Vietnam and Malaysia. The designed significant wave height results indicate an increase trend less than 3% for stations in the upper gulf and 17% over all stations in the lower gulf. Outside GoT, it is remarkably increase to 33%. This is because the upper gulf planform is confined while the lower gulf configuration is in the open sea area which is more exposed to tropical monsoon from South China Sea. Two GCMs perform comparable results of wave height and wave direction. The average intensity of extreme events is getting higher from 1 to 4 storms per year to 2 to 5 storms per year at most in the far future. Also, the mean storm duration becomes longer from 10 hours to 14 hours in the future at half of locations. Wave directions have locally changed. The trend of wave direction is slightly shifted to Northeast in the far future with less number of waves from west direction. Climate change has influenced to wave parameters from the lower gulf of Thailand extended to Malaysia. Increment of design significant wave heights under future extreme climate in regional scale to present waves are provided with 20 and 50 years return periods which can be used to examine the robustness of coastal infrastructures further.

Keywords: Extreme wave, Design wave, Gulf of Thailand, Climate change

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PAPER ID: TA005

ANALYSIS OF FARMERS' CHOICE OF ADAPTATIONS TO CLIMATE CHANGE AT NONG SUA DISTRICT, RANGSIT CANAL, THAILAND

Ashraf Sheikh Zeeshan [1, a], Sutat Weesakul [2,b*] ,
Nalinrat Kalampabut [3,c] and Sanidda Tiewtoy [4,d]

The study investigated the farmer's perception towards climate change and examines that how farmers perceived trends in climatic parameters recorded at meteorological stations. The surveyed data from questionnaires are collected in 2015 to 16 at farm level for 208 households with 95 percent confident levels consisting of the farmer's households belonging to two sub districts i.e Bung Cham Aor (BCA) and Sala Kru (SLK) sub districts, Nong Sua district, Pathumthani, Thailand. Average temperature is increased with increased number of hot days and reduced number of cold days with 66% to 76 % respondents. Annual rainfall, rainfall duration and its frequency are decreased with 69% respondents while length of dry period is extended with 75 % respondents. It shows that short memory in recent severe climate which strongly affect their productivity has influenced their perceiving for long term climate change. In total, 71% of farmers in study area adapt to climate change. Farmers prefer agricultural adaption as the most selected choice with 69 % compared to financial, technology and external adaptations. This study also identified the major agricultural adaptations used by the farmers. Changing in sowing and planting date, use of fertilizer and pest management practice, and change in cropping pattern are the most fours adaptations that local farmers practically used in the field. Independent factors affecting the choice of agricultural adaptations are identified using multivariate probit model for discrete choice at farm level. It is confirmed that experience, farm size, income, climate information and noticing climate change are the four important ascending factors affecting the farmer's choice to farm-level adaptation. Income represents wealth which is normal hypothesized to adopt agricultural technologies requiring sufficient financial support.

Levels of satisfaction are also evaluated, it is clearly shown that BCA has significant satisfactory than SLK sub districts with average score 3.60 compared to 2.82 for income and agricultural yield aspects. This is because the development of community water resources management at Bung Cham Aor to plan and use effectively available water. Using science and technology approach with strong participation from community, farmers can learn to use data and develop their own system for water management for climate adaptation and enhance the level of satisfaction.

Keywords: Farmer perception, agricultural adaptation, multivariate probit mode, community water resources management

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PAPER ID: TA006

CHANGE OF THE PROBABILITY DISTRIBUTION OF ANNUAL MAXIMUM RIVER DISCHARGE DERIVED FROM THE D4PDF DATASETS AT THE INDOCHINESE PENINSULA

Patinya HANITTINAN[1 *], Yasuto TACHIKAWA[2],
Yutaka ICHIKAWA[3] and Kazuaki YOROZU[4]

This study investigates the differences in the probability distribution function of the future annual maximum river discharges (2051-2110) at the Indochinese Peninsula derived from the new climate datasets – database for Policy Decision making for future climate change (d4PDF). First, daily river discharge of the future period was simulated using the kinematic wave flow routing model, 1K-FRM. Based on this analysis, we combined fifteen 60-member ensembles separately for six different sea surface temperature (SST) patterns, which allows us to examine the statistical significant of the difference between the probability distribution. Then, we applied a non-parametric, two-sample Kolmogorov-Smirnov (K-S) test to the annual maximum river discharge produced by SST patterns in 15 groups. Finally, the results of each case indicate that the differences in probability distribution of the annual maximum discharges are statistically significant for the majority of the Indochinese Peninsula, except parts of the Mekong delta and southern Peninsula in Thailand. The implication of this finding should help underpin the case to merge the datasets from different SST patterns and fully utilize it in frequency analysis of extremely large datasets for a more credible hydrologic impact assessment.

Keywords: Climate change, Indochinese Peninsula, d4PDF, Kolmogorov-Smirnov test, 1K-FRM, Annual maximum daily discharge

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PAPER ID: TA008

EFFECT OF LAND COVER CHANGE TO ANNUAL SEDIMENTATION IN NAN BASIN, THAILAND

Pakoksung Kwanchai[1*] and Takagi Masataka[2]

Land cover changes are the key points of the effect of sediment as same as erosion over the watersheds area. The sediment or erosion may one cause of flood and drought situation. This study aims to determine the effect of land cover change to sediment volume in annual. The changes of land cover in the Nan river basin, Thailand are based on the satellite remote sensing product as the MODIS land cover dataset. The sediment data from 2001 to 2013 was used to identify the erosion modeling with rainfall, topography and land cover types. Universal Soil Loss Equation (USLE) model was used to estimate the erosion of soil between different land cover map (2001 and 2013). Result presented that the forestation area of the study area was decreased rapidly from 12,620 km^2 in 2001 to 9,415 km^2 in 2013 (about 25% decreasing), but the developing area was increased immediately from 3,190 km^2 in 2001 to 3,285 km^2 in 2013 (about 20.8% increasing). From decreasing of forestation area and increasing of developing area, the average soil erosion potential was increased from 29.94 ton/year in 2001 to 44.27 ton/year in 2013 (about 47.8% increasing). This study can be used to reveal the effect of land cover change for awareness of loss on a forestation.

Keywords: Land cover change, Soil erosion Models, MODIS, Nan basin, USLE

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PAPER ID: TA009

COMPARISON OF THE SPATIAL RAINFALL IN KHUN DAN PRAKAN CHON RESERVOIR BY SPATIAL INTERPOLATION TECHNIQUES

**Peerapong Rattanaburi[1, a *], Lerdphan Sukyirun[2,b]
and Wisuwat Taesombat, D.Eng. [3,c]**

Comparison of the spatial rainfall in Khun Dan Prakan Chon Reservoir by spatial interpolation techniques aims to evaluate spatial interpolation techniques and compare different rainfall interpolation methods to produce spatial rainfall estimates. The interpolation methods used in this study were inverse distance weighting, kriging, Co-Kriging, isohyetal, thiessen polygon and thin plate spline. Daily rainfall data from 21 rain gauges in Khun Dan Prakan Chon Reservoir surrounding point stations were used to estimate rainfall in September, 2008 and 2011. The accuracy of estimations was assessed through basic statistics, such as mean error (ME) and root mean square error (RMSE). Isohyetal has performed the lowest RMSE in Khun Dan Prakan Chon Reservoir and ME has provided positive value that is over-estimated rainfall.

Keywords: Rainfall, Spatail Rainfall, Khun Dan Prakan Chon Reservoir, Kriging, Co-Kriging and Interpolation Rainfall

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PAPER ID: TA011

ASSESSMENT OF SATELLITE RAINFALL ESTIMATES AS A PRE-ANALYSIS FOR WATER ENVIRONMENT ANALYTICAL TOOLS: A CASE STUDY FOR TONLE SAP LAKE IN CAMBODIA

Arun. Chan. Phoeurn[1,a]*, Sarann.Ly[2,b]

source of water supply and food security in Cambodia. However, this area is in the need for rainfall information which can cover the entire area for an accurate hydro-hydraulic modeling and climate modeling. In this case, Satellite Rainfall Estimates (SREs) would play a major role in the improvement of modeling. The study aims to assess the spatio-temporal performance of two high resolution satellite products such as TRMM 3B42V7 and CHIRPS V.2. One-hundred and sixty four (154) stations around the Tonle Sap Lake and Mekong River were selected for the pre-analysis prior input into the models within the study period of 2000 to 2004. After this, proper bias correction method is proposed. To do this, GIS and statistical indicators were used for the comparison.

Both TRMM and CHIRPS provide a good correlation with the gauge. Around 90% of stations have CC varies from 0.5 to 0.9. In addition, the median error of SREs are about 30 mm/month. Both satellite showed very similar pattern of bias spatially and temporally. This can be said that even though TRMM has the lower spatial resolution compared to CHIRPS, the performance of it is quite the same. However, high error for some stations still exist that could be cause due to the seasonal influence, topography, measurement error that need to be taken into account in the process of bias correction.

Keywords: CHIRPS, Hydraulic modeling, Remote sensing, Satellite rainfall estimates, TRMM, Tonle Sap Lake

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PAPER ID: TA014

CLIMATE CHANGE AND LANDSLIDE RISK ASSESSMENT IN UTTARADIT PROVINCE

Shotiros Protong

The incidents of sudden landslides in Thailand during the past decade have occurred frequently and more severely. It is necessary to focus on the principal parameters used for analysis such as land cover/land use, rainfall values, characteristic of soil and digital elevation model (DEM). The combination of intense rainfall and severe monsoons is increasing due to global climate change. Landslide occurrences rapidly increase during intense rainfall especially in the rainy season in Thailand which usually starts around mid-May and ends in the middle of October. The rain-triggered landslide hazard analysis is the focus of this research.

The combination of geotechnical and hydrological data is used to determine permeability, conductivity, bedding orientation, overburden and presence of loose blocks. The regional landslide hazard mapping is developed using the Slope Stability Index SINMAP model supported on Arc GIS software version 10.1.

Geological and land use data are used to define the probability of landslide occurrences in terms of geotechnical daTA The geological data can indicate the shear strength and the angle of friction values for soils above given rock types, which leads to the general applicability of the approach for landslide hazard analysis. In terms of hydrological data, the millimetres/twenty-four hours of average rainfall data are used to assess the rain triggered landslide hazard analysis in slope stability mapping. The period 1954-2012 is used for the baseline of rainfall data for calibration of present-day conditions. Future climate scenarios are simulated by spatial and temporal scales. The precipitation trends are needed to predict the future climate. The Statistical Downscaling Model (SDSM) version 4.2, is used to assess the simulation scenario of future change for latitudes 16 o 26' and 18o 37' and between longitude 98 o 52' and 103 o 05'; the study area is Uttaradit province, northern Thailand. The landslide hazard mapping will be compared and shown by areas (km2) in both the present and the future under climate simulation scenarios A2 and B2 in Uttaradit province. The risk areas should be preserved for land use planning in order to reduce the high risk in hilly and mountainous terrain.

PAPER ID: TA015

ASSESSMENT OF AN URBAN DRAINAGE SYSTEM IN PHNOM PENH USING STORM WATER MANAGEMENT MODEL

Sokchhay Heng[1*], Penghour Hong[2] and Sarann Ly[3]

The current climate change issue, commonly introducing more intense rainfall within a short time, together with a rapid population growth in Phnom Penh, the capital of Cambodia, have posed an accumulative stress on city drainage system. This study investigates the current capacity of sewage network with a diameter ranging from 0.8 to 2.0 m in a catchment of Chamkarmon district covering an area of about 1 km^2. Storm Water Management Model was selected to simulate the catchment runoff flowing into the drainage system. A questionnaire survey was carried out to determine the historical inundation situations. Such information is useful in judging the model performance. The study area was divided into 11 sub-catchments. The simulation was conducted for an extreme storm event occurring on 28 September 2014 with an intensity of 109.8 mm over a four-hour and a half period. Nine of 11 sub-catchments were found inundated and this result is similar to that obtained from the questionnaire survey. Four sub-catchments were inundated severely for a duration of 1.5–3.0 h. Two scenarios were proposed to improve the inundation conditions. Adding two new sewage lines in the downstream area was found as the optimum solution. It significantly reduces the inundation period of the severe sub-catchments to 0.63–2.95 h. The maximum overflow surcharge was also reduced relatively, from 3.18–7.08 m^3/s to 1.55–6.40 m^3/s. This modelling approach provides a sustainable solution to urban drainage management in Phnom Penh.

Keywords: Urban flood, urban drainage, SWMM

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PAPER ID: TA016

DEVELOPMENT OF DESIGN STORM PATTERN WITH CLIMATE CHANGE IN MONSOON ASIA

Muhammad Mudassar Rehan[1, a *], Sutat Weesakul [2,b], Winai Chaowiwat [3,c] and Wiwat Charoensukrungruang[4,d]

General characteristics of rainfall in Asian monsoon climate have been studied and synthetic design storm pattern have been developed including climate change using field investigation data at Asian Institute of Technology (AIT). Recorded period of rainfall is 22 years from 1990 to 2007 and 2009 to 2012 with 5 minutes interval. Total numbers of selected storms are more than 600. Temporal distribution of rainfall in one day have been derived and it shows one peak at 18:00 to 20:00 contribute to 27 % of average temporal rainfall in one day. Recorded storm data have been extracted for 2, 5 and 10 years return period and used as data to derive a storm pattern. There are totally 49 storms ranging from 35 to 585 minutes. Criteria to select the appropriate storm pattern for the good fit compared to those selected one are the shape, peak intensity and time to peak. Among triangular shape, complex trapezoidal shape and a curved shape, the Chicago Design Storm (CDS) is found to be the best fit with proposed modified peak rainfall intensities by reduction to 5 and 10 minutes intensities. Results showed reduced absolute percentage errors are from 57% to 32% and 21 % respectively. This is a remarkably improve the peak intensity design. To take into account effect of climate change to design storm, the Equidistance Quantile-Matching method (EQM) is applied to modified IDF curve and their related parameters which is used in expression of a new storm pattern. Climate change is then reflecting in design rainfall pattern and shows intensity increasing 24% at most.

Keywords: Synthetic storm pattern, Chicago design storm (CDS), Climate change and intensity-duration-frequency curve (IDF)

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PAPER ID: TA017

CORRELATION ANALYSIS BETWEEN TSENGWEN-WUSHANTOU RESERVOIRS OPERATION AND ENVIRONMENTAL FACTORS

Yi-Lung Yeh [*], Sheng-Hsien Hsieh and Teng-Pao Chiu

Zengwen-Wushantou reservoir is the most important water supply system for the Chianan area as well as the irrigation water source of for the Chianan Plain, Taiwan. The water storage amount in the reservoir is affected by inflow and outflow. The inflow is affected by the rainfall amount in the catchment and the outflow is affected by the water evaporation and target water consumptions. This study collected water storage volumes of the reservoir in ten-day intervals from 1990 to 2014. The study also collected rainfall amounts in nine rainfall stations in ten-day intervals; these stations included Zengwen, Shuishan, Leye, Lijia, Biaohu, Matoushan, Longmei, Sanjiaonanshan, and Dadongshan. In addition, four target water consumption amounts were collected in ten-day intervals; these included rice, sugar, industrial, and population water consumption. We used correlation analysis to investigate the relationship between the water storage volumes, rainfall amounts in the rainfall stations, and the four target water consumptions. The dominant factors affecting the reservoir storage were determined by correlation analysis. These selected factors established the relationship between the water storage volumes and the main impact factors using multiple linear regression analysis. The results suggested that the main impact factor on the reservoir storage capacity was the rainfall amount, which has the highest effective rate in the Zengwen station, followed by Dadongshan station.

The major factors that impact water storage were irrigation water for the rice, followed by industrial water. The significance test verified that reservoir storage capacity had a significant relationship with irrigation water for rice, industrial water consumption, and water used for sugar cane. The multiple linear regression of the water storage volumes with the main affecting factors can be determined by the following equation: $y = 177.3823 + 0.1189x_1 + 0.2061x_2 + 0.3275u_1 + 0.3585u_2 + 9.4545u_3 + 0.3665u_4$, in which y is the reservoir storage capacity, x_1 and x_2 are the rainfall amounts in Dadongshan and Zengwen stations, respectively, and u_1, u_2, u_3, and u_4 are the water consumptions for rice irrigation, sugar cane irrigation, industrial water consumption, and the population consumption, respectively.

Keywords: Zengwen-Wushantou reservoir system, environmental key factors, multi- Regression, water resources allocation

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PAPER ID: TA018

SPATIAL HETEROGENEITY AND TRANS-BOUNDARY POLLUTION: A CASE STUDY ON THE 3S RIVER BASIN.

**Nguyen Thi Thuy Tranga[1, a], Sangam Shrestha[2, b],
Manish Shrestha[2, c*], Avishek Datta[2, d],
Akiyuki Kawasaki[3, e]**

We examine the current and the future water quality issues of the 3S (Sekong, Sesan and Srepok) River Basin of Southeast Asia. The 3S River Basin is a transboundary River between Cambodia, Laos and Vietnam and contributes 16% of the total annual flow to the Mekong River. Hydrological model SWAT was used to represent the hydrological process and nutrient loading of the basin. The nutrient loading map of the basin was developed and revels that the highest contribution of the nutrient comes from Vietnam, upstream of Sesan and Srepok Rivers contributing more than 70% of the total nutrient loading. This can be attributed to intensive agriculture and urban areas in Vietnam. Similar results were obtained for the future periods under RCP 4.5 and RCP 8.5 scenarios. Therefore it can be summarized that human activities plays an important role in the occurrence of pollution in the basin and the lower part of the basin suffers from the dense populated upstream rather than pollution from the local source.

Keywords: Climate change, Discharge, Nutrient map, Transboundary, Water quality

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PAPER ID: TA021

CHANGE OF WATER BUDGET BETWEEN 1960'S AND 2000'S AT THE SEASONAL TROPICAL FOREST IN NORTHERN THAILAND

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Lack of the long-term observation data of rainfall and runoff at watershed, especially in tropical rainforests, prevent us from estimating the future influence for the climate change, because it is difficult to separate the degree of influence of long-term change of meteorology and runoff characteristic. We have observed rainfall and runoff at the Kog Ma D seasonal tropical forested watershed, near Chiang Mai, northern Thailand in 2000's and compared them with the previous series of rainfall and runoff observation conducted in 1960's (previous period) by the Kasetsart University researchers. It was revealed that the distributions of very thick topsoil depth make the stable base flow together with the fractured bedrock in this watershed. The stable base flow makes the stable swamp area near the weir. These constant saturated area make the quick runoff while raining. These runoff characteristics are the same among 2000's and previous observation period. Although the annual rainfall decrease in 2000's, the amount of rainfall in the dry season increase slightly. At the same time, annual runoff showed the decrease tendency. The water loss that is calculated by subtracting runoff amount from rainfall showed almost the same among 2000's and previous observation period. We could conclude that the difference of these two observation period can be summarized by the decrease of rainfall and show the commonality of the water loss and runoff characteristics.

Keywords: long-term observation, runoff characteristics, annual rainfall, Kog Ma watershed, water loss

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STOCHASTIC SIMULATION AND FREQUENCY ANALYSIS OF THE CONCURRENT OCCURRENCES OF MULTISITE EXTREME RAINFALLS

Ke-Sheng Cheng

Traditionally, hydrological frequency analyses were independently conducted at individual sites using annual maximum rainfalls. While this approach can provide useful results for site-specific design rainfall depths, it fails to offer insightful information about the return period of the concurrent occurrence of multi-site extreme rainfalls. There have been many evidences that a single major storm can result in annual maximum rainfalls of different durations at several sites, as demonstrated by the Typhoon Morakot in 2009. Thus, spatial correlation of the same-event rainfall depths at different sites plays an essential role in characterizing the concurrent occurrences of multi-site extreme rainfalls. In this study, we propose an innovative approach of multi-site storm rainfalls simulation, aiming to tackle the problem of frequency analysis of multi-site extreme rainfalls. The approach is composed of four major components: (1) delineating homogeneous regions within the study area using K-means cluster analysis, (2) standardizing and modeling the same-event rainfall depths at different sites by a Pearson Type III random field, (3) stochastic simulation of multi-site storm rainfalls using a covariance matrix conversion algorithm, and (4) determining the return periods of concurrent occurrences of multi-site extreme rainfalls. Using historical hourly rainfall records available at 25 rainfall stations in southern Taiwan, site-specific rainfall depths of different durations and return periods of this study were found to be very close to results of a previous study of single-site frequency analysis, indicating good applicability of the proposed approach. Additionally, the return period of four specific sites within the Kao-Ping River Basin (Shan-di-men, Ah-li, Jia-sian and Chi-shan) exceeding 1000 mm rainfalls in a 24-hour period, a scenario similar to rainfalls of Typhoon Morakot, was found to be only 514 years, as oppose to more than 2000 years or even higher by other previous studies.

Keywords: Stochastic simulation, Multi-site extreme rainfalls, Frequency analysis, Semi-variogram modeling, K-means cluster analysis

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CLIMATE EXTREMES, PEOPLE'S PERCEPTION AND ADAPTATION IN LOWER SONGKHRAM RIVER BASIN, THAILAND

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There is a growing concern on the impacts of climate change and climate variability on water resources, agriculture, fisheries, and consequently livelihood of local people in Lower Songkhram River Basin of Thailand. Thus, it is important to examine the people's perceptions on climate change and climate variability and its impact on their livelihood. In addition, this research will help the policy makers to scale up innovative adaptation measures by study the local people adaptation. As a result, the objectives of this study are to analyze the recent and future trend in hydro-climatic and water quality, to examine the level of people's perception of climate change and climate variability at the household level, and study the people adaptation strategies against the climate change impacts on water availability and agriculture production.
The trends of climate data have been calculated by Mann-Kendall test and Sen's slope. In part of precipitation indices, it shows significant trends in six indices from seven indices but different station in recent trend. Mostly, there are significant trends under RCP 8.5during 2055s. For RCP4.5, there are trends only in Sakon Nakhon province. In part of temperature indices, it shows significant trends in some indices in recent trend. For the future trend, mostly have significant trend under RCP 8.5during 2085s. Moreover, there are some trends lightly in another future period. To understanding the rural farming community's perception of climate change impacts on their socio-economic activities and environment, their adaptation at the household level and opinions on government mitigation measures. This study is based on both primary and secondary data collected via a survey of 25households in three villages. The results show that people can perceive the change in rainfall and temperature but they cannot perceive the change in season. In terms of adaptation options, there is government came to give a recommendation to local people about the change of weather and climate, but not every people can get that. Finally, results will show local people perceive climate change acutely and respond to it, based on their own indigenous knowledge and experiences. It is expected that this study will help policy makers to develop more appropriate adaptation policies in Lower Songkhram River Basin.

Keywords: Climate change, RClimdex, Trend Analysis, People's Perception, Adaptation, Lower Songkhram River Basin, Thailand

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PAPER ID: TA026

ASSESSMENT OF WATER RESOURCES DURING THE 21ST CENTURY IN NORTHERN THAILAND WITH FOCUS ON PING RIVER BASIN

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The effects of climate change on the hydrology and water resources of the upper Ping River basin, Thailand are assessed by utilizing the IPCC SRES-climate scenarios during the 21st century from the ECHAM5 and the CCSM3 global climate model (GCM). The hydrologic response of streamflow in the upper Ping River basin to the climate change is performed under A1B, A2 and B1 with total 12 projections. The Watershed Environmental Hydrology-Hydro Climate Model (WEHY-HCM) is used to perform dynamical downscaling from the global atmospheric scale (~200 km) to the regional atmospheric scale over the study basin via the MM5 regional atmospheric model at 9 km grid resolutions and hourly time intervals. The watershed module then couples the atmospheric and the land surface hydrology processes with its physically based model feather, and simulates the watershed flows. The Global Climate Model (GCM)-historical control runs (1971 to 2000) were downscaled, corrected for their bias, and tested for the models' performance by a goodness of fit of model and observed flow via cumulative distribution functions. From the established GCMs' reliability in producing future climate variables, the future hydrologic flows of the study area can be generated and the effects of the climate change can be studied. Based on the ensemble average of 12 realizations, the results (2016-2099) show that toward the end of the 21st century, future projected flows yield a significant upward trend with 95% confidence level. The study basin will have a streamflow increase of 17.3% (6.36 billion m^3) on average, compared to the average flows from 1988 to 2015 (5.24 billion m^3). This key model results show that the projected flows under the future climate change conditions are changing, and this change will directly affect the hydrology and water supply of the upper Ping River basin and the Bhumibol Dam. Thus, the need for newly adjusted water policies and management options must be investigated further in more detail due to the effect of climate change conditions.

Keywords: Climate change, Global Climate Models, Dynamical downscaling, Ping basin, Bhumibol Dam

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Session B

Participatory Management for Water and Irrigation Project

INVITED PAPER B

PRINCIPLES AND METHODS FOR PIM IN ACTION-*IS THE JAPAN'S MODEL EXCEPTIONAL?-*

Dr. Masayoshi Satoh
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Improving water management in irrigation projects is believed to be of urgent importance after so much investment on the projects. One of the effective methods for the improvement is Participatory Irrigation Management (PIM), for which big efforts have been made in the past decades and not seen remarkable successful in the world yet. Development of practical methods for PIM implementation is strongly required. We may get some useful lessons for that from successful cases in the world. Although the cases are limited in number, the Japanese model may be one of them. The question is whether the major reason for the success exists in the local and indigenous conditions or in common principles that are applicable to other localities.

This presentation shows the background conditions of Japanese irrigation, and clarifies that the widely believed reasons for success, 1) 1,800 mm of yearly rainfall making its irrigation less important, 2) the cooperative nature of the Japanese farmers making conflict resolutions easy, are not correct. It also introduces the role-sharing between governments and farmers in large scale irrigation projects, followed by discussion on the Japanese system to encourage the farmers to participate in the projects and to form and manage their WUA (Land Improvement District, LID) under the conditions of conflicts among different local farmers. It concludes that this Japanese model is based on the common principles such as information dissemination, accountability, equity,and transferring decision making power to farmers, thus the governments are successful in involving farmers into the projects and water management to most effectively and efficiently achieve the government objectives.

PAPER ID: TB001

WATER-FOOD NEXUS: WATER USE EFFICIENCY IN CENTRAL ASIA

JUNG Younghun[1*] , LEE Eulrae[2] , CHOI Byungman[3]

The excessive water use of Central Asian countries have brought the environmental disaster in Aral Sea. Two transboundary rivers in Aral Sea basin are main sources of the shared water resources in Central Asian countries. In this regard, they need to improve the efficiency in using the shared water resources to overcome their environmental and economic difficulties. Accordingly, the twin objectives of this study were firstly to analyze the challenges of water resources in the Aral Sea Basin and secondly to estimate the efficiency of agricultural water use according to the crop types and the irrigation methods. The results showed that the economic efficiency of water use in Central Asian countries was lower than other Asian countries. Furthermore, climate change has increased temperature which can induce evapotranspiration and snow- or glacier-melting in the Aral Sea Basin. Finally, this study illustrated that the selection of the crop types and irrigation methods can improve the quantitative and economic efficiency of water use. However it is asked as a necessary preliminary to provide a clear outline of interaction to avoid hierarchy and failure of coordination and collaboration for regional win-win approach. In such outline, this study will deliver valuable information on water efficiency in Aral Sea basin.

Keywords: water-energy-food nexus, climate change, sustainable development, assessment tool

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PAPER ID: TB002

IMPROVING CROP WATER USE WITH THE USE OF EFFICIENT IRRIGATION TECHNOLOGIES AND COCONUT MULCH HUSK: A STUDY ON LONG-BEAN PRODUCTION

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This study investigated the applicability of coconut husk mulch and irrigation techniques for long bean production in Laos. The objectives are to detemine the efficiency of water irrigation techniques and soil moiture content for long bean cultivation. This study use experiments by applying coconut mulch cover and uncover the long bean pilot plots with different dip irrigation techniques. This study also monitored the environment aspects such as temperature, evaporation, precipitation, and groundwater level. The results showed that long bean grew well across different temperature and moisture conditions. The best system of water irrigation was found to be the drip technique with coconut husk in which coconut husk could better absorb water and infill to the soil as nutrients which proved by the crop growth stages. In addtion, the drip system with coconut husk also reduce water quantity as compared to water irrigated to the certain period. This can be said that it is an alternative for farmers to plant cash crop in drought areas affected by climate change by using abundant groundwater resources in the country.

Keywords: cash crop, Long-bean, irrigation, coconut mulch husk.

PAPER ID: TB004

PARTICIPATORY WATER MANAGEMENT IN THE SPECIFIC LOCALE OF SUB-WATERSHED: NEGOTIATION PROCESS AND INSTITUTIONALIZATION.

MAN PUROTAGANON, PhD.[1, a *]

This article will present the application of the framework: 'stakeholders' analysis' which will help understand the complex relationships among water users, and the application of conceptual framework of 'institutionalization' in understanding the cooperation and negotiation processes among multi-stakeholders in water management. Examples will be taken from five sub-watersheds: Upper Loei; Lower Huayluang, Udonthani; Huaysaneng, Surin; Middle reach of Moon River, Roi-et; and Chi, Mun and Khong River, Ubonratchathani.

Keywords: stakeholders' analysis, institutionalization, multi-stakeholders, negotiation process, water management, multi-stakeholders' platform.

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PAPER ID: TB005

WATER QUALITY PROFILES AND THE RESERVOIR UTILIZATION WITH SPECIAL REFERENCES TO JATILUHUR, CIRATA AND SAGULING RESERVOIRS

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Reservoir is one of the unique ecosystems which are functioning in both ecological and economic services. The objective of this study is to analyze the hydrological characteristics represented by Jatiluhur, Cirata and Saguling as cascade reservoirs. Surveys at Jatilhur, Cirata and Saguling reservoirs were conducted on July 2014, March 2015 and September 2015, respectively. Meanwhile, The results on the survey in Jatiluhur, Cirata and Saguling reservoirs showed that the average depths are 32.9 m, 34.9 m and 17.9 m, respectively. Jatiluhur reservoir covers 7,780 ha of area with maximum depth of 90 m. Meanwhile, Cirata reservoir covers approximately 6,200 ha of area with maximum depth of 106 m. In addition, Saguling reservoir covers approximately 4,869 ha of area with maximum depth of 90 m. All of those reservoirs serve as important hydroelectricity power. Next, the percentage value of fish cages at Cirata reservoir was larger (3.95%) than those at Jatiluhur (1.00%) and Saguling (0.70%) reservoirs. It indicated the potential impact from fish cages as pollutant at those reservoirs. In addition, based on water quality profiles (dissolve oxygen/DO, Chl-a and temperature), upwelling caused water quality degradation. In order to maintain the sustainability of the lake, basic ecological information is necessary for the next study.

Keywords: Jatiluhur reservoir, Cirata reservoir, Saguling reservoir, Water quality, Fish cages

PAPER ID: TB006

PROPOSAL OF A RESERVOIR MANAGEMENT METHOD BASED ON THE OBSERVED ACCUMULATED AREAL MEAN RAINFALL FOR THE SIRIKIT RESERVOIR IN THE CHAO PHRAYA RIVER BASIN, THAILAND

Kentaro Dotani[1, a *], Masashi Shimosaka[1, b], Taichi Tebakari[1, c] and Shuichi Kure[1, d]

The Chao Phraya River basin (CPRB) in Thailand has been confronted with serious drought situation since 2012. Historically, the CPRB also has drought risk in every single dry season. On the other hand, the CPRB had a massive flooding in 2011, which affected on not only Thai socio-economics but also global supply-chain of industrial production. Even though the CPRB has two multi-purpose and large-scale reservoirs, Bhumibol and Sirikit reservoirs, serious both flooding and drought has been existed from ancient times.

The purpose of this study is to propose a new reservoir operation system on science-based which can be easily put into practice; we studied a reservoir optimum operation for large scale reservoir considering the country's situation. This study proposed the new reservoir operation method that for reducing risks of drought and flood. The method was determined characteristics of rainfall in the target basin using historical hydrologicalinflow data on reservoir and historical rainfall data on catchment area of reservoir. In our proposal method, daily release was decided by using accumulated daily rainfall data, daily inflow data and storage volume. A The usefulness of the reservoir operation method was verified using historical hydrologicalinflow data on reservoir and daily rainfall daTA on catchment area of reservoir. This proposed method was applied for the Sirikit reservoir. As a result, tThe proposed reservoir operation method could contribute stabilization of release discharge and storage volume. It means that the risk of drought is low. In addition, the method could control release discharge without rising risks of flood in lower section of the basin.

Keywords: Accumulated areal mean rainfall, Reservoir management, The Sirikit reservoir, The Chao Phraya River basin.

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Session C

Emerging Technologies in Water Management and Environment Towards W-E-F Nexus

INVITED PAPER C01

WATER-ENERGY-FOOD NEXUS: THE ROADMAP IN KOREA

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Water, energy and food (WEF) are essential for human well-being, poverty reduction and sustainable development. However, experts expect that demand for freshwater, energy and food will increase significant over the next decades due to population growth, economic development, urbanization and climate change. The interdependence of these three resources is known as the water-energy-food (WEF) nexus. The WEF nexus complicates addressing these resources' scarcity independently, as actions taken with regard to one resource are likely to affect the other two. Moreover it is recommended developing a proper and tailored concept of the WEF nexus and assessment tool to aid its harmonious development and to meet the global environmental standard. The development of the WEF nexus concept and assessment tool is necessary to understand the interconnections in quantitative way and have better chance to improve the management of those valuable resource for future security. Recently K-water launches a research program to establish a roadmap on the WEF nexus to cope with a water shortage caused by a severe drought, energy and food crisis in future. The roadmap includes: (i) assessment of current status of water, energy and food sector (ii) suggestion of efficient management practices of water, energy and food (iii) development of database on nexus elements and assessment tools for policy implementation based on nexus approach (iv) new technologies of the nexus and determine sites of the nexus test-bed. With the recent water-energy-food nexus technology innovation, much attention has been paid into water and energy efficiency improvement and cost saving technologies such asfloating photovoltaic power plant, reuse and recycling technologies of waste water& waste heat, smart farming by ICT &IoT.

Keywords: sustainable development, interdependence, nexus approach

INVITED PAPER C02

SMART URBAN WATER SYSTEMS – IN PRACTICE

Sten Lindberg[*1a], Morten Rungø[2b]and Somchai Chonwattanam[3c]

Providing sufficient and safe drinking water and collecting and treating the used water and storm water in ever growing cities was already a fewdecades ago a very complex management and technical challenge. The Climate changes have added further complexity to this challenge. Changes in annual rainfall depths, more high intensity rainstorm – combined with the continued growth of the cities call for smarter solutions. The advances within sensors, communication, models, web-technology and knowledge make it feasible to combine the elements into integrated urban water management systems - IUWMS.
The presentation describes examples of IUWM deployed or under preparation in Thailand and Vietnam. Reference is made to cities where IUWM is an established management element.
Bangkok Metropolitan Administration, with financial support from the UN program CTCN, are currently implementing an operation Urban Flood Warning system. Based on actual measurements of water levels in channels (klong) and Chao Phraya river combined with information from a number of rainfall gauges and short term rainfall forecasts, the system evaluate flood risk in the selected focus area. The results – in terms of maps with flood prone areas are continuously updated and displayed on a web-portal, accessible for the citizens of Bangkok.
The climate changes and the growing cities makes is evenmore important to have efficient water distribution systems. The loss of water, due to low effective management or physically deteriorated pipe- and pump-systems is excessively high in many cities. The presentation includes examples of the use of smart technology in reducing the water losses.

Keywords: Smart water cities, urban flooding, flood warning,
Integrated Urban Water Management, water efficiency, non-revenue water

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ACHIEVING SUSTAINABLE RESOURCES SECURITY THROUGH THE WATER-ENERGY-FOOD NEXUS

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Climate Change, Urbanization, and Population growth are global stressors that are increasing the uncertainty of resource which is necessary for human activities.OECD(2012) predicted that resources demand of water, energy and food will be increased by 55%, 80%, 60% respectively in 2015. Resource security has been threatening by this uncertainty and aggravation of imbalance between the supply and demand of resources. Especially, climate change, which is very impactive to global water crisis, is the most critical crisis and common challenge for humanity. Much effort has been made to achieve the Sustainable Development Goals (SGDs) and the Water-Energy-Food (WEF) Nexus has attracted worldwide attention as a new paradigm to reach the resource security goals established in the SDGs. WEF Nexus is begun to be discussed at Bonn 2011 international conference in earnest and on the rise as concept of the most interested to resource security in the world.

WEF Nexus has to be considered secure sustainable resources and create a new industrial eco-system by incorporating the strategies of the WEF Nexus. The strategies mainly consist of these key concepts. These are Nexus DB system, impact assessmenttool, the Nexus element technology and legal and institutional systems.

To achieve these strategies, we are in the process of quantifying the trade-offs or synergy effects through big data analyses to detect correlations between resources.The technologies of Nexus can be classified into two groups: 1) Element technology and 2) Connection technology. Element Technology means the increasing the 1st efficiency through improvement & development of element technologies and connection technology means the maximizing 2nd efficiency by interconnecting individual element technologies. Moreover the legal and institutional backgrounds should be supported to reflect these technologiesthrough policy.

Finally, we will prepare a plan that leads to a win-win strategy for both the legal & institutional systems which prevents resources conflictions. We expect that WEF Nexus technology will help to overcome the existing resource crisis and establish a stable economic foundation for future generations.

Keywords: water-energy-food nexus, climate change, sustainable development, assessment tool

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PAPER ID: TC003

CHARACTERISTICS OF CH_4 FLUX FROM PADDY FIELD ADOPTING THE INTERMITTED IRRIGATION TECHNIQUE DURING THE WINTER-SPRING AND SUMMER-AUTUMN SEASONS IN THE RED RIVER DELTA, VIETNAM

Methane (CH_4) emission from paddy contributes to increasing the total global warming potential in Vietnam. It is important to implement eco-friendly paddy water management (e.g. alternate wetting and drying (AWD)) to reduce greenhouse gas emissions in Vietnam. The study on the application of intermittent irrigation technique has been done in the Red River Delta, Vietnam. The objectives were to investigate the temporal changes in CH_4 fluxes from six paddy plots in the winter-spring season and the summer-autumn season and to specify the influential factors to CH_4 emissions using multiple regression analysis (MRA). The cumulative CH_4 flux in the winter-spring season was one quarter of that in the summer-autumn season (9.0 g m^{-2} in the winter-spring season (91days) and 37.3 g m^{-2} in the summer-autumn season (85days)). The percentage of CH_4 flux in intermittent irrigation period to the total cropping period was 11% in the winter-spring season and 49% in the summer-autumn season, respectively. Though the improved paddy water management may be effective in the winter-spring season due to less rainfall, the countermeasures for the summer-autumn season is also important. The results of MRA show the correlations between CH_4 fluxes and the influential factors (the paddy ponding water level, the soil water content at 5 cm deep, the soil temperature, electrical conductivity, pH, redox potential (Eh) of upper soil layer) are low in the both seasons. However, the CH_4 fluxes decrease when the volumetric water content at a depth of 5 cm is under 0.25 and when the Eh is above 220 mV.

Keywords: paddy water management, methane emission, intermittent irrigation, multiple regression analysis, Vietnam

PAPER ID: TC007

WATER ENERGY CARBON NEXUS IN URBAN WATER SUPPLY SYSTEM OF KATHMANDU VALLEY

Mimansha Joshi

Urban water services are challenged from different dimensions of sustainability. Although not evident, water services consume a considerable amount of energy through extraction, treatment, distribution and conveyance. While a myriad number of studies have been carried out globally to quantify WEC nexus in urban water supply systems, only a handful of studies have been carried out in Asia. In order to bridge this gap, this study estimated the existing energy and carbon footprint from the cycle, which further expands to examining how the energy implications change when new planned water supply is operational in Kathmandu valley. It uses secondary data achieved through interactions with concerned stakeholders and through best estimations and assumptions.

The study revealed that about 250 GWh – 286 GWh of energy is used for water supply in Kathmandu valley, accounting for 0.04% of total energy consumption of Kathmandu.

Households and private tankers were found to be very energy intensive. On assuming that water distribution through private tankers are eliminated after planned water supply system is operational, the valley can save about 140 GWh of energy and about 35 ktCO2e carbon emissions as the energy intensity decreases from 12.77 kWh/m3 to 2.72 kWh/m3. Furthermore, as groundwater extraction gets reduced by 12% after MWSP, Kathmandu will be able to save about Rs. 7 million a year.

As a result, the study aims to contribute to the formulation of a policy in water and energy sectors to reduce GHG emissions.

Keywords: Water, Energy, Carbon, Urban Water Cycle, Kathmandu, Climate Change, Sustainability

PAPER ID: TC008

SATELLITE BASED SUB-DAILY DOWNSCALING OF GAUGED RAINFALL FOR FLOOD ANALYSIS VIA FULLY DISTRIBUTED HYDROLOGICAL MODEL

Pallav Kumar Shrestha[1, *], Sangam Shrestha[1] and Sarawut Ninsawat[2]

Flood events bear pronounced sub-daily variations originating from the variation of rainfall during storm events. Hence, correct flood simulations require sub-daily gauged rainfall which may not be available in all cases. This study proposes to route this issue thru a satellite based approach wherein daily gauged rainfall is downscaled to three hourly (3-h) resolution using diurnal variability of Tropical Rainfall Measurement Mission's (TRMM) 3B42 level 3 data (R_{sat}). Three rainfall datasets – TRMM-downscaled rainfall (R_{ds}), R_{sat} and daily gauged rainfall downscaled uniformly at 3-h intervals (R_{uni}) – are then forced into a fully distributed model, SHETRAN, which is pre-calibrated with gauged hourly rainfall ($R_{control}$) for 2011-12. R_{ds} shows improved degree of agreement and correlation to $R_{control}$ compared to R_{sat} and R_{uni}. Evaluation of the 2-year hourly hydrograph shows R_{ds} clearly outperforming R_{uni} (hourly Nash-Sutcliffe Efficiencies of 0.72 & 0.64 respectively). Correlation analysis of Q_2 flows (magnitudes that are exceeded only 2% of the time) shows R_{ds} to simulate flood events more accurately than R_{uni} (correlation coefficient of 0.57 & 0.35 respectively). Comparison of flood peak magnitudes (forty flood events in Q_2) without timing consideration shows R_{ds} outperforming R_{uni} and performing on par with $R_{control}$ (correlation coefficient of 0.84, 0.39 & 0.88 respectively) in flood peak simulation. However, R_{ds} yielded a varying peak flood timing error which could be attributed to various factors including the satellite's sensing mechanism. This study concludes that satellite based sub-daily downscaling of daily gauged rainfall could be a good option for flood analyses in cases where sub-daily gauged measurements are not available.

Keywords: Gauged rainfall, satellite rainfall, sub-daily downscaling, flood analysis, TRMM, distributed hydrologic model

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PAPER ID: TC009

A CASE STUDY ON INDUSTRIAL MISMANAGEMENT OF TANNERIES IN HAZARIBAGH: WATER POLLUTION AND CHROMIUM POISONING IN DHAKA, BANGLADESH

Nilay Kumar Sarker

: Tanneries of Hazaribagh produce large amount of liquid and solid wastes. Nature of liquid waste shows it is highly polluted; BOD (Biological Oxygen Demand) - 1823 ppm, COD (Chemical Oxygen Demand)- 3662 ppm, TDS (Total Dissolved Oxygen)- 16358 ppm, DO (Dissolved Oxygen)- 0.0, pH - 4.05, Cr - 987 ppm. Liquid waste is disposed to Buriganga river without any treatment. Solid wastes are comprised of raw trimmings, salt, hair, lime and unhairing sludge, fleshing, splits/trimming and processed skin waste. Workers of these tanneries are not paid well, they work in an unsafe and unhealthy environment, child labor and gender discrimination is a common scene. Workers suffer from various diseases due to pollution caused by tanneries. From fleshing and chromium contaminated trimmings Shutki is produced, it is used for chicken and fish feed and through chicken and fish chromium poisoning occurs to human body. Burning of processed skin waste is responsible for chromium poisoning via air.

Keywords: Hazaribagh, Tannery, Waste, Shutki, Chromium poisoning, Water pollution

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PAPER ID: TC010

QUANTIFYING CLIMATE CHANGE IMPACT ON RICE PRODUCTION IN NORTHEAST OF THAILAND: A CRITICAL REVIEW THROUGH WATER FOOTPRINT CONCEPT

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Climate change impact on rice yield and its corresponding water footprint was investigated for a case study in Northeast of Thailand. CERES-Rice crop growth model was used to simulate rice production which was set up and validated using yield data during 2009-2013. Three different rice varieties (KDML 105, RD 6 and ChaiNat-1) were considered in the study. The present water footprint (green, blue and grey) of rice, defined as amount of water evaporated during growing period or rice, was then calculated for irrigation area. To quantify potential impact of climate change on rice production in future, climate scenarios from three were downscaled and bias corrected for Nam Oon Basin and then supplied to CERES-Rice model. The future reference time was divided into three time slices; early future (2020s), mid future (2050s) and far future (2080s) and studied. At all-time slices, yield decreased for KDML 105 and RD6, resulting in increased water footprint potential future scenarios of decreasing precipitation and increasing temperature. This may be due to increased evapotranspiration, higher irrigation demand and lower final yield. On contrary, crop yield increased resulting in decreased water footprint for ChaiNat-1 under increasing summer temperature and decreasing precipitation for all periods. Since, ChaiNat-1 is a drought resistant variety, thus it could bear the harsh effect of in temperature increase resulting in higher water productivity. The study also showed blue footprint will be very large as compared to green and grey water footprint; huge amount of irrigation water will be needed to meet the evaporation demand in future. The results obtained from study highlights need for proper adaptation strategies to reduce or maintain acceptable water footprint under future climate.

Keyword: Climate Change, Food Security, Rice Production, Water Footprint

PAPER ID: TC013

DEVELOPING FOOD-ENERGY-WATER (FEW) NEXUS INDICATORS WITH A DPSIR FRAMEWORK: EXPERIENCE FROM TAIWAN

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Research has shown complex linkages between food-energy-water (FEW). Indicator plays a key role in any FEW nexus. FEW nexus development requires decisions concerning the selection and definition of indicators. The core purpose of this research is to develop a set of newly indicators for possible links and relationships between FEW. This research addresses to the key question for FEW nexus indicators: How to indicate and measure different components of FEW elements? These indicators require interdisciplinary teams to decipher and define them. Focusing on these less explored elements of FEW nexus and the flows between them, this research applies a Driving forces, Pressure, State, Impact and Response (DPSIR) approach to identify a list of indicators that could be used in regional and national scale. To see if and how DPSIR framework can help to operationalize indicator development, "LIFEWAY (Linked Indicators for Food, Energy and Water AvailabilitY)" is explored including definitions and elements selection. We found that there is a strong number of indicators that express driving force and response of governance and fewer of those that inform on pressure, state and impact. The lessons learned can provide major practical insights into the ongoing consultation update process of moving towards clarifying the FEW nexus.

Keywords: food, energy, water, dpsir, indicator.

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EFFECT OF WATER MANAGEMENT ON GROWTH OF MALABAR CHESTNUT

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Yu-Hsin Yang[1,d] Ying-Rong Chen[1,e] and Yu-Sen Chang[1,f *]**

Malabar chestnut is a drought tolerant crop with enlarged hypocotyl which stores and provides water. Stem water content may be associated with problems in post-transport rot. Water content in plant has typically been determined via destructive methods. This study aimed to determine water content non-destructively for the real-time monitoring of water status to prevent stem rot. Our study also investigated the effects of water restriction on the growth of malabar chestnut. One-year-old healthy and uniform seedlings of potted malabar chestnut were used as material. Full irrigation and water restrictions for 2, 4, and 8 weeks were applied on the plants to study the effects of water on the plant. A separate experiment was conducted in the summer and autumn to investigate seasonal effects on water content, trunk rot and bud number after simulated transport. Third experiment has developed non-destructive techniques for the determination of water content in malabar chestnut. As irrigation was reduced, stem diameter, water content, and chlorophyll fluorescence of the malabar chestnut exhibited a downward trend over the period of irrigation reduction. Spectral measurements showed similar trend. Reflectance at 1450 nm and 1650 nm had the highest correlation with water content while WBI (R900/R970) was the highest NDVI. Malabar chestnut produced in summer had a mean water content of 81.8%, and those that were produced in autumn had a mean water content of 66.4%. Non-destructive determination of water content serves as a useful technique before transport for the rapid classification of malabar chestnut based on the water status.

Keywords: water restriction, monitoring, non-destructive

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PAPER ID: TC016

THE ROLES OF VIRTUAL WATER FOR ASSESSING THE IMPACTS OF FOOD SECURITY AND GLOBAL FOOD TRADE ON WATER-ENERGY-FOOD NEXUS

Sang-Hyun Lee[1, a *], Jin-Yong Choi[2,b], Rabi H. Mohtar[3,c] and Seung-Hwan Yoo[4,d]

Globally, an increase of population, climate change, food security, and water shortage are the main factors for sustainable development. In particular, typical water management was generally related to water supply from water resources; however, food consumption and trade can be regarded as the important factors for water management in perspective of water demand. Therefore integrated approach among water, food, and trade. This study started from some questions about how food policy and trade affects water management. Therefore, we introduced various researches which estimated virtual water use in changes of a food consumption and food self-sufficiency in Korea. In addition, another researches showed the impacts of international food trade on water saving or loss using the concept of virtual water trade, which refers to water embedded in food products. Finally, we tried to provide the new point of views for integrated water and food management through Water-Energy-Food Nexus system.

Keywords: Virtual water, water footprint, food trade, food security, Nexus

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Session D

Disaster Management/ Groundwater Management

INVITED PAPER D01

JAPAN'S RIVER POLICIES AND TECHNICAL WORKS FOR DISASTER RISK REDUCTION UNDER CLIMATE CHANGE

Hirotada Matsuki

Flood disasters had occurred frequently all over Japan while Japan had poor governance and river management facilities. People thought it natural for them to prevent their community from floods and took measures with their self-responsibility.
After that, flood and water resource managements in a whole basin came into action under river authorities, and the Disaster Management Basic Act and relative regulations have been developed based on the experiences of huge flood disasters of ISEWAN Typhoon(1959) and others.
Flood damages and the victims have been slightly decreased by all thinkable measures, and the improvement of efficient water use and environmental conervation have been also promoted.

While large-scale disasters have occurred more frequently in Japan. In September 2015, a dyke-break and huge flooding occurred at Kinugawa river, which flows in the outer metropolitan area of Tokyo.
It is predictable that enormous disasters which exceed the scale of past disasters will increase gradually under changing climate.
On this occasion, river authorities, residents and relatives have to recognize the following mind, 'River facilities have limited functionfor preventing floods. It should be expectedthat unexpected-scale disasters will occur inevitably in the near future.'And they also have to proceed integrated measures against such enormous disasters by structural and non-structural measures.

In this paper, the transition of regulations on water-related disasters would be explained from the viewpoint of Japan's climate and historical background of Japan, and various challenging measures against large-scale water disasters in recent years would be introduced.

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INVITED PAPER D02

PREDICTION OF EXTREME FLOODSAND RISK CURVE DEVELOPMENTUNDER A CHANGING CLIMATE

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To estimate probabilistic characteristics of extreme floods and magnitudes of largest-class floodsunder a changing climate is a key issue for building up an adaptation strategy. To evaluate the change of extreme rainfall and flood characteristics, a nonstationary hydrologic frequency analysis was applied to future extreme rainfall outputs projected by MRI-AGCM 3.2S (20km resolution atmospheric general circulation model developed by Metrology Research Institute in Japan). The results showed that the magnitudes of the annual maximum short-term rainfall increase for the near future in most parts of Japan and this tendency was intensified in the end of the 21st century.

As well asa nonstationary hydrologic frequency analysis,the magnitudes of largest-class floods caused by typhoons under a changing climate were examined by using numerical typhoon simulation outputs. The rainfall data used for the flood simulation was developed by a physically-based course ensemble typhoon experiment for the Ise Bay Typhoon in 1959under apseudo global warming condition(Takemi et al, 2012). The simulatedrainfall data was given to a distributed rainfall-runoff model consideringflood regulation with dam reservoir operations and flood control basins. It wasrevealed that the largest flooddischarge at the Hirakata station, located at the upper part of the Osaka City area happened at the flood simulation using the typhoon course closest to the best track of the Ise-Bay Typhoon, which means the actualIse Bay Typhoon course was the worst course for flood disaster in the Osaka area; the peak discharge in thepseudo global warming experiment showed 10% increase than the control experiment.

Finally, a method to construct a flood riskcurve, a relation between the annual maximum damage due to flood inundationandits exceedance probability, was developedfor a probabilistic assessment of economic loss by flood disasters. The flood risk curve was obtained by integrating the exceedance probability of the annual maximum rainfall that causesa given inundation damage for all historicalspatio-temporal rainfall patterns. A flood risk curve and a flood damage probability map were demonstrated in the Yodo River basin, and then an adaptation strategy is discussed based on the flood risk curves for differentscenarios of designing hydraulic structures under climate change.

Keywords: climate change, nonstationary hydrologic frequency analysis, largest-class flood, flood risk curve

INVITED PAPER D03

ASSESSMENT OF THE IMPACTS OF GROUNDWATER ABSTRACTION AND CLIMATE CHANGE ON GROUNDWATER RESOURCES IN MEKONG DELTA, VIET NAM

Bui Tran Vuong1*, NgôDuc Chan1, Le Hoai Nam1, Tran Viet Bach2,
Phan Nam Long1, Pham Van Hung1

A quantitative assessment of impacts of groundwater abstraction and climate change on groundwater resources in Mekong Delta by using groundwater flow and transportation models is presented. Intensive and uncontrolled groundwater abstraction activities and climate change in the Mekong Delta caused reduction of groundwater level and saline water intrusion in aquifer system. The existing groundwater abstraction was inventoried and the aquifer system characterized. Seasonally groundwater recharge at present and in future under different scenarios of climate change were calculated using the WetSpass software. Groundwater flow and transportation models were set up to assess the impacts of groundwater abstraction and climate change on groundwater resources (the recharge outputs calculated by WetSpass software were used as inputs for these groundwater models). Results show that, due to groundwater abstraction during a period of 2000 to 2010, the groundwater level decrease at the rate of 0.50; 1.76; 1.24; 1.98; 1.42 and 2.58m/year for aquifers: upper-Pleistocene (qp3), upper-middle Pleistocene (qp2-3), lower Pleistocene (qp1), middle Pliocene (n22), lower Pliocene (n21) and upper Miocene (n13), respectively; and since 2004, the annual change of storage is negative meaning that groundwater resources is under depletion. Under the different scenarios of climate change, the groundwater level in all aquifers decrease at the rate from minimum of 0.016 to maximum of 0.25 m/year; the annual change of storage of the whole Mekong Delta in 2100 is negative and groundwater resources will continue to decline; last but not least, the areas having saline groundwater in all aquifers increased at a rate of minimum of 8.4 to maximum of 38.1 km2/year. If unchecked, this will have serious implications on the livelihoods of the population in the delta.

Key words: Climate change, Groundwater abstraction, Groundwater recharge, Numerical Model, Saline-fresh groundwater interface, Mekong Delta.

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Presented by Mr. Nguyen Tien Tung, Director of Sub_Division for Mekong Water Resources Planning.

PAPER ID: TD001

GROUNDWATER BALANCE AND RIVER INTERACTION ANALYSIS IN PLEISTOCENE AQUIFER OF THE SAIGON RIVER BASIN, SOUTH OF VIETNAM BY STABLE ISOTOPE ANALYSIS AND GROUNDWATER MODELING

Tran Thanh Long[1, a *], Sucharit Koontanakulvong[1,b]

Groundwater is playing an important role in water extraction and utilizations especially in mega city such as Ho Chi Minh City, Binh Duong City. The excessive-extraction of groundwater and land subsidence of these cities are dramatically increased because of high water demand for domestic and industrial fields meanwhile Saigon River basin significantly contribute to balance the surface water and groundwater. Land surface recharge is considerably sensitive driving force to the groundwater reserves which is not fully understood. The study tries to explore the sources from land surface and river in the Saigon River basin, South East of Vietnam. First, the groundwater balance is contributed via groundwater modeling during 1995-2015. Second, the relationship between surface hydrology and groundwater is detected from surface and groundwater analysis. Final, the sources from land and river recharges are recognized by combination of isotope analysis and groundwater modeling. The sources of both recharges will be helpful for groundwater modeling researches and effective master planning of integrated water resources management in Saigon River Basin.

Keywords: Saigon River Basin, MODFLOW, stable isotopes, sources land and river recharge

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PAPER ID: TD002

ESTIMATION OF RIVER CONDUCTANCE VALUES ALONG SAIGON RIVER, VIETNAM

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The Saigon River system is one of the largest resources contributing water supply for domestic and industrial fields at Ho Chi Minh City and Binh Duong Province, which has been facing the drought issue at downstream in recent years. To manage the water resources in Saigon Basin effectively, the groundwater and river interaction parameters need to be assessed seriously. However, in the past researches, the parameters seem to be less described with fully understanding. In this study, a groundwater modeling of the main stream of Saigon River using local boundary conditions derived from the regional groundwater flow model is used to estimate the river recharge to the aquifer. The conductance values of river bed based on soil type are defined at a selected river stretch (Thudaumot area) through calibrated and verified by the groundwater model using the observed piezometric heads during 2000 to 2007. The estimation of conductance values are applied for interaction analysis between Saigon River recharge and groundwater reserve.

Keywords: Saigon River, Groundwater Model, Conductance, Pumping rates, Interaction.

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PAPER ID: TD003

ESTIMATION OF HYDROLOGICAL PARAMETER DISTRIBUTION BY GEOSTATISTICAL METHODS IN THE UPPER CENTRAL PLAIN, THAILAND

Pwint Phyu Aye [1, a *], Sucharit Koontanakulvong [2,b]

Thai farmers traditionally relied on rain and flood water for crops, but the water amount needed for rice cultivation was not adequate in dry years and, thus, used groundwater as supplement. Groundwater model is necessary to assess the groundwater potentials in this area. Groundwater flow models require specification of several input parameters. The problem of estimating hydrological parameter distribution, in particular, hydraulic conductivity, from input-output measurements is re-examined in a geostatistical framework. The structure of the parameter field is identified, mathematically representations of the semivariogram. Linear estimation theory is applied to provide minimum variance and unbiased point estimates of hydrogeological parameters ('Kriging') to obtain the distributed conductivity field. This study used the bore logs data of 1128 observation wells in the area. The estimated hydraulic conductivity distribution are verified with the observed peizometric heads and simulated values from the regional groundwater model. This study focuses on the estimation of hydrogeological parameter distribution in regional groundwater modeling in the study area. The estimated hydrogeological parameter distribution will improve the quality of groundwater modeling in the study area.

Keywords: hydrogeological parameter, distribution, geostatistical method, groundwater modeling

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PAPER ID: TD004

MECHANISM OF LAND SUBSIDENCE DUE TO GROUNDWATER PRODUCTION.

The major land subsidence in Bangkok and vicinity areas was thought to be due to the overexploitation of groundwater of Chao Phraya groundwater basin. The rapid declined of the piezometric pressure of the aquifers led to believe that the major land subsidence came from fine-grained compaction of aquitards that squeezed out pores water. But from the analysis of previous data, it led to another conclusion of the major land subsidence causes by coarse-grained compaction within the aquifer and supplement with fine-grained compaction from aquitards on top of the major one. Major land subsidence causes by high-capacity production well at great- depth, due to their small cross-section area of screen and without filter-pact or with inefficient filter-pact. The well of high capacity pump, small-screen area will create higher velocity of flow in the aquifer to rush through the well-screen and also bring about an aquifer sands into well causing cave and cave-in close to screen. The space of cave and high velocity of turbulent water flow to well enable the sand grains to slip or move and with the stressed of overburden pressure will compact the sand layer of the aquifer. With repeated action of sand production will lead to more sand compaction near well and spread out radially causing a depression of 1 to 2 km. in diameter in long run. The more compaction of the aquifer at each steps will create higher velocity of water that rush into the well with the same pump, the higher velocity at each steps will lower the piezometric pressure accordingly. Furthermore, the lengthy lowering piezometric pressure of the aquifer will supplement with fine-grained compaction of the enclosed and included aquitards with minor degrees of compaction. If this type of wells happened to situate nearby, it could form a network of regional depression or land subsidence like Ramkumhaeng- Bangkapi – Ladpraow area.

PAPER ID: TD005

FLOW BUDGET AND CONJUNCTIVE USE PATTERN OF GROUNDWATER SYSTEM UNDER CLIMATE CHANGE IN UPPER CENTRAL PLAIN, THAILAND

Chokchai Suthidhummajit[1, a*], Sucharit Koontanakulvong[2, b]

The Upper Central Plain of Thailand, where farmers depended on both surface water and groundwater. Water allocated from the Bhumibol and Sirikit Dams are limited and caused water shortage in the dry years. Most farmers turn to use groundwater to supplement irrigation water in the dry years. In this area.

This study aims to understand the conjunctive use mechanism of surface water and groundwater mechanism under climate change scenario. The conjunctive use pattern of surface- as well as groundwater were investigated by field surveys and groundwater flow modeling, using the MODFLOW model to simulate the groundwater movement over the 10 years . The study used the bias-corrected MRI-GCM data to project the future climate condition (during 2015 -2039 and 2075-2099) and assess the impact on groundwater system. The conjunctive use mechanism, in this study, analyzed the flow budget of surface water use and groundwater system in term of water demand, rainfall, reservoir storage, groundwater recharge, groundwater storage, groundwater pumping in each water year pattern. The study shows the flow budget, conjunctive use pattern of each season and water year in the past and in the future under climate change scenarios.

Keywords: flow budget, conjunctive use, pattern, climate change, Upper Central Plain, Thailand

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PAPER ID: TD006

FLOOD MAPPING ALONG THE LOWER MEKONG RIVER IN CAMBODIA

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Located in Southeast Asia, Cambodia is one of the most disaster prone countries, where flooding rank the top of the natural disaster. Flood affects and threatens not only humans' and animal's life, properties, infrastructures, but it is also an obstacle to the current development. Furthermore, without having the efficient modern technology to predict flood situation in Cambodia, the disaster in this country become more serious. The objective of this research study is to simulate flood inundation area by using software HEC-RAS. HEC-RAS is a hydraulic model software capable of calculating any hydraulic river study including flood. In this study, the Lower Mekong River with approximately 50 km length was selected to delineate flood map from 2000 until 2013 and also 10-year return period map. The available data are 11 years of the measured water level at the upstream and downstream stations, 18 surveyed cross-sections and DEM with grid cell size 30 m x 30 m were used to understand the recurrence of the floods in the study area. The output from the model was delineated into map including flood extent and flood depth from 2000 until 2013 (without 2009, 2010 and 2012). The results show that flooding varied from year to year; however, the greatest flood was during 2000 and again in 2011. The simulated flood maps were compared with observed data to figure out that the model was accurate for flood mapping. These results will be useful for river engineers, experts, and decision makers to manage river floods.

Keywords: Flooding, Flood Map, HEC-RAS Model, Mekong River, Return Period

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PAPER ID: TD008

DROUGHT RISK ASSESSMENT OF IRRIGATION PROJECT AREAS IN A RIVER BASIN

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A model is developed for drought risk estimation in a river basin with an irrigation project. Drought risk is expressed as a product of drought hazard, exposure and vulnerability. Drought hazard is a function of rainfall, groundwater potential, groundwater quality and water storage in reservoirs. Exposure is the presence of irrigation system and crop areas inside or outside the irrigation project. Vulnerability or the lack of resistance damages due to drought depends on types of irrigation system, types of crop and their economic values. Vulnerability and exposure can be combined as consequences. The product of normalized hazard and consequences is called risk. The model is applied to assess drought risk in drought year of 2015 in the Munbon-Lamsae River Basin in Northeast Thailand. Monthly data in the past 30 years are collected. This includes rainfall, stream flow, groundwater potential and groundwater quality; and available water storage in reservoirs. Maps of hazard, consequences and risk conditions of the study area are computed in drought months such as in June 2015. The maps are calibrated for consistency with the actual field conditions by adjusting the weighting factors or coefficients of the model parameters. The developed model is further applied to estimate change in drought risk due change of irrigation system, for example when the types of irrigation system is changed from surface irrigation system to sprinkler irrigation system. The drought risk in the study area is significantly reduced because the sprinkler system can supply irrigation water more efficiently with less water loss.

Keywords: Drought hazard, vulnerability, exposure, risk, irrigation, Munbon-Lamsae river basin

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PAPER ID: TD009

ASSESSMENT OF RAINFALL-RUNOFF MODELS FOR STREAMFLOW PREDICTIONS IN THE NAM SONG RIVER BASIN

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Flood disaster is one of the problems threatening sustainable water resources management in many parts of the world. The Nam Song River basin in Lao PDR has long been affected by floods. The severity of major floods continues to increase in recent years. This is probably be a result of changes in the pattern and amount of rainfall which is highly variable in monsoon regions. The issue is aggravated by scarce meteorological and hydrological gauges and unequally distributed of the gauges over the basin. Reliable predictions of streamflow and flood for improved water resources management in the Nam Song basin are therefore particularly challenging. The overall aim of this study is to assess the performance of rainfall-runoff models for streamflow and flood predictions under the limitation of data scarcity. Three rainfall-runoff models, HEC-HMS, IFAS and SWAT, with different complexities were tested. The hydrological data used in this study were obtained from four rainfall gauges and two streamflow gauges. The period of the study was from 1996 to 2013. The calibration period was from 1996 to 2004 for parameter estimation and sensitivity analysis and the validation period was from 2005 to 2013. The performance of the models were evaluated at two temporal resolutions including daily and monthly scales. The correlation coefficient (r) and Nash-Sutcliffe efficiency (NSE) were used as performance indices. While all the rainfall-runoff models tested in this study performed equally well for predicting daily and monthly streamflow time series, they had different capabilities in prediction high flows that might lead to flooding. IFAS outperformed HEC-HMS and SWAT when predicting high flows. Due to its best performance in predicting high flows and overall streamflow time series, IFAS was considered to be more suitable than HEC-HMS and SWAT models for flood prediction applications for the Nam Song River Basin.

Keywords: ungauged basin, Nam Song River basin, rainfall estimation, rainfall-runoff model

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PAPER ID: TD010

AN ASSESSMENT OF SALTWATER INTRUSION IN CEBU CITY AQUIFERS

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Nicole H. Guerra[1], Raymond Albert L. Ng[1] and Mario P. de Leon, PhD[1]**

Constructing adequate models of the groundwater aquifer is an essential component of integrated water resources management, especially in the effort to curb the effects of saltwater intrusion in coastal areas. In the Philippines, the Department of Environment and Natural Resources has declared Cebu City as early as the year 2004 to be among the major cities in the country with the most critical balance conditions, suffering from the depletion of groundwater sources and the incidence of saltwater intrusion. However, save for the ongoing well-monitoring and plotting of isohaline contours by the Metro Cebu Water District (MCWD), in the years following the publication of DENR-CEST (2004) not much attention had been given to construct a groundwater model of Cebu City with updated daTA In this light, an analytical model is useful for a quick assessment of the groundwater condition given limited access to daTA

A simplified analytical model of the Cebu City aquifers is presented to determine the current position of the presumed sharp saltwater-freshwater interface, and visualize cones of ascension. Ten representative wells were assessed individually regarding the likelihood of saline contamination. Moreover, the cones of ascension of these ten wells have been simulated considering the effects of well interference. In defining the freshwater head and the distance of the toe of the freshwater-saltwater interface from the shore, the Glover relation was primarily used. Simulation results are illustrated by two- and three-dimensional representations.

Calculations and graphical representations were all carried out using Microsoft Excel spreadsheets. Three of ten wells were shown to be contaminated, while two more are threatened. Simulations with data gathered in the year 2014 also showed an alarming drawdown condition in the aquifer. Aside from the contribution to a greater public awareness of the threat of saltwater intrusion, the findings may serve to guide the policy-making of MCWD as to establishing allowable rates of groundwater extraction.

Keywords: Analytical model, Cebu, groundwater, saltwater intrusion

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FLOOD RISK MAPS AND ITS APPLICATIONS

LingFeng Chang[1], Wen-Tsun Feng[2], MingDaw Su[3*],

Floods are among the most frequent and costly natural disasters in terms of human hardship and economic loss. Most of the governments invest heavy resources to provide information for impact mitigation of this natural disaster. Flood potential maps are the most common available information among this data category. Although flood potential maps provide precious information about flooding occurrences, its values and usefulness may be slashed with the absences of socioeconomic data and vulnerability models for damage assessment.

This paper presents three categories of flood risk map, which are flood hazard risk map for flooding occurrence potential, flood lose risk map for financial damages caused by flooding, and the flood resilience map to take into account the social vulnerability. These three flood risk maps can be overlaid with each other to produce four combinations providing spatial risk information for regional flood risk management. Taipei metropolitan area was used as an example study area for this proposed flood risk management framework and the interpretations of the proposed flood risk maps.

Keywords: Risk, Flood, Risk Map, Hazard, Exposure, Vulnerability, Resilience

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ANALYSIS OF RAINFALL INDUCED LANDSLIDE DAM GEOMETRIES AND FAILURES

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. Landslide dam is formed as consequence of natural disasters such as typhoon and earthquake. The water impounded behind the landslide dam in a river may inundate the upstream areas and thus the formation of landslide dam possesses hazardous risk to the areas in the vicinity of the landslide dam. Recently, the occurrence of landslide dam problems has been aggravated due to the effects caused by climate change and the further expansion of land use in mountainous areas. Landslide dam hazard is often analyzed as a single event. There is still no research describing landslide dam hazards as a cascading disaster which starts from the occurrence of landslide located near river banks, forms a dam in the river, and ends when the dam overtops. This paper investigates the failure process of rainfall induced landslide dam in 3-dimensions through laboratory experiments and numerical method. The results indicated that both bottom erosion and side bank erosion played an important role in the breach evolution process. By using the identical sediment and constant inflow rate, the dam height is directly proportional to the rate of erosion. The peak discharges maybe much greater than normal inflow rate. In the simulation, the outflow discharge and the variation of dam surface erosions were well estimated by the 2D surface flow erosion/deposition model.

Keywords: Landslide dam, breach, overtopping, numerical simulation

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IRON OXIDE COATED ACTIVATED CARBONS FOR ARSENATE ADSORPTION FROM GROUNDWATER*

Manavanh Muongpak[1, a], Sutha Khaodhiar[2,b *] and Jenyuk Lohwacharin[3,c *]

Arsenic is an abundant element that exists in both natural and anthropogenic sources, including groundwater in many parts of the world. Adsorption is one of the best technologies for arsenic removal from water, particularly for a small-scale system. The aim of this study was to investigate the arsenate (As (V)) adsorption onto iron oxide coated activated carbon. The physicochemical properties were characterized by scanning electron microcopy (SEM) with energy dispersive X-ray spectroscopy (EDX), porosity and pore size distribution analysis. Batch experiment was conducted to examine the effects of the equilibrium solution pH, adsorbent dosage, contact time and co-existing ions on arsenate removal. The results indicate that the maximum arsenate adsorption efficiency is achieved 90% in the condition of equilibrium pH 5.5, adsorbent dosage of 5 g/L and contact time of 16 h with the initial arsenate (As (V)) concentration of 1 mg/L. Langmuir and Freundlich models for the arsenate adsorption were used to determine the adsorbent capacity for arsenate removal by iron oxide coated activated carbon. The equilibrium data was described by Langmuir and Freundlich isotherms.

Keywords: Arsenate, Adsorption, Activated carbon, Iron oxide, Groundwater

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SWAT AND MODFLOW MODELING OF SPATIO-TEMPORAL RUNOFF AND GROUNDWATER RECHARGE DISTRIBUTION

JEERAPONG Laonamsai[1, a] and AKSARA Putthividhya[1,b*]

Thailand's changing climate patterns has led to instability and challenges to the people and the nation's economy. Drought caused by irregular rainfall has become a significant issue in Thailand in the most recent years as the central plain has no large water reservoirs of its own and is currently relying on dams in the lower Northern region for water. Long periods of droughts are impacting rice and other cash crops production. Water scarcity is a global threat that is estimated to hit Thailand hard and the country is in need to develop a long-term plan to deal with these challenges. Effective water management needs to be practiced and conjunctive use of surface water and groundwater is being implemented. This paper aims to use SWAT model for spatio-temporal surface water simulation and the estimation of groundwater recharge rates. Sensitivity analysis, calibration, validation, and uncertainty analysis were performed by SWAT-CUP software. Due to the semi-distributed features of SWAT and the difficulty of calculating groundwater distributed parameters, recharge values estimated by SWAT were used in a MODFLOW model for groundwater simulation at steady and unsteady states. Surface water and groundwater potentials in Sukhothai province of Thailand were estimated based on aquifer hydrodynamic coefficients from calibrated and validated modeling results. SWAT and MODFLOW models were successfully tested and the results of the combination of the two models were found acceptable.

Keywords: SWAT, MODFLOW, Groundwater recharge, Runoff, Conjunctive Use.

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GROUNDWATER VULNERABILITY AND RISK ASSESSMENT IN THAILAND USING GIS-BASED MODIFIED DRASTIC APPROACH

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Groundwater resources in Thailand have become increasingly important due to surface water shortage problem in the dry season, especially in the agricultural-intensive area located in the Chao Phraya river basin. While water supply is a crucial issue, there is also evidence to suggest that the quality of groundwater resources is also under threat as a result of high concentrations of human/economic activities (e.g., industrial, agricultural, and household). Numerous groundwater contaminated sites have been reported from both natural and anthropogenic activities with extent of plume consumption. Therefore, this paper attempts to assess groundwater vulnerability and risk maps on he basis of hydrological and hydrogeological aspects and human impacts. All major hydrological, geological, and hydrogeological factos affecting and controlling groundwater migration, including water depth (D), net recharge (R), aquifer media (A), soil media (S). topography (T), impact of vadose zone (I), and hydraulic conductivity (C), were incorporated into the well-established DRASTIC model in a Geographical Information System (GIS)-based environment. Three different vulnerability zones were determined in the representative basins according to DRASTIC scores low (< 100), medium (100-140), and high (> 140). The linear regression statistical analysis between rainfall-groundwater depth and adjusted hydraulic conductivity (K) will be applied to modify some parameters in the original DRASTIC model. The final original and modified DRASTIC models will be tested using hydrochemical daTA The original DRASTIC model provided a conservative estimate of low risk while the advanced DRASTIC one represents an advanced stage of physical correlation between the vulnerability index and contaminant concentration in the representative area.

Keywords: Groundwater, Vulnerability, DRASTIC.

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PAPER ID: TD022

POTENTIAL IMPACT AND RISK ASSESSMENTS OF FUTURE CLIMATE CONDITIONS ON SALINISATION IN CENTRAL HUAI LUANG RIVER BASIN, NORTHEAST, THAILAND

Kewaree Pholkern[1, a], Phayom Saraphirom[2, b*], Wanpen Wirojanagud[3, c], Kriengsak Srisuk[4, d]

Potential impact and risk of the future climate conditions on salinity distribution were assessed in order to have the possible future land and groundwater conditions database for the integrated agricultural system planning for the next 10, 20 and 30 years in Huai Luang River Basin. Hydrodynamic of the groundwater and soil salinities were dependent on hydrologic, hydrogeologic, climate and landuse conditions. The study area was the most important rice production area of Udon Thani Province, which covered by saline soils around 35%. The assessment was performed by two hydrological models, HELP for recharge estimation, and SEAWAT for groundwater flow and salt transport simulations. After calibration, validation and sensitivity analysis, three scenarios of the projected weather datasets namely, ECHAM5 A1B, WET, and DRY were used to project the movement of waterlogging and salinity area boundaries. The expansion of saline groundwater and waterlogging areas were found for all future climate conditions, especially for the Wet and ECHAM5 A1B. The highly saline area will be reduced, while the medium saline to slightly brackish area will be extending in the next 30 years. The future risk areas were found at the discharge areas around Mueang district and Kut Chap District covering the area about 79.96%, 75.34%, and 73.57% for ECHAM5 A1B, Wet, and Dry scenarios, respectively. Future risk areas will be increased from 2015 around 17%.

Keywords: soil salinity, climate change, groundwater model, Huai Luang River Basin, SEAWAT

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IMPACT OF DECREASING PERCENTAGE OF IMPERVIOUSNESS AREA WITH FLOODING IN URBAN AREA AT SUKHUMVIT, BANGKOK, THAILAND

Detchphol Chiwatkulsiri[1, a *], Sutat Weesakul [2,b] and Ashish Shrestha [3,c]

The trend of frequency, intensity and volume of extreme precipitation under climate change has been increased. Urban flooding has become more frequent phenomenon in most of the cities. The climate change could have potentially outsized impact in existing ecological, human system and built systems. Most of the urban drainage systems are designed under stationary climate consideration, as the consequences most of them are running over capacity before their design period. The technologies for the urban drainage have been developed over a long period of time. For example, rainwater harvesting, green roofs, urban green space and pervious pavements. These technologies have multiple benefits alongside with flood mitigation by decreasing of imperviousness area in the urban area. The study, specific to Sukhumvit, Bangkok, aims to analyze the performance of urban drainage under the changing rainfall due to the normal and climate change condition in different percentage of imperviousness. The effect of decreasing imperviousness area is studied with application of 1 dimensional and 2 dimensional modelling approach using tools like Mike Urban and Mike Flood software.

The study shown the flood inundation area and flood inundation duration are reducing due to the effect of decreasing imperviousness in the study area. The two step of decreasing, from 70% (as model calibration) to 60% and 50% investigated that the flood inundation area was reduced as same as the normal and climate change condition. It is confirmed that impervious area have an important impact on runoff. The Flood inundation area and flood inundation duration was reducing compared from present condition with cases of decreasing percentage of imperviousness area.

Keywords: Urban flooding, drainage system, imperviousness area, infiltration

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LAND COVER/USE SCENARIO BUILDING AND ITS IMPACT ON FLOODING INSIDE THE ILIGAN RIVER BASIN

Milano, Alan E., Suson, Peter D., Salcedo, Stephanie Mae B. and Blasco, Jennifer G

This study aims to assess the impact on flooding when no proper land use management is done and another is when sound land use management is adopted. Hence, two (2) land cover/use scenarios were created. The two scenarios were the Projected Land Cover and the Desired Land Use. The two scenarios were created from a previous study whereby the impact on the two scenarios on runoff behavior was determined. The output of that study was then used as an input to determine the impact of flooding in terms of extent and depth/level. The results shows that the effect on flooding by Projected Land Cover shows more areas have been flooded with more areas inundated with higher flood depth level as compared to the Desired Land Use scenario in the five (5) Rainfall Return Period which is the 5 years, 10 years, 25 years, 50 years and 100 years. The reason behind this is because the Projected Land Cover has higher runoff values as against the Desired Land Use scenario considering that runoff is the source for flood waters.

The difference in runoff values between the two land cover/land use scenarios is attributed to forest vegetation. In particular, the Desired Land Use scenario has more forest vegetation cover and it has better forest cover quality than the projected land cover scenario. Such condition helps improve soil infiltration and thus reduces runoff. In addition the presence of agroforestry in the Desired Land Use scenario which is non-existent for the Projected Land Cover scenario also contributes to lower runoff in the Desired Land Use scenario. That is because Agroforestry land use is also known to improve soil infiltration. The study shows when land cover conditions are left by itself without any intervention, the impact of flood disaster is magnified. The study also proves the important role in adopting proper land use management in mitigating flood hazard as represented by the Desired Land Use scenario.

Keywords: flooding depth and extent, runoff, projected land cover, desired land use

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EVALUATION OF NEAR-REAL-TIME SATELLITE-BASED RAINFALLS OVER THAILAND

Teerawat Ram-Indra[1] , Supattra Visessri[2] and Piyatida Ruangrassamee[3*]

Performance of high resolution near-real-time satellite-based rainfall datasets has been improved significantly. The availability of high temporal and spatial resolution satellite-based rainfall products enable flood forecasting at near-real-time to prevent and mitigate flood loss. In this study, three near-real-time satellite-based rainfall products, namely TRMM Real-Time Multi-Satellite Precipitation Analysis (TRMM 3B42RT), Global Rainfall Map in Near-Real-Time (GSMaP_NRT), PERSIANN-Cloud Classification System (PERSIANN-CCS) were evaluated over Thailand during 2008-2012 including extreme rainfall during 2011 flood. Observed rainfall from Thai Meteorological Department was used to assess the satellite-based rainfall products using a set of indicators describing the capability to detect rainfall event and efficiency to capture rainfall pattern and amount. TRMM 3B42RT, GSMaP_NRT and PERSIANN-CCS were found to have good capability in detecting rainfall event and capturing both rainfall pattern and amount with TRMM 3B42RT performing the best. This suggests that the three datasets are potentially able to improve flood forecast especially after the process of bias correction. Quantile mapping was applied to adjust the systematic bias of the satellite-based rainfalls. The results showed significant improvement in accumulative rainfall especially for GSMaP_NRT and PERSIANN-CCS.

Keywords: satellite, near-real-time rainfall, flood, bias correction

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INPUT-OUTPUT ANALYSIS OF WATER DEFICITS IN NAN RIVER BASIN, THAILAND

Pavisorn Chuenchum[1] , Pongsak Suttinon[2*] and Piyatida Ruangrassamee[3]

Increasing demand of water resources along with high variabilities of precipitation pose a challenge in managing water resources under physical and economic constraints. An integrated hydro-economic accounting allows tracking of sectoral water consumption and assessing economic value of water resources. This study applies input-output table for analysis of sectoral water deficits in Nan River Basin, Thailand. Nan River Basin is one of the most important tributaries of the Chao Phraya River in Thailand. It contributes about 25 to 40 percent of annual flows in the Lower Chao Phraya River Basin. Regional input-output table was developed based on the national input-output table. Water supply was simulated using the Rainfall-Runoff model, Integrated Flood Analysis System (IFAS). Water demand for domestic, agricultural, industrial, and service sectors were estimated using available secondary database. The calculation of sectoral water deficits, and regional input-output table was based on data from 2010. The results showed that economic loss of water deficits from the input-output analysis was comparable with the reported figures. In addition, economic loss from cross-sectoral analysis was found to be two to three times higher than that from analysis of each sector separately.

Keywords: Water deficits, Input-output table, rainfall-runoff model, Nan River Basin

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Session: Ground Water under Changing Word

INVITED PAPER D04

THE PHEDEX MODEL: ANOMALOUS (NONLOCAL) SOLUTE TRANSPORT IN GROUNDWATER MODELED BY KEEPING TRACK OF AGE OF SORBATE

Prof Dr. Tim Ginn
Ph.D., Civil and Environmental Enginerring, WSU, 2016- Present

Anomalous transport of solutes or flowing water or suspended colloids or bacteria etc. has been the subject of intense analyses with multiple formulations appearing in scientific literature from hydrology to geomorphology, to chemical engineering, to environmental microbiology to mathematical physics. Primary focus has been on time-nonlocal mass balance formulations such as multirate mass transfer (MRMT), fractional-time advection-dispersion (tFADE), continuous-time random walks (CTRW), and dual porosity (DP) modeling approaches, that employ a convolution with a memory function to reflect respective conceptual models of delays in transport. These approaches are effective or "proxy" ones that do not always distinguish transport from immobilzation delays, are generally without connection to measurable physicochemical properties, and involve variously fractional calculus, inverse Laplace or Fourier transformations, and/or complex stochastic notions including assumptions of stationarity or ergodicity at the observation scale. Here we show a vastly simpler approach ("PhEDEX") to time-nonlocal mass balance formulations that is free of all these things, and is based on expressing the memory function in terms of a rate of mobilization of immobilized mass that is a function of the time immobilized. Our approach treats mass transfer completely independently from the transport process, and it allows specification of actual immobilization mechanisms or delays. Remarkably, any memory function can be expressed this way, including all of those associated with the MRMT and tFADE approaches, as well as conventional CTRW models. Furthermore, the PhEDEX approach can be used to construct completely new memory functions, e.g., forms that generate oscillating tails of breakthrough curves such as may occur in sediment transport, forms for delay-differential equations, and so on. Because the exposure-time approach is both simple and localized, it provides a promising platform for modeling nonlinear processes and for upscaling age-dependent multicomponent reaction systems.

THE POSSIBILITY OF USING SOLUTE AGE TO EVALUATE THE EFFECTIVENESS OF RIVERBANK FILTRATION (RBF) SYSTEM

Larbkich, Warangkana [1]; Neupauer, Roseanna M [2]

An RBF system has been used as a supplementary source of clean water supply and is a promising tool for climate change adaption .A key parameter in siting the RBF well is the travel time of the contaminants from the river to the RBF well which must be sufficiently long to allow the contaminants to be removed by natural process .Solute age is a measure of the amount of time that a solute has been in an aquifer.It can be used to calculate the amount of time that sorbing contaminants travel from the river to the RBF well .Solute age is useful in designing RBF systems to ensure sufficient time for reaction along the flowpaths between a river and an RBF well .This is not limited only to the case that river water is contaminated by a tracer but also for the case that river water is contaminated by a sorbing solute .Also, the governing equation of solute age can be developed by the governing equation of groundwater age.The presentation introduces the concept of solute age, the governing equation of solute age and the application of solute age to evaluate the effectiveness of riverbank filtration)RBF (system .

Keywords: solute age, groundwater age, travel time, riverbank filtration(RBF) system

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SIMULATION AND OPTIMIZATION METHODOLOGIES TO ESTIMATE GROUNDWATER SUSTAINABLE YIELD IN THE CENTRAL CHI RIVER BASIN, NORTHEAST THAILAND

Dr. Tussanee Nettasana, Dr.Warangkana Larbkich, Tipwimon Chomphukawinand Nongnuch Klahan

The flowing artesian aquifers are important sources of water supply and agricultural uses in theCentral Chi River Basin, the severe drought and salt-affected area in the northeast of Thailand. Groundwater wells were developed from a sequence of unconsolidated gravel, sand, silt, and clay units which were deposited by the Chi River and its tributary channel sediments.The aquifers in this area consist of an unconfined aquifer and two confined aquifers. The unconfined aquifer is composed of gravel, sand, silt, and lateritic soils. The thickness of this aquifer ranges from 10 to 30 meters. The confined aquifers are sandy gravel intercalated by clay layers. The depths from the surface to these aquifers are 30-50 and 40-150 meters, respectively.The simulation-optimization model has developed as a tool to determinesustainable yields to prevent an adverse impact to groundwater resources.The groundwater model isbeing constructed with MODFLOW and Modular Groundwater Optimizer (MGO) to define the groundwater flow system and optimize the pumping well operation, respectively. The model domain covers the area of 680 km^2 and consists of 106 columns, 104 rows and 9 layers.The groundwater model is calibrated by using PESTunder steady state condition. The calibrated groundwater model was then linked to an optimization model to determine optimal sustainable yieldswhile maintaining hydraulic heads at or above specified levels. Four scenarios of hydraulic head constraints are considered in this optimization model. The formulatedoptimization model provides the maximum yield of aquifer that satisfies most of the constraints.Results show that sustainable yield estimated in each sub-district area varies substantially andprovides supporting information of groundwater resources management to policy makers.

Keywords: groundwater simulation, optimization, sustainable yield

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ROLES OF GROUNDWATER IN THE FED TRIANGLE WATER RESOURCES MANAGEMENT MODEL IN THAILAND

Chaiporn Siripornpibul

Rural people in Thailand, especially in the Northeastern Region of Thailand. Most of them are farmers, their living conditions are very depending on variation of seasonal rainfall. The major problems in this area are flooded, drought and salt water. Even though this region has moderate rainfall about 1,348 mm./year, but the capacity of existing reservoirs and storages are very low which cause of flood and drought problem every year. While the groundwater resources are developed mainly for domestic use, but not much for agriculture compared to its potential in many areas. The other problem is the existing of salt water that occurred by groundwater flow systems that dissolved rock salt underneath and flow upward to the surface in the discharge areas and causes both saline soil and salt water. The variety of both quantity and quality of water resources plays a great role and control the socioeconomic condition of the region. The proposed new management named by the author as " FED Triangle Model" that will show the Linkages of the possible activities amongst 3 major problems Flood (F), Environment or Ecology (E) and Drought (D) may raise the new hope for appropriate management of water resources. It will help rural people to access and use water in dry season, especially under the concept of the "Conjunctive Water Use". Surface water is used in the wet season and switching with groundwater used in the dry season when the surface water sources are dried up. However, we have to carefully select crop types harvesting in a dry season that suitable for a dry period and also the effective water uses, especially a micro irrigation technique and artificial recharge scheme should be considered too. According to technical review, there are many high potential areas in the Northeastern region to be developed and use groundwater following this concept.

Keywords: FED Triangle Model, Water Resources Management, Roles of Groundwater, Conjunctive Water Use, artificial recharge scheme.

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ASSESSING AND CHARACTERIZING THE EFFICACY OF THE CONSTRUCTED WETLAND FOR TREATING POLLUTANTS IN LANDFILL LEACHATE

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Constructed wetlands are one of the effective wastewater treatment systems which have been utilized since 1950s. Characterizing landfill leachate and monitoring the treatment system are important for operation and development of the system. The objectives of this study were to delineate hydrologic and chemical processes occurring in the constructed wetland which has been treating landfill leachate from Athens 691 Landfill in Ohio since 1996. The treatment system consisted of six wetland cells. The leachate has high levels of BOD5, COD, ammonia, and metals, and low pH and low DO. Field parameters, inflow and outflow rates between wetland cells, and water isotopes were measured monthly to monitor water quality, flow, and storage change. The storage change in each month was corresponded to inflow and outflow rates. Seasonal water
samples were collected from the wetland cells and analyzed for water chemistry and water isotopes to evaluate removal efficiencies. The results indicate that the average removal efficiencies of iron, manganese, ammonia, and sulfate were 99 %, 94 %, 84 %, and 69 %, respectively. The results from PHREEQCI indicated that iron and sulfide minerals were precipitating. The modeled data were in keeping with the observed metal concentrations which were decreasing as the water flows through the treatment cells. The removal efficiencies of ammonia, nitrate, BOD5, and COD were influenced by the seasonal variations of water temperature which constrains biological processes. Results of this study suggest that the constructed wetland could provide efficient and long-term option for treating landfill leachate in cost effective manner.

APPLICATION OF THE PRECIPITATION-RUNOFF MODELING SYSTEM (PRMS) TO THE INVESTIGATION OF THE EFFECTS OF LAND-USE CHANGES ON THE RUNOFF COEFFICIENT IN THE PRACHINBURI RIVER BASIN, THAILAND

Phatcharasak Arlai*1, Santhan Phodchasit1

The Precipitation-Runoff Modeling System (PRMS), a deterministic, distributed-parameter, physical process based modeling system, has been set up in the Prachinburi river basin in eastern Thailand, which is heading for substantial economic development with subsequent additional needs of surface- and groundwater resources. This article aims to disclose on how to set up the PRMS- model to determine the effects of land-use changes on streamflow and the runoff coefficient C, in particular, in the Tap Lan National Park, Prachinburi River Basin. More specifically, PRMS was set up by integrating GIS- information, satellite data and secondary hydrological data observed over the last 20 years and, subsequently, calibrated and validated. The results show that PRMS is well able to model the daily runoff in the basin. Then the effects of land-use changes in the Tap Lan national park which has been facing s ubstantial deforestation by illegal activities in recent years has been examined. The results disclose that the ensuing land-use change, i.e. conversion of tropical forest to farmland, leads to an increase of the runoff coefficient C from pres ently C = 0.2 to C = 0.3 in the coming years, for the extreme case of 100% forest-to- farmland and/or resorts conversion.

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HYDROLOGICAL ASSESSMENT USING STABLE ISOTOPE FINGERPRINTING TECHNIQUE IN THE UPPER CHAO PHRAYA RIVER BASIN

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bstract Recently, nation-wide water stress due to an exceptionally less rainfall and the expansion in agriculture and industry development is threatening lives and Thailand's socio-economic status. Groundwater is an increasingly important resource to human populations in Thailand as it has been served as the secondary source of drinking and agricultural water in drought-hit provinces in the majority of Chao Phraya river basin. A comprehensive understanding of movement and distribution processes within the hydrological systems is necessary for a sustainable resource development without adverse effects on the environment, and isotope techniques are effective tools for fulfilling critical hydrogeological information needs. This study is therefore focusing to assess the spatial and temporal distribution of rainfall using water stable isotope technique as well as the surface water-groundwater interactions for the aquifer systems in the Upper Chao Phraya river basin systems. Local precipitation, surface water, and groundwater along the main river courses and their tributaries are directly sampled. Massive precipitation isotopic composition database from existing IAEA monitoring network (GNIB) along with local Bangkok precipitation isotope signature are compared with precipitation from Chiang Mai province in the North of Thailand to better identify the rainfall isotopic compositions. In addition to the isotopic differentiation of precipitation in the area, its impacts on isotopic characteristics of surface water and groundwater are additionally explored. LMWLs for local rainfall in Bangkok and Chiang Mai are generated with some seasonal variation of rainfall isotope signature due to rain out effect. Surface water in the study area is influenced by evaporation at some degree, revealing that rainfall may not be the primary source of surface water. Yom river's isotope values are far more D and ^{18}O-enriched compared to Ping's and Nan's, suggesting the mixing of groundwater with river water and/or the source of surface water may come from dry-period precipitation. Stable oxygen and hydrogen isotope data in groundwater again fall on an evaporation line, and is thus indicative of the effects of high evaporation rates through the top surficial material. The isotopic similarity with the more depleted □D and □^{18}O of groundwater samples suggests the potential mixing of groundwater with river water by different mixing processes (54% from river water and 46% from rainfall). The results of stable isotope analyses show correlations in the isotope signature of shallow (i.e., < 50 m deep) and deeper aquifer (i.e., > 50 m deep) which may be associated with hydraulic connection and/or similar hydrogeological conditions. *d*-excess stable isotope analyses are beneficial to identify the relative contributions of the wet and dry seasonal sources to the groundwater recharge. The results indicate that groundwater sources in the area are composed of an average of approximately 71.4% wet seasonal sources and 28.6% dry seasonal sources.

Keywords: Stable isotope, fingerprinting, groundwater-surface water interactions, recharge, water resources management

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THE STUDY ON GROUNDWATER QUALITY AND QUANTITY FLUCTUATION NEAR THE COASTAL AREADUE TO CLIMATE CHANGE, THAILAND.

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Thailand has been coping with water scarcity in various regions as a result of isolation in groundwater and land-use for agricultural management. A shortage of water for agricultural affected by drought in early and late rainy season brought about by low productivity. Nowadays, climate change is a hot issue to impact all global natural resources including water resources. Climate change effects to groundwater quality, and quantity fluctuations not only in recharge area but also near coastal areas. That's why we face with drought and flooding every year. Higher temperatures lead to reduce groundwater level and diminish groundwater quality.Water usage has been increased over recent decades, due to population and economic growth. Also changes in lifestyle, and water supply systems expansion, with irrigation water use being by far and most important cause.

The study area is located at the Pak Phanang Basin, Southern Thailand. Groundwater quality near the coastal plain is almost brackish and salty. Hydrogeology underlying the basin is silty sand, very fine sand, and weathered rock. The difficulties to set up of monitoring wells and network are because of both water quality and hydrogeology. Groundwater plays an importance role to increase agricultural productivity and farmer income. It leads to a sustainable agricultural management and economic development. However, to sustain groundwater resources for agricultural, a well plan and efficiency use of groundwater for agricultural areas bring about benefits for sustainable Thailand economic development in the future. Consequently, a comparison how climate change impacts to groundwater quality and quantity near the coastal plain which needs to be improved for planning sustainable groundwater management.

ASSESSMENT OF CLIMATE CHANGE ON GROUNDWATER VULNERABILITY TO DROUGHT OF AREAS IN EASTERN THAILAND

SEEBOONRUANG Uma

Groundwater is a major natural water resource and also an alternative source of water supply during seasonal droughts. In addition to urbanization and industrialization, groundwater has been increasingly threatened by seasonal climate variability and climate change. Climate change gradually gives rise to global temperature and has long term adverse impacts on rainfall fluctuation and subsequently an irreversible impact on groundwater recharge. Areas under perennial droughts, especially the eastern region of Thailand, can become more vulnerable from this unfavorable drastic climate change. Reduced precipitation can contribute to shortages of water supply in a number of agricultural areas along with industrial estates in the region. Therefore, identifying those hotspots and prioritizing zones whose subsurface systems may become susceptible and vulnerable to highly severe droughts due to climate change are significantly crucial. These hotspot areas are identified in this study by applying the concept of climate vulnerability assessment including three components; exposure index, sensitivity index, and adaptive capacity index. The climate change exposure index is defined by the change in future rainfall analyzed by a GCM model. The sensitivity index is obtained from the modified DRASTIC technique. The current occurrence of seasonal droughts characterizes the adaptive capacity in this region.The three factors are then mergedand ranked through the overlay matrix technique.The results are presented in the form of maps of hazard, impact and vulnerability and are useful for better groundwater management and planning as well as policy decision-making.

Keywords: Groundwater, Vulnerability, Impact assessment, Climate change

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IMPACT OF CLIMATE AND LAND USE CHANGES ON SURFACE WATER AND GROUNDWATER POTENTIAL IN HUAI SAIBAT WATERSHED, NE, THAILAND

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Impacts of climate and landuse changes on surface water and groundwater potential in Huai Saibat Watershed were evaluated by modeling technique. The application of SWAT and MODFLOW models was demonstrated for water balance analysis in the 676 km^2 watershed. The hydrological data from 1995 to 2015 was selected for model calibrations. The analysis was based on combined nine climate and landuse scenarios: Wet, Dry, A1B, Wet-U1, Dry-U1, A1B-U1, Wet-U2, Dry-U2, and A1B-U2. The simulation results were summarized on an annual basis and divided into 22 sub-watersheds across the watershed for IWRM planning in the future. The water balance of base year (2015) indicated that the annual surface water is about 150 MCM, the projection results from Wet and A1B climate scenarios were given the result of about 350 MCM and 500 MCM/year, respectively, while Dry condition will have approximately 150 MCM/year. The average groundwater recharge of the base year was 70 mm/year and will be increased in the future under the Wet and A1B scenarios to be about 180 and 150 mm/year, respectively, while Dry scenario has recharge between 80 and 100 mm/year. Groundwater sustainable yield of the watershed under Dry condition was limited to be about 10-13 MCM/year, while Wet and A1B scenarios the yields will be varied between 21 and 28 MCM/year depends on the landuse conditions. The projection results notified that water availability will be highly depended on the variability of climate and land use conditions.

Keywords: Surface Water, Groundwater, Modeling, Climate Change, Huai Saibat Watershed

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HYDROGEOCHEMICAL FEATURESOFKARST IN THEWE STERN THAILAND

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The hydrogeochemical features of typical karst region in Western Thailand were discussed based on the high-resolution automatic hydrochemical monitor and karst spring water quality test data. The standard dissolution tablet method was employed to calculate dissolution rate ofdifferent lands and main characters and dynamic factors of Thailand karst growth were analyzed. Comparing with thetypical karst spring region inthesouthwest China, karstic water ofthe Western Thailand has the features ofhigh calcium (100-120 mg/L), high contents ofbicarbonate ions(8.6-9.3mmol/L) and high specific conductance (700-820 µs/cm); the dissolution quantity of soils in the dry season was between 28.95 mg/mi-d and 214.84 mg/mi-d; the annual dissolution quantity was twice-three times greater than that ofJinfo Mountain inChongqing orGuangxi Mashan County peak cluster depressions, indicating that under the condition oftropical monsoon climate, the karst process in river catchment was significantly stronger than that ofsubtropical karst region inthesouthwest China.

Keywords: Karst development, Hydrogeochemistry, Dissolution rate, Western Thailand, PhuToeiunderground river catchment

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DEVELOPING POLICY RECOMMENDATIONS FOR THE WATER, ENERGY, AND FOOD SECURITY OF THAILAND

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Presently, the entire world is encountering crises and problems regarding energy and food security and water management. These crises and problems have threatened human lives, economies, societies, and security across the globe. Sustainable management of water, food, and energy cannot be successfully implemented at the level of individual nations or by applying only one field of knowledge. Interdisciplinary knowledge is essential. This research aims to develop policy recommendations for the water, energy, and food security of Thailand. Its priority is, therefore, to investigate the viewpoints and ideas of academics, administrators, doers, and experts in the fields of water, energy, and food at both national and international levels. The research was conducted by collecting, analyzing, and synthesizing policies and knowledge from other research, undertaken by a variety of sectors in Thailand, concerning water, energy, and food. Current problems and needs were synthesized from the research. Data obtained from field work was also applied toward policy recommendations and proposals for operational plans applicable to a number of sectors in the future.

This research shows that holistic approaches are required for solving problems and establishing policies, which merit national agendas assigned to them. Hosts are, therefore, clearly required, and cooperation among sectors can help to drive policy. Each ministry, department, and other sector needs to engage in coordinating and solving problems collaboratively. Meanwhile, sectors must be designated to monitor, evaluate, and assess the achievement of the projects, with stakeholders contributing at every step. Global policy and trends regarding the three issues of water, energy, and food security should be considered as well.

Appendix

Appendix I- Participants list

Registration

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20	นายพีระพงศ์ รัตนบุรี	วิศวกรชลประทานปฏิบัติการ	สบอ.	popirre60@gmail.com		

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21	นส.อารีรัตน์ อนุชน	นักอุทกวิทยาชำนาญการพิเศษ	สบอ.	areeratanuchon@gmail.com		
22	นายธาดา สุขะปุณพันธ์	ผู้เชี่ยวชาญด้านที่ปรึกษาอุทกวิทยา	กรมชลประทาน	Thada@yahoo.com		
23	นายกาญจนดินทร์ สระประทุม	ผู้อำนวยการโครงการเงินกู้และกิจการต่างประเทศ	สบก.			
24	นายกษิดิ์เดช ชีตา	วิศวกรโยธาปฏิบัติการ	สบก.	kasidet.cheeta@gmail.com		
25	นายศุภวุธ ~~เชิบผุป~~ เอินยุบ	วิศวกรปฏิบัติการ	สบก.	tuwarasarawut@gmail.com		
26	นายอัคราวุฒิ อินทรพาณิชย์	วิศวกรชลประทานชำนาญการ	สบก.	uck_uck1@hotmail.com		
27	นางสาวศิริกัญญา หลักฐาน	วิศวกรชลประทานปฏิบัติการ	สบก.	sirinatcha98@gmail.com		
28	นางสาวพิสินี ปฏิพัทธ์ปถวี	วิศวกรชลประทานปฏิบัติการ	สบก.			
29	นางสาวนิชา บัวสำลี	วิศวกรชลประทานปฏิบัติการ	สบก.			
30	นางสาวปิยะชนก อิสโร	นักวิเทศสัมพันธ์ปฏิบัติการ	สบก.	prettyminle@gmail		
31	นายชัยวัฒน์ จันทวี	หัวหน้าฝ่ายวางโครงการที่ 1	สบก.			
32	นายชัชชัย เพชรอักษร	วิศวกรชลประทานชำนาญการพิเศษ	สชป.1	Chatpongnoi@hotmail.com		
33	นายศุภโชค กามินี	วิศวกรชลประทานชำนาญการ	สชป.3	rivercrow@hotmail.com		
34	นายบุญธรรม ปานเปี่ยมโภช	ฝจน.ชป.4	สชป.4	boonthum41@gmail.com		
35	นายบุญส่ง ไสยกานนท์	นายช่างชลประทานชำนาญการ	สชป.6			
36	นายอรรถพร ปัญญาโฉม	ผชช.ด้านวิศวกรรมชลประทาน	สชป.10	PUNYACHOM@HOTMAIL.COM		
37	นายเนรมิต เทพนอก	ผจบ.ชป.12	สชป.12			
38	นายบุญลือ คงชอบ	ผจบ.ชป.~~16~~ 14	สชป.14	boonlue99@hotmail.com		
39	นายอนุชา ยังตรง	วิศวกรชลประทานชำนาญการพิเศษ	สชป.16			

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1	นายธนา สุวัฑฒน	ผู้อำนวยการสำนักวิจัยและพัฒนา	สวพ.			
2	ดร.สมเกียรติ อภิพัฒนวิศว์	วิศวกรโยธาชำนาญการ	สวพ.			
3	นายสุภฤกษ์ เหรียญบุบผา	วิศวกรโยธาชำนาญการพิเศษ	สวพ.	oak1702@yahoo.com		
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7	นายจีรภัทร์ เตชะกุลชัยนันต์	วิศวกรชลประทานชำนาญการ	สวพ.(สถาบัน)			
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20	นายพีระพงศ์ รัตนบุรี	วิศวกรชลประทานปฏิบัติการ	สบอ.	popirre60@gmail.com		

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22	นายธาดา สุขะปุณพันธ์	ผู้เชี่ยวชาญด้านที่ปรึกษาอุทกวิทยา	กรมชลประทาน	thada999@yahoo.com		
23	นายกาญจนดินทร์ สระประทุม	ผู้อำนวยการโครงการเงินกู้และกิจการต่างประเทศ	สบก.			
24	นายกษิดิ์เดช ชีตา	วิศวกรโยธาปฏิบัติการ	สบก.	Kasidet.cheeta@gmail.com		
25	นายศุภวุธ เย็บผุป	วิศวกรปฏิบัติการ	สบก.	tuvarasarawut@gmail.com		
26	นายอัคราวุฒิ อินทรพาณิชย์	วิศวกรชลประทานชำนาญการ	สบก.	UCK_UCK1@hotmail.com		
27	นางสาวศิริกัญญา หลักฐาน	วิศวกรชลประทานปฏิบัติการ	สบก.			
28	นางสาวพิสินี ปฏิพัทธ์ปถวี	วิศวกรชลประทานปฏิบัติการ	สบก.			
29	นางสาวนิชา บัวสำลี	วิศวกรชลประทานปฏิบัติการ	สบก.			
30	นางสาวปิยะชนก อิสโร	นักวิเทศสัมพันธ์ปฏิบัติการ	สบก.			
31	นายชัยวัฒน์ จันทวี	หัวหน้าฝ่ายวางโครงการที่ 1	สบก.			
32	นายชัชชัย เพชรอักษร	วิศวกรชลประทานชำนาญการพิเศษ	สชป.1	Chatpongnai@hotmail.com		
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34	นายบุญธรรม ปานเปี่ยมโภช	ฝจน.ชป.4	สชป.4	boonthum41@Gmail.com		
35	นายบุญส่ง ไสยกานนท์	นายช่างชลประทานชำนาญการ	สชป.6			
36	นายอรรถพร ปัญญาโฉม	ผชช.ด้านวิศวกรรมชลประทาน	สชป.10	PUNYACHOM@HOTMAIL.com		
37	นายเนรมิต เทพนอก	ผจบ.ชป.12	สชป.12			
38	นายบุญลือ คงชอบ	ผจบ.ชป.~~16~~ 14	สชป.14	boonlue99@hotmail.com		
39	นายอนุชา ยังตรง	วิศวกรชลประทานชำนาญการพิเศษ	สชป.16	ANUCHADEWEY@GMAIL.com		
	น.ส. วรรณิษา ธนศรวรนันท์	นักวิเทศสัมพันธ์ปฏิบัติการ	สบก.	wannatwan@hotmail.com		
	น.ส. พรรณพลอย ชาวเรือ	วิศวกรชลประทานปฏิบัติการ (สพบ(สกบัน))				
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3	**Assoc.Prof.Prapaporn Khopaibool, Dr.Med.Vet.**	Thailand Research Fund	**Thailand**			
4	**Mr. Somboon Apasssakij**	Thailand Research Fund	**Thailand**			
5	**Dr.Phakpoom Tippakoon**	Thailand Research Fund	**Thailand**			
6	**Mrs. Sureerat Chanama**	Thailand Research Fund	**Thailand**		[illegible]	[illegible]
7	**Ms. Saravanee Singtong**	Thailand Research Fund	**Thailand**		Saravanee S.	Saravanee S.
8	**อ.จิรสรณ์**		**Thailand**			
9	**Mr. Nop Sailamai**	Thailand Research Fund	**Thailand**		[illegible]	[illegible]
10	**Ms. Kittikarn Kukaew**	Thailand Research Fund	**Thailand**		[illegible]	[illegible]
11	**Ms. Matanapan Jiwjiam**	Thailand Research Fund	**Thailand**		[illegible]	[illegible]
12	**Wansom Seesung**	Thailand Research Fund	**Thailand**		[illegible]	[illegible]
13	**Nithipreeya Chanthavong**	Thailand Research Fund	**Thailand**		[illegible]	[illegible]

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4	**Dr. Saisunee Budhakooncharoen**	Thai Hydrologist Association	**Thailand** ชมพู	Dr.saisunee@gmail.com		
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6	**ดร.วจี รามณรงค์**	Thai Hydrologist Association	**Thailand**	Vachi1983@gmail.com		
7	**ดร.ชัยวัฒน์ เอกวัฒน์พานิชย์**	Thai Hydrologist Association	**Thailand**			
8	**คุณนพคุณ โสมสิน**	Thai Hydrologist Association	**Thailand**	Nophakhun@hotmail.com		
9	**คุณสมคิด บัวเพ็ง**	Thai Hydrologist Association	**Thailand**	Sbuapeng@hotmail.com		
10	**คุณชัยวัฒน์ ผลพิรุฬห์**	Thai Hydrologist Association	**Thailand**	Chaiwat.seatec@gmail.com		
11	**คุณสมเกียรติ กิจสุวรรณกุล**	Thai Hydrologist Association	**Thailand** ชมพู	Sombe1@hotmail.com		
12	**คุณสุวัฒน์ เชาว์ปรีชา**	Thai Hydrologist Association	**Thailand**			

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13	**ดร.ภาณุวัฒน์ ปิ่นทอง**	Thai Hydrologist Association	**Thailand**			
14	**Miss Marayart Petcharat**	Thai Hydrologist Association	**Thailand** ชมพู		[signature]	[signature]
15	นายปรีชา เศษฤทธิ์	Thai Hydrologist Association	thailand			
16	นายยิ่งเปรียว [illegible]	Thai Hydra			[signature]	
17	นาย ชูลิต วัชรสินธุ์					
18	น.ส. บุษพา ปิดทอง					
19	จ.อ. ธนะพันธ์ กฤดากร	Thai Hydra		-	[signature]	
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2	นายบุญชุบ ส่งตระกูลศักดิ์	National Economic and Social Development Board (NESDB)	Thailand			
3	นายอาทิตย์ มะลิทอง	National Economic and Social Development Board (NESDB)	Thailand			
4	นางสาวสุภัทรา เชิดชูไชย	National Economic and Social Development Board (NESDB)	Thailand			
5	นางสาวเอมอร พฤกษ์สุริยา	National Economic and Social Development Board (NESDB)	Thailand			

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5	**น.ส. กติกา พรรณบัวตูม**	สำนักงานนโยบายและแผนทรัพยากรธรรมชาติและสิ่งแวดล้อม	**Thailand**	katika.pun@hotmail.com		
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2	**Assoc. Prof. Chaiyuth Sukhsri, CU**	Chulalongkorn University	**Thailand**			
3	**Asst. Prof. Dr. Aksara Putthividhya** TD020, TD021	Chulalongkorn University	**Thailand**	TD020, TD021		
4	**Asst. Prof. Dr. Anurak Sriariyawat**	Chulalongkorn University	**Thailand**			
5	**Assoc. Prof. Dr. Tuantan Kitpaisalsakul**	Chulalongkorn University	**Thailand**			
6	**Dr. Piyatida Ruangrassamee**	Chulalongkorn University	**Thailand**			
7	**Dr. Pongsak Suttinon**	Chulalongkorn University	**Thailand**			
8	**Dr. Supattra Visessri**	Chulalongkorn University	**Thailand**		สุภัทรา	สุภัทรา
9	**Dr. Patama Singhruck**	Chulalongkorn University	**Thailand**			
10	**Mada Buathong**	Chulalongkorn University	**Thailand**		Mada	Mada
11	**Daunpen Panayangkool**	Chulalongkorn University	**Thailand**		Daunpen	
12	**Napaporn Noppakhun**	Chulalongkorn University	**Thailand**			

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8	**Mr. Wei Cheng Lo**	National Cheng Kung University	**Taiwan**	lowc@mail.ncku.edu.tw		
9	**Mr. Yi-Lung Yeh** TA017	National Pingtung University of Science and Technology	**Taiwan**	yalung@mail.npust.edu.tw	Chiu Teng-Pao	Chiu-Teng-pao
10	**Shang-Lien Lo** TC013	National Taiwan University	**Taiwan**	mhyuan@gmail.com	Mei Hua Yuan	Meihua Yuan
11	**Yung- Liang Peng (dinner 25)** TC014	National Taiwan University	**Taiwan**	r92628132@ntu.edu.tw	Yung-Liang Peng	Yung-Liang Peng

Taiwan (1)

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25-26 January 2017

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Taiwan (2)

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1	**Datuk Mohd Adnan Mohd Nor (tour)**	Academy Science of Malaysia (ASM)	**Malaysia**		[signature]	[signature]
2	**Ir. Mohd Zaki bin Mat Amin (tour)**		**Malaysia**		[signature]	[signature]
3	**Dr. Wardah Tahir**	Universiti Teknologi Mara	**Malaysia**		[signature]	
4	**Mrs. Intan Shafeenar Ahmad Mohtar**	Universiti Teknologi Mara	**Malaysia**		[signature]	
5	**Prof. FredolinTangang, PhD**		**Malaysia**	ftangang@gmail.com	[signature]	[signature]
6	**Ms. Htay Htay Than (tour)**	Director, Department of Meteorology and Hydrology	**Myanmar**		[signature]	[signature]
7	**Mr. Saykham Sithavong**	Deputy head of Irrigation Department, Faculty of Water	**Lao, PDR**	s.sithavong@nuol.edu.la	[signature]	[signature]
8	**Mr. Iep Keovongsa (THA present)**	National University of Laos TB009	**LPDR**	iepwred@gmail	[signature]	[signature]
9	**Mr. Sarann Ly (THA present)**	Institute of Technology of Cambodia ~~TB 007~~	**Cambodia (ASEAN)**	ly.sarann@itc.edu.kh	[signature]	[signature]
10	**Ms. Phoeurn Chan Arun**		**Cambodia**		[signature]	[signature]

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11	**Mr. Uy Samnang**	Institut de Technologie du Cambodge (ITC)	**Cambodia**			
12	**Dr. Heng Sokchhay**	Institut de Technologie du Cambodge (ITC)	**Cambodia**			
13	**Dr. Le Minh Nhat**	Head of the Climate Change Adaptation Department of	**Vietnam**	nhatkyoto@gmail.com		
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17	**Mr. Hoai Luu-Duc**	Hochiminh City University of Technology	**Vietnam**			
18	**Prof. Alan E. Milano**		**Phillippines**	aemilano1960@yahoo.com		
19	**Dr. Renan Ma. Tanhueco**	De La Salle University	**Philippines**			
20	**Mr. Nelson Stephen L. Ventura (THA present)** Tomorrow	De La Salle University	**Philippines**	raymondalbertng@gmail.com		
21	**Dr. Hadi Kardhana**	Institut Teknologi Bandung	**Indonesia**			

No.	Name	Office/ Position/ Institute		Email	Signature	Signature
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23	**Mr. Luki Subehi/Luki/Subehi (THA present)**	Indonesian Institute of Sciences (LIPI) TB005	**Indonesia (ASEAN)**	luki@limnologi.lipi.go.id		
24	**Prof. Kuo-Lin Hsu**	University of California, Irvine	**USA**			
25	**Dr. Phu Nguyen**	University of California, Irvine	**USA**			

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5	Mr Apichai Sunchindah	Independent Expert		apichai.sun@yahoo.com		
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ใบลงทะเบียนสื่อมวลชน

งานประชุมวิชาการระดับนานาชาติ

ภายใต้หัวข้อ THA 2017 International Conference on Water Management and Climate Change towards Asia's Water-Energy-Food Nexus"

วันพุธที่ 25 มกราคม 2560 ตั้งแต่เวลา 09.00 – 18.00 น. ณ โรงแรม สวิสโฮเต็ล เลอ คองคอร์ด กรุงเทพฯ

ลำดับ	ชื่อ-สกุล	ชื่อเล่น	สำนักข่าว	SECTION	Tel.	E-mail
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13	[illegible]		TV 3			
14	[illegible]		TV3.			
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วันพุธที่ 25 มกราคม 2560 ตั้งแต่เวลา 09.00-18.00 น. ณ โรงแรม สวิสโฮเต็ล เลอ คองคอร์ด กรุงเทพฯ

ลำดับ	ชื่อ-สกุล	ชื่อเล่น	สำนักข่าว	SECTION	Tel.	E-mail
16	[illegible]	[illegible]	TV5		0914289196	palla.wa@hotmail.com
17	[illegible]	[illegible]	enjoygen		089-6835741	enjoygen.net@gmail.com
18	[illegible]	[illegible]	POSTURNEWS		086-493-0516	POSTURNEWS@gmail.c
19	[illegible]		TV9		081-1743866	
20	[illegible]		NationTV		061-4197785	tanpisit@outlook.com
21	[illegible]	[illegible]	[illegible]		095-1241532	choojaksolo@gmail.co
22	[illegible]		[illegible]		[illegible]	[illegible]
23	[illegible]		NBT		081-0567116	
24	[illegible]	[illegible]	Idea [illegible]		[illegible]	somchai[illegible]
25	[illegible]		[illegible]		089-210-9161	
26	[illegible]		TV [illegible]		095-8393335	
27	[illegible]		NBT		075 [illegible]	
28	[illegible]		[illegible]		—	089-920-8025
29						
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วันพุธที่ 25 มกราคม 2560 ตั้งแต่เวลา 09.00-18.00 น. ณ โรงแรม สวิสโฮเต็ล เลอ คองคอร์ด กรุงเทพฯ

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34	[illegible]		เนชั่น TV		095-9508706	-
35	[illegible]				085-2957451	poy.singhagul@gmail.com
36	[illegible]		TV.7			
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Appendix II- Photo of Seminar

Open Ceremony

Keynote Presentation

Press Conference

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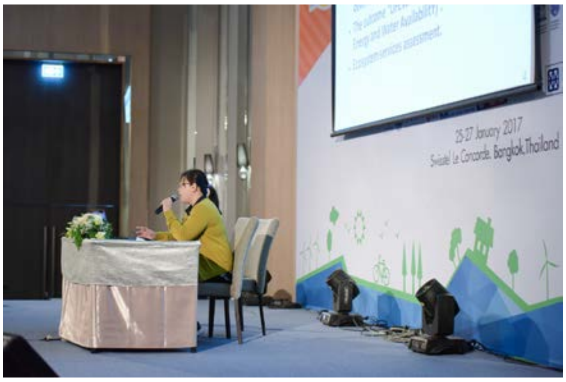

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ASEAN Workshop

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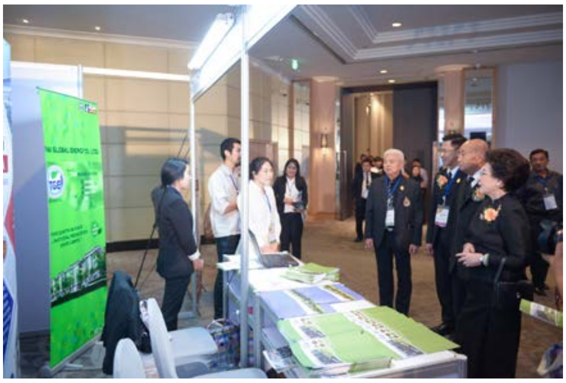
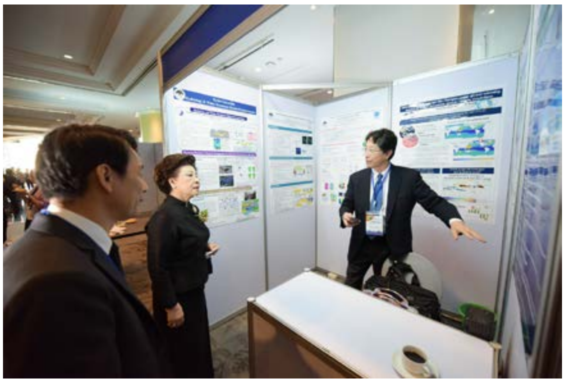
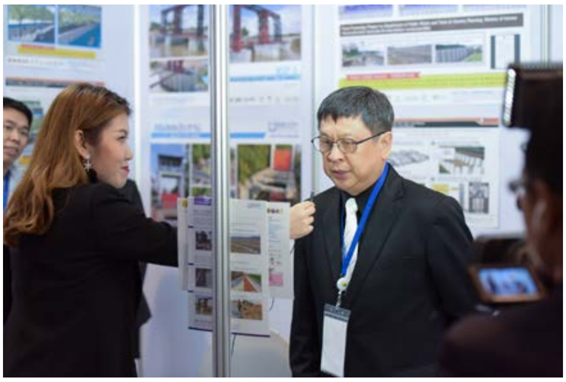
Booths Exhibition







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Welcome Party







Farewell Party