THA 2019
International Conference on
Water Management and Climate Change
Towards Asia's Water-Energy-Food Nexus and SDGs

23-25 January 2019
Swissotel Bangkok Ratchada, Thailand

CONTACT INFORMATION AND DETAILS:

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For more detailed information you are more than welcome to visit our website:
http://www.watercu.eng.chula.ac.th
http://aseanacademicnetwork.co

Preface

The THA 2019 International Conference on "Water Management and Climate Change towards Asia's Water-Energy-Food Nexus and SDGs" was organized from January 23rd to 25th, 2019 at Swissôtel Le Concorde, Bangkok. The event was organized by Chulalongkorn University, in association with 8 national and 9 international collaborative agencies. The 8 national co-organizers are the Thai Hydrologist Association (THA), Kasetsart University (KU) Kamphaengsaen Campus, Asian Institute of Technology (AIT), Royal Irrigation Department (RID), Department of Water Resources (DWR), Department of Groundwater Resources (DGR), Thailand Research Fund (TRF), and Office of the National Water Resources (ONWR). The 9 international collaborative agencies include Kyoto University, National Taiwan University (NTU), National Chen Kung University (NCKU), Department of Hydraulic and Ocean Engineering National Cheng Kung University, Korea Water Resources Association (KWRA), The International Society of Paddy and Water Environment Engineering (PAWEE), International Water Resources Research Institute (IWRRI), Japan Society of Hydrology and Water Resources, and Japan-ASEAN Science, Technology and Innovation Platform (JASTIP). The main objective of the THA 2019 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, WEF Nexus, and Sustainable Development Goals (SDGs). The conference brought together leading researchers, engineers, scientists, and officials in the domain of interest from around the world.

The THA 2019 international conference was successful according to the main objective of serving as the public assembly. Welcome speech of the THA 2019 international conference was given by Assoc.Prof.Dr.Supot Teachavorasinskun, Dean of Faculty of Engineering, Chulalongkorn University, on behalf of Prof. Dr. Bundhit Eua-arporn, President of Chulalongkorn University. The opening remarks was given by Air Chief Marshal Chalit Pukbhasuk, the Privy Council of Thailand. At this conference we had three keynote speakers, 377 Thai participants, 142 foreign participants from 17 countries including Australia, Cambodia, China, Germany, India, Indonesia, Japan, Korea, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Taiwan, United Kingdom, United Arab Emirates, and Vietnam. The three keynote presentations given by distinguished speakers who were invited to participate

in the conference emphasized the implementation of the 2030 agenda for sustainable development in cities of Asia and the Pacific, importance of the Water-Food-Energy-Security Nexus in Asia-Pacific, and Water-Energy-Food Nexus: Current Status and Challenges in Thailand. There were 21 invited paper and 83 selected papers to present under 4 subthemes. In detail 37 papers on Climate Change and Uncertainty in Hydrology and Meteorology, 1 paper on Participatory Management for Water and Irrigation Project, 11 papers on Emerging Digital Technologies in Water Management and Environment Towards Nexus and SDGs, and 34 papers on Disaster Management and Groundwater Management.

The first subtheme on Climate Change and Uncertainty in Hydrology and Meteorology 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 Management for Water and Irrigation Project covers participatory management experiences shared by presenters from many countries and water use efficiency for crop and water-energy-food nexus.

The third subtheme on Emerging Digital Technologies in Water Management and Environment Towards Nexus and SDGs covers many issues of water-energy-food nexus and SDGs. 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 and Groundwater Management covers many issues about policy on disaster management, assessment of extreme events including flood, drought and landslide. In addition to 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 2019 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 19 invited presentations from ASEAN countries; 10 of which were for the country report and the other 9 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 invited speakers from China and Japan.

The exhibition at the THA 2019 International Conference consisted of 23 booths from governmental agencies and public and private companies. Applications, models, tools and technologies were displayed at the booths..

At the end of the THA 2019 International Conference, the Bangkok Statement 2019 was announced by Asst. Prof. Dr. Anurak Sriariyawat, Head of the Department of Water Resources Engineering, Chulalongkorn University. The closing remarks were given by Assoc. Prof. Dr. Sucharit Koontanakulvong, Chairman of THA2019 Working Committee.

Major outputs obtained from the THA 2019 can be summarized below:

- Knowledge dissemination and exchange from the presentations. At this conference and workshops we had 3 keynote speakers, 377 Thai participants, 142 foreign participants from 17 countries: Australia, Cambodia, China, Germany, India, Indonesia, Japan, Korea, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Taiwan, United Kingdom, United Arab Emirates, and Vietnam, 21 invited papers, 83 technical papers participated.
- Formal announcement of Bangkok Statement 2019 for collaboration in the ASEAN Academic Networking in Water & Disaster Management and Climate Change.
- A technical training on "Nexus" and "Downscaled MRI-GCM data applications"
- 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 and SDGs.

This document presents main conclusions from the THA 2019 International Conference on "Water Management and Climate Change towards Asia's Water-Energy-Food Nexus and SDGs". Related materials that will be issued separately are the THA 2019 proceedings, a book titled "Water Management and Climate Change towards Asia's Water-Energy-Food Nexus and SDGs", and the Special Issue of THA2019 in Engineering Journal (EJ) (http://www.engj.org/index.php/ej/; ISSN: 0125-8281), Faculty of Engineering, Chulalongkorn University and Hydrological Research Letters (HRL), Japan Society of Hydrology and Water Resources (http://www.hrljournal.org; ISSN: 1882-3416).

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 2019 International Conference toward the desired objectives and achievement.

The organizers of the THA 2019 International Conference on "Water Management and Climate Change towards Asia's Water-Energy-Food Nexus and SDGs" and the coordinator of the ASEAN Academic Networking in Water and Disaster Management and Climate Change

Dr. Supattra Visessri
Dr. Sucharit Koontanakulvong
Editor of Proceeding THA 2019

Bangkok Statement, 24 January 2019

Thailand Hydrologists Association (THA) and ASEAN Academic Network in Water, Disaster Management and Climate Change

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, met during the THA 2019 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, Kyoto University and Meteorological Research Institute (MRI) under TOGOU project to provide very high resolution NHRCM data and conduct workshop on how to process NHRCM data for hydrological impact studies during THA 2019 and the data will be available for network members. Also thank to United Nations Economic Commission for Europe, Palais des Nations, Geneva to provide advices on a nexus approach to transboundary cooperation that induced the nexus training during THA2019 too.

Agree to distribute very high resolution MRI data and continue capacity-building training on data application. ASEAN members agree to collaborate on flood, governance and water planning under nexus concept under SDG principles.

Request that the ASEAN Network, Chulalongkorn University and ASEAN members to explore the possibility of a GCM data applications to impact studies on water and 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 2021 based on the theme identified.

Conference Organizing Institutes

Chulalongkorn University (CU), Thailand

Thai Hydrologist Association, Thailand

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

Asian Institute of Technology, Thailand

Royal Irrigation Department (RID), Thailand

Conference Organizing Institutes (con't)

General of Department of Water Resources (DWR), Thailand

Department of Groundwater Resources, Thailand

Thailand Research Fund, Thailand

Office of the National Water Resources, Thailand

Collaborative agency

Kyoto University, Japan

National Taiwan University, Taiwan

National Cheng Kung University (NCKU), Taiwan

Department of Hydraulic and Ocean Engineering,
National Cheng Kung University (NCKU), Taiwan

Korea Water Resources Association,
Republic of Korea

Collaborative agency (con't)

International Society of Paddy and Water Environment Engineering (PAWEES)

International Water Resources Research Institute, Republic of Korea

Japan Society of Hydrology and Water Resources, Japan

Japan-ASEAN Science, Technology and Innovation Platform (JASTIP)

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6	Miss Jongjit Niranathmateekul	Director General of Department of Groundwater Resources
7	Dr. Subin Pinkayan	President of Thai Hydrologist Association
8	Prof. Suthipun Jitpimolmard, M.D.	Director General of Thailand Research Fund
9	Dr. Somkiat Prajamwong	Secretary General of Office of the National Water Resources
10	Prof. Dr. Yasuto TACHIKAWA	Kyoto University, Japan
11	Prof. Dr. Wei Cheng Lo	NCKU, Taiwan
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29	Prof. Dr. Wansik Yu	K-water, Republic of Korea

30	Prof. Dr. Joo-Cheol Kim	K-water, Republic of Korea
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37	Assoc. Prof. Dr. Yongwon Seo	Yeungnam University, Gyeongsan, Republic of Korea
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39	Prof. Dr.Yangbo Chen	Sun Yat-sen University, China
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54	Asst. Prof. Dr. Nitirach Sanguanduan	Kasetsart University
55	Assoc. Prof. Dr. Chaisri Suksaroj	Kasetsart University
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61	Dr. Songsak Bhaddraravudthichai	Kasetsart University
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68	Assoc. Prof. Dr.Uma Seeboonruang	King Mongkut's Institute of Technology Ladkrabang, Thailand
69	Dr. Chanyut Kalakan	Burapha University, Thailand
70	Dr. Srisunee Wuthiwongyothin	Burapha University, Thailand
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72	Dr. Tipaporn Homdee	Nakhon Phanom University, Thailand
73	Assoc. Prof. Dr. Sacha Sethabutra	Srinakharinwirot University, Thailand
74	Dr. Phayom Saraphirom	Khon Kaen University, Thailand
75	Assoc. Prof. Dr. Sucharit Koontanakulvong	Chulalongkorn University, Thailand
76	Asst. Prof. Dr. Anurak Sriariyawat	Chulalongkorn University, Thailand
77	Asst. Prof. Dr. Aksara Putthividhya	Chulalongkorn University, Thailand

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81	Dr. Supattra Visessri	Chulalongkorn University, Thailand
82	Dr. Patama Singhruck	Chulalongkorn University, Thailand
83	Dr. Somkiat Apipattanavis	Office of the National Water Resources, Thailand
84	Dr. Atsamon Limsakul	Department of Environmental Quality Promotion, Thailand
85	Dr. Oranuj Lophensi	Department of Groundwater Resources, Thailand
86	Dr. Aranya Fuangswasdi	Department of Groundwater Resources, Thailand
87	Dr. Sukrit Kirtsaeng	Thai Meteorological Department, Thailand
88	Dr. Piyaman Srisomporn	Hydro and Agro Informatics Institute, Thailand
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5	Miss Marayart Petcharat	Thai Hydrologist Association

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*** Download the presentation on the website.**

http://www.aseanacademicnetwork.com/node/19

AIMS AND SCOPE

The objective is to provide a platform for researchers, scientists, practitioners, and policy makers to share and present new advances, research findings, perspectives, and experiences in Disaster, Irrigation and Water Management towards W-E-F Nexus. Special attentions will be given to developing certain skills or competence, or general upgrading of performance ability for climate change adaptation, participatory water management disaster and environmental management, and sustainable development in irrigation and drainage in the monsoon Asia. The conference will bring together leading researchers, engineers, scientists, and officials in the domain of interest from around the world

The conference will bring together leading researchers, engineers, scientists, and officials in the domain of interest from around the world topics of the conference are:

A. **Climate Change and Uncertainty in Hydrology and Meteorology**

B. **Participatory Management and Technologies for Water and Irrigation Projects**

C. **Emerging-Digital Technologies in Water Management and Environment Towards Nexus (WEF) and SDGs (Big Data, IOT)**

D. **Disaster Management/ Groundwater Management**

The presentation contents can be highlighted as follows:

Session A Climate Change and Uncertainty in Hydrology and Meteorology

The session started with the research results of downscaling research based on the Multi-Model Simulations of SEACLID/CORDEX Southeast Asia. The climate change data had been utilized to study impact on weather prediction, design wave, river discharge, landslide risk, reservoir operation. The studies on satellite rainfall estimate, extreme rainfall, urban flood, spatial heterogeneity and trans-boundary pollution were presented and lastly, the change of water budget in the seasonal tropical forest was presented for discussion.

Session B Participatory Management and Technologies for Water and Irrigation Projects

The session started with question on principles and methods of PIM in Action from Japanese experiences. The study on improving crop water use with efficient irrigation technologies was presented and discussed with the negotiation process and institutionalization in the participatory water management. The water use efficiency is discussed with the Water-Food Nexus approach.

Session C Emerging-Digital Technologies in Water Management and Environment Towards Nexus (WEF) and SDGs (Big Data, IOT)

WEF Nexus in practices were introduced to achieve sustainable resources security with proposed indicators under a DPSIR framework. New concept on Water Footprint for quantifying impact on rice production was reviewed and criticized. Lastly the concept of smart urban water systems – in practice was introduced for discussion.

Session D Disaster Management/Groundwater Management

The session started with the introduction of policies and technical works on river management for disaster risk reduction under climate change and the research on extreme flood frequency analysis and risk curve development under a changing climate was also presented. The assessment of the climate change impacts of groundwater abstraction was presented with various studies on groundwater parameter estimation under various situations. The discussion evaluation of near-real-time satellite-based rainfalls and research on Input-Output analysis of water deficits were presented for discussion.

Publication Opportunities

Journal Publication

Selected manuscripts from THA2019 proceedings will be recommended to be published in the Engineering Journal (EJ) : International Journal ISSN 0125-8281 (indexed with ESCI (Web of Science), Scopus, IET Inspec, Index Copernicus, DOAJ, and TCI: http://www.engj.org.)

Conference Proceedings

The full papers after correction will be published in the Conference Proceedings.
(selected/related full papers will also be published in book titled "Water Management and Climate Change towards Asia's Water-Energy-Food Nexus and SDGs" after peer revie)

Programme THA2019 and Asean forum

Programme of THA 2019 International Conference, Day 1 (Wednesday – 23 January 2019)

Time	Wednesday – 23 January 2019
08.00-09.00	Registration at Swissôtel Bangkok Ratchada (Venue : LE CONCORDE BALLROOM)
09.00-09.45	Opening Ceremony 1. Introduction Speech by MC 2. Congratulation Speech by Assoc. Prof. Dr. Supot Teachavorasinskun, Chulalongkorn University 3. Opening Speech by Air Chief Marshal Chalit Pukpasuk, Privy Councilor Group Photo
09.45-10.15	Exhibition tour / Press Interviews (Venue : JAMJUREE Room)
10.15-10.30	Coffee Break
10.30-11.00 11.00-11.30 11.30-12.00	Keynote Addresses **Keynote Speakers I** : Ms. Natalja Wehmer (Natasha), Sustainable Urban Development Section, Environment and Development Division, United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP) Topic : Issues and Approaches in Implementing the 2030 Agenda for Sustainable Development in Cities of Asia and the Pacific **Keynote Speakers II** : Prof. Zafar ADEEL, Pacific Water Research Centre, CANADA Topic : The importance of the water-food-energy-security nexus in Asia Pacific **Keynote Speakers III** : Dr. Somkiat Prajamwong, Office of the National Water Resources (ONWR), Thailand Topic : Water-Food-Energy Nexus: Current Status and Challenges in Thailand
12.00-13.00	Lunch Break Venue: Fourth Avenue (4th floor)

Scope Session presentation

Plenary session presentation Venue : SALON A		Plenary session presentation Venue : SALON B		Plenary session presentation Venue : JAMJUREE		Plenary session presentation Venue : SAKTHONG	
Chair	Dr. Somkiat Apipattanavis	Chair	Prof. Dr. Kwansue Jung	Chair	Assoc. Prof. Dr. Tuantan Kitpaisalsakul	Chair	Asst. Prof. Dr. Aksara Putthividhya
Briefing	Dr. Kanoksri Sarinnapakorn	Briefing	Mr. Mahippong Worakul	Briefing	Asst. Prof. Dr. Areeya Rittima	Briefing	Dr. Manussawee Hengsuwan
A01 13.00-13.20	**Guest Speaker :** **Changes of the precipitation and the Monsoon Transitional Zone in East Asia: past and future** **Prof.Dr. Wen CHEN** Chinese Academy of Sciences, CHINA	B01 13.00-13.20	**Guest Speaker :** **PARTICIPATORY APPROARCH IN ADAPTIVE WATER MANAGEMENT AND RURAL DISASTER PLANNING BY IRRIGATION GATE OPERATION** **Prof. Dr. Takao Masumoto** Akita Prefectural University, JAPAN	C03 13.00-13.20	**Guest Speaker :** **Urbanization and its impact on flood responses** **Prof. Dr. Yangbo Chen** Sun Yat-sen University, China	D01 13.00-13.20	**Guest Speaker :** **Sustainable groundwater management in Anthropocene** **Prof. Dr. Makoto Taniguchi** Research Institute for Humanity and Nature (RIHN), JAPAN
TA114-1 13.20-13.40	**A NEW APPROACH OF RAINFALL FREQUENCY ANALYSIS USING EVENT-MAXIMUM RAINFALLS** Prof. Dr. Ke-Sheng Cheng National Taiwan University	TB207-1 13.20-13.40	**FLOODING MONITORING AND FLOOD INUNDATION ANALYSIS MODEL UGING UAV** Dr. Mikyoung Choi Chungnam National University, Korea	TC302-1 13.20-13.40	**Evaluation of Satellite Precipitation from Google Earth Engine in Tonle Sap Basin, Cambodia** Assoc. Prof. Dr. Ekasit Kositsakulchai Kasetsart University Kamphaeng Saen Campus	D02 13.20-13.40	**Guest Speaker :** **Delivering Big Data and the Changing Landscape of Mobile and Web-based Technologies to Address Groundwater Security Challenges** **Mr. Sachin Shah** U.S. Geological Survey, Geospatial Science and Cyber Innovation Branch
TA135-1 13.40-14.00	**UNCERTAINTY IN RUNOFF ESTIMATION FOR A CATCHMENT OF THE THA CHIN RIVER'S UPPER PLAIN IN CHAI NAT PROVINCE, THAILAND** Assoc. Prof. Sombat Chuenchooklin Naresuan University	TA140-1 13.40-14.00	**Assessment of near-real-time satellite-based precipitation over Thailand** Mr. Narongthat Thanyawet Chulalongkorn University	TC315-1 13.40-14.00	**WATER AND FOOD RELATIONSHIP EVALUATION ON WEF NEXUS IN GREENHOUSE WITH WATER STRESS AND SOIL CONDITION** Miss. PUREUN YOON Seoul national university	TD442-1 13.40-14.00	**METHOD TO ACCESS WATER SCARCITY FOOTPRINT OF PRODUCT BASED ON ISO 14046 FOR THAILAND : A CASE STUDY OF 44 PRODUCTS IN THAILAND** Dr. Natworapol Rachsiriwatcharabul The Federation of Thai Industries
TA112-1 14.00-14.20	**COMPARISON OF PHYSICS-BASED AND DATA-DRIVEN MODELS FOR STREAMFLOW SIMULATION OF THE MEKONG RIVER** Assoc. Prof. Giha Lee Kyungpook National University	TA141-1 14.00-14.20	**RECONSTRUCTION OF THE GREAT FAMINE OF WESTERN INDIA USING HISTORICAL RAINFALL AND GLOBAL REANALYSIS DATASETS: CHALLENGES AND UNCERTAINTIES** Dr. Seemanta Sharma Bhagabati The University of Tokyo	TC304-1 14.00-14.20	**Resilience Index for Chlorine Analysis in Water Distribution Networks** Miss. Suparak Kaewsang Kasetsart University	TD422-1 14.00-14.20	**Delineation of Unconventional Groundwater: I. Soda Groundwater in Songkhla, Thailand** Assoc. Prof. Dr. Helmut Duerrast Prince of Songkla University
TA137-1 14.20-14.40	**OPTIMAL RESERVOIR OPERATIONS UNDER INFLOWS UNCERTAINTY IN NAM NGUM RIVER BASIN USING MIXED-INTEGER NONLINEAR PROGRAMMING** Mr. Bounhome Kimmany Chulalongkorn University	TA142-1 14.20-14.40	**INTERESTING STATISTICAL CHARACTERISTICS OF PRECIPITATION EXTREMES IN MAJOR RIVER BASINS OF JAPAN USING A LARGE ENSEMBLE OF CLIMATE SIMULATIONS "D4PDF"** Prof. Shigenobu Tanaka Kyoto University	TC319-1 14.20-14.40	**MONITORING LANDSCAPE CHANGES IN CATCHMENT USING REMOTE SENSING TECHNIQUES** Dr. Wen-Sheng Lin National Taiwan University	TD421-1 14.20-14.40	**DELINEATION OF UNCONVENTIONAL GROUNDWATER: II. SALINE GEOTHERMAL GROUNDWATER IN KRABI, THAILAND** Miss. Wipada Ngansom Prince of Songkla University
		TA143-1 14.40-15.00	**Joint probability for flood risk assessment in Yom River Basin** Ms. Choticha Arssiri Chulalongkorn University	TC313-1 14.40-15.00	**CLASSIFICATION OF THE RAINFED AREAS FOR THE WATER DEVELOPMENT PROJECTS IN THAILAND** Mr. Supapap Patsinghasanee Department of Water Resources	TD410-1 14.40-15.00	**Assessments of Groundwater-Surface Water Connectivity for the Lower Yom and Nan Rivers** Dr. Puripus Soonthornnonda Naresuan University
Coffee Break (15 minutes)							

Programme of THA 2019 International Conference, Day 1 (Wednesday – 23 January 2019)

Wednesday – 23 January 2019							
Scope Session presentation							
Plenary session presentation Venue : SALON A		Plenary session presentation Venue : SALON B		Plenary session presentation Venue : JAMJUREE		Plenary session presentation Venue : SAKTHONG	
Chair	Dr. Somkiat Apipattanavis	Chair	Prof. Dr. Su Ming-Daw	Chair	Prof. Dr. Tawatchai Tingsanchali	Chair	Dr. Tussanee Nettasana
Briefing	Dr. Kanoksri Sarinnapakorn	Briefing	Dr. Piyatida Ruangrassamee	Briefing	Asst. Prof. Dr. Aksara Putthividhya	Briefing	Dr. Arissara Painmanakul
A03 15.15-15.35	**Guest Speaker :** **Dynamic decision support systems based on Nash bargaining solution for water resources management in a reservoir-river basin** **Associate Prof. Dr. Lai Sai Hin** University of Malaya	B02 15.15-15.35	**Guest Speaker :** **Migration and Collective Action: Evidence from China** **Professor Eduardo Araral** National University of Singapore	C01 15.15-15.35	**Guest Speaker :** **Treating water to appropriate standards for different uses at the WEF Nexus** **Dr. Andrew Dansie** UNSW Global Water Institute, AUSTRALIA	D03 15.15-15.35	**Guest Speaker :** **Tham Luang Cave Systems in the view of Hydrogeology and related issues** **Mr. Chalporn Siripornpibul** Department of Mineral Resources, Ministry of Natural Resources and Environment, Thailand.
TA130-1 15.35-15.55	**Climate change impact on rainfall pattern in Bangkok Metropolitan region** Dr. Shotiros Protong Department of Water Resources, Thailand	C06 15.35-15.55	**Guest Speaker :** **Spatio-Temporal Mapping of Water Consumption at Public Institutions: Case of United Arab Emirates (UAE) University** **Dr. Mohamed Yagoub** United Arab Emirates University	C05 15.35-15.55	**Guest Speaker :** **Conservation, Protection and Augmenting Water Resources in Peri-Urban and Rural areas – Towards better governance and management at local level using modern digital technologies.** **Dr. Lawrence Surendra** The Sustainability Platform	D04 15.35-15.55	**Guest Speaker :** **GROUNDWATER PROTECTION IN LARGE CITIES** **Dr. Vuong Bui Tran** Deputy Director of the Division of Water Resources Planning and Investigation for the South of Vietnam
TA110-1 15.55-16.15	**Calibration, Validation and Uncertainty Analysis of SWAT Model for predicting reservoir inflow in Umiam Watershed, Meghalaya** Mr. JEFFREY DENZIL K. MARAK INDIAN INSTITUTE OF TECHNOLOGY, GUWAHATI	TA145-1 15.55-16.15	**MERGED SATELLITE AND GROUND-BASED PRECIPITATION PRODUCTS FOR EVALUATION OF VERY HIGH RESOLUTION RCM SIMULATIONS OVER CAMBODIA** Mr. Theara Tha Chulalongkorn University	TC303-1 15.55-16.15	**Impact of Water Losses on Pressure and Energy in MWA Trunk Main Network, Thailand** Assoc. Prof. Dr. Adichai Pornprommin Kasetsart University	TD457-1 15.55-16.15	**ENHANCING THE ROLES OF GROUNDWATER IN THE CONTEXT OF THE SUSTAINABLE DEVELOPMENT** Asst. Prof. Dr. Aksara Putthividhya Chulalongkorn University
TA127-1 16.15-16.35	**EFFECT OF CLIMATE CHANGE ON WATER MANAGEMENT IN LOWER CHAO PHRAYA RIVER** Asst. Prof. Sanit Wongsa King Mongkut's University of Technology	TA144-1 16.15-16.35	**ADAPTATION STRATEGIES FOR RAINFED RICE PRODUCTION UNDER CLIMATE CHANGE SCENARIOS IN THE SONGKHRAM RIVER BASIN, THAILAND** Mr. Siriwat Boonwichai Asian Institute of Technology	TC317-1 16.15-16.35	**OUTLIER DETECTION OF REAL-TIME RESERVOIR WATER LEVEL DATA USING ARTIFICIAL NEURAL NETWORK MODEL** Mr. MAGA KIM Seoul National university	TD401-1 16.15-16.35	**Relationship between groundwater,hydrology and water use in lower north region of Thailand** Assoc. Prof. Dr. Tuantan Kitpaisalsakul Chulalongkorn University
		TD420-1 16.35-16.55	**HISTORICAL SHORELINE CHANGE OF THAP SAKAE COAST, PRACHUAP KHIRI KAN, THAILAND** Ms. Nathamon Phanomphongphaisarn Chulalongkorn University	TC307-1 16.35-16.55	**Lagranglan analysis of the Chao Phraya River estuarine circulation** Dr. Sirod Sirisup National Electronics and Computer Technology Center	TD407-1 16.35-16.55	**Groundwater and surface water interaction estimates via groundwater model - case study in Plaichumphol Irrigation Project, Thailand** Miss. Pwint Phyu Aye Chulalongkorn University
18.00	Reception Dinner (For registration participant) Venue: Pool side meeting room (5th floor)						

Programme of THA 2019 International Conference, Day 2 (Thursday – 24 January 2019)

Thursday – 24 January 2019					
Scope Session presentation					
Plenary session presentation Venue : SALON A		Plenary session presentation Venue : SALON B		Plenary session presentation Venue : JAMJUREE	
Chair	Dr. Pariwate Varnakovida	Chair	Prof. Dr. Tawatchai Tingsanchali	Chair	Assoc. Prof. Dr. Koshi Yoshida
Briefing	Assoc. Prof. Dr. Usa Humphries	Briefing	Dr. Praphawadee Otarawanna	Briefing	Asst. Prof. Dr. Sanit Wongsa
A02 09.00-09.25	Guest Speaker : Future change analysis of extreme floods using large ensemble climate simulation data Prof. Dr. Tachikawa Yasuto Kyoto University, JAPAN	C04 09.00-09.20	Guest Speaker : Multi-scale water-energy-food nexus in Asia Prof. Dr. Makoto Taniguchi Research Institute for Humanity and Nature (RIHN), JAPAN	D05 09.00-09.20	Guest Speaker : ADAP-T for Water Disaster Risk Management and Sustainable Development Prof. Dr. Oki Taikan Tokyo University, JAPAN
TA101-1 09.25-09.45	Assessment of Runoff Sensitivity to Changes in Precipitation at the Indochina Region Dr. Patinya Hanittinan Kyoto University	TA152-1 09.20-09.40	NATURE-BASED SOLUTION FOR FLOOD MANAGEMENT AT NONG SUA DISTRICT, RANGSIT CANAL, THAILAND Dr. Sutat Weesakul Hydro and Agro Informatics Institute	TA124-1 09.20-09.35	CALIBRATING LAI PARAMETER WITH REMOTE SENSING DATA FOR SIMRIW-RS IN THAILAND Assoc. Prof. Dr. Mongkol Raksapatcharawong Kasetsart University
TA106-1 09.45-10.05	Assessment of Runoff generation using the Simple Biosphere Model with Urban Canopy for upper Chao Phraya River Basin, Thailand Mr. Teerawat RAM-INDRA Kyoto University	TC322-1 09.40-10.00	LAND USE CLASSIFICATION OF SMALL AGRICULTURAL PARCELS USING MULTIPLE SYNTHETIC APERTURE RADAR IMAGES Assoc. Prof. Takanori NAGANO Kobe University	TC318-1 09.35-09.50	EVALUATION OF THE RELATIONSHIP BETWEEN ELECTRIC CONDUCTIVITY AND SPECTRAL INDEX FOR SOIL SALINITY MAPPING OF RICE PADDY FIELD IN KHON KAEN PROVINCE Assoc. Prof. Dr. Masayasu Maki Tohoku Institute of Technology, Japan
TA111-1 10.05-10.25	A STUDY ON BIAS CORRECTION METHOD FOR RUNOFF GENERATION DATA BASED ON REFERENCE DATA CREATED BY LAND SURFACE MODEL Mr. Yusuke Mizushima Kyoto University	TC320-1 10.00-10.20	DTM GENERATION WITH UAV BASED PHOTOGRAMMETRIC POINT CLOUD IN LAMPHACHI RIVER Mr. KITIPONG THONGCHUA Kasetsart University	TA148-1 09.50-10.05	DEVELOPMENT OF FUTURE CLIMATE SCENARIO BASED ON MULTI GCMS OF CMIP5 AND RAIN GRIDDED DATA OBSERVED BY MULTI-AGENCIES IN THAILAND Assoc. Prof. Dr. Masashi Kiguchi The University of Tokyo, Japan
				TA121-1 10.05-10.20	STATISTICAL CHARACTERISTICS OF RAINFALL IN THAILAND USING GRIDDED DATA DURING 1981-2017 Mr. Shoujun Arai Toyama Prefectural University, Japan
Coffee Break (15 minutes)					
Chair	Dr. Pariwate Varnakovida	Chair	Dr. Siriluk Chumchean	Chair	Assoc. Prof. Dr. Masashi Kiguchi
Briefing	Assoc. Prof .Dr. Usa Humphries	Briefing	Miss. Phuengchat Chantawongso	Briefing	Asst. Prof. Dr. Chaiwat Ekkawatpanit
TA113-1 10.40-11.00	Characteristics of River Discharge Simulation Using NHRCM 5km Output by a Distributed Hydrologic Model in Thailand Miss. Aulia Febianda Anwar Tinumbang Kyoto University	B03 10.35-10.55	Guest Speaker : Disaster Irrigation and Water Management towards Nexus (WEF) and Sustainable Development Goals Professor Leong Ching National University of Singapore	TA139-1 10.35-10.50	EVALUATION OF ECONOMIC DAMAGES ON RICE PRODUCTION UNDER EXTREME CLIMATE AND AGRICULTURAL INSURANCE FOR ADAPTATION MEASURES IN NORTHEAST THAILAND Assoc. Prof. Dr. Koshi Yoshida Ibaraki University, Japan
TA129-1 11.00-11.20	Estimating probability distribution of benefit from flood control projects Mr. Keita Kobayashi Kyoto University	TD408-1 10.55-11.15	DETERMINATION OF DEEP PERCOLATION via FIELD SENSOR MEASUREMENTS IN SAIGON RIVER BASIN, VIETNAM Mr. Long Thanh Tran Chulalongkorn University	TA120-1 10.50-11.05	SEASONAL STREAMFLOW FORECASTS BASED ON PHYSICAL MODEL FOR CHAO PHRAYA RIVER BASIN IN THAILAND – INVESTIGATE THE EFFECT OF SPRING PREDICTABILITY ON STREAMFLOW FORECAST Mr. Wongnarin Kompor Tokyo Institue of Technology, Japan
TA108-1 11.20-11.40	INVESTIGATING THE EFFECT OF INITIAL SOIL MOISTURE ON RIVER DISCHARGE USING PSEUDO-DISCHARGE DATA GENERATED BY A DISTRIBUTED HYDROLOGIC MODEL Dr. Kazuaki Yorozu Kyoto University	TD412-1 11.15-11.35	Grid-based Socioeconomic Database for Exposure Estimation in Flooding Risk Analysis Prof. MINGDAW SU National Taiwan University	TA126-1 11.05-11.20	IMPACT OF HEAVY RAINFALL CAUSE BY CLIMATE CHANGE ON URBAN AREA IN BANGKOK, THAILAND Asst. Prof. Sanit Wongsa King Mongkut's University of Technology Thonburi, Thailand
TA105-1 11.40-12.00	FUTURE CLIMATE PROJECTIONS WITH HIGH HORIZONTAL RESOLUTION MODEL FOR IMPACT ASSESSMENTS IN WATER SECTORS IN SOUTHEAST ASIA Dr. Tosiyuki NAKAEGAWA Meteorological Research Institute, Japan Meteorological Agency			TD435-1 11.20-11.35	NUMERICAL EXPERIMENT OF CHANGE IN FLOODED AREA USING GRIDDED RAINFALL DATA DURING 1981-2017 IN THE MUN AND THE CHI RIVERS BASIN, THAILAND Mr. Shigehiko Oda Toyama Prefectural University, Japan
				TA125-1 11.35-11.50	IMPLEMENTATION OF NAYS2DFLOOD MODELING FOR INTEGRATED FLOODPLAIN/STORMWATER MANAGEMENT : CASE STUDY IN SUKHUMVIT AREA, BANGKOK, THAILAND Asst. Prof. Dr. Sanit Wongsa King Mongkut's University of Technology Thonburi, Thailand
Lunch Break Venue: Fourth Avenue (4th floor)					

Programme of THA 2019 International Conference, Day 2 (Thursday – 24 January 2019)

Thursday – 24 January 2019					
Scope Session presentation					
Plenary session presentation Venue : SALON A		Plenary session presentation Venue : SALON B		Plenary session presentation Venue : JAMJUREE	
Chair	Dr. Atsamon Limsakul	Chair	Assoc. Prof. Dr. Tuantan Kitpaisalsakul	Chair	Asst. Prof. Dr. Aksara Putthividhya
Briefing	Asst . Prof. Dr. Jerasorn Santisirisomboon	Briefing	Dr. Chokchai Suthidhummajit	Briefing	Assoc. Prof. Dr. Mongkol Raksapatcharawong
C08 13.00-13.15	**Guest Speaker :** **Use artificial intelligence and IoT technologies to build smart irrigation system.** **Dr. Richard Huang** Synergy Technology Co.,Ltd.	D06 13.00-13.15	**Guest Speaker :** **FLOOD COMPUTATIONS FOR CHANGING RIVER ENVIRONMENT IN KOREA** **Prof. Dr. Jun Kyung Soo** Sungkyunkwan University, KOREA (KWRA)	TA146-1 13.00-13.15	**AN ASSESSMENT OF CLIMATE CHANGE IMPACTS ON EXTREME FLOOD AND DROUGHT IN YOM AND NAN RIVER BASINS** Asst. Prof. Dr. Chaiwat Ekkawatpanit King Mongkut's University of Technology Thonburi, Thailand
TA102-1 13.15-13.30	**IRRIGATED WATER MANAGEMENT UNDER CLIMATE CHANGE SCENARIO USING WATER EVALUATION AND PLANING (WEAP) MODEL IN STUNG SRENG BASIN, CAMBODIA** Mr. Ratboren Chan Institute of Technology of Cambodia	TD404-1 13.15-13.30	**EFFECTIVENESS OF THE LEVEE AGAINST FLOODING AT DIFFERENT RAINFALL RETURN PERIODS IN MANDULOG RIVER, ILIGAN CITY, PHILIPPINES** Prof. Alan Milano Mindanao State University–Iligan Institute of Technology	TA147-1 13.15-13.30	**IMPACTS OF CLIMATE AND LAND USE CHANGES ON SOIL EROSION AND SEDIMENT YIELD IN NAN RIVER BASIN, NORTHERN THAILAND** Ms. Patchares Chacuttrikul The University of Tokyo, Japan
TA155-1 13.30-13.45	**EVALUATION OF SEMIVARIOGRAM MODELS IN THE STUDY OF SPATIAL INTERPOLATION OF SOIL SALINITY** Mr. Kanoksuk Chankon King Mongkut's University of Technology Thonburi	TD409-1 13.30-13.45	**REVIEW AND FUTURE DIRECTION OF RESEARCH ON DELTA AT RISK AND RESILIENCE TO WATER-RELATED DISASTERS** Mr. Alvin Yesaya University of Tokyo	TD459-1 13.30-13.45	**MODIFIED CRITICAL ANTECEDENT PRECIPITATION INDEX (CAPI) FOR FLOOD WARNINGS IN UPPER NAN WATERSHED, NAN PROVINCE, THAILAND** Dr. Venus Tuankrua Kasetsart University
TA163-1 13.45-14.00	**Accumulation of Polycyclic Aromatic Hydrocarbons (PAHs) and Carbon composition in Lakes sediments core in Thale Noi, Phatthalung** Mr. Natthapong Iadtem Prince of Songkla University	TD447-1 13.45-14.00	**Estimation of groundwater use pattern and distribution in the coastal Mekong Delta, Vietnam via socio-economical survey and groundwater modeling.** Mr. Pham Van Tuan Chulalongkorn University	TA151-1 13.45-14.00	**EFFECT OF LAND USE CHANGE ON HYDROLOGICAL SERVICES IN NA LUANG SUB-WATERSHED, WIANG SA DISTRICT, NAN PROVINCE, THAILAND** Mr. Teerawach Phetcharaburanin Kasetsart University
TD438-1 14.00-14.15	**FLOODING IN ODA RIVER BASIN DURING TORRENTIAL RAINFALL EVENT IN JULY 2018** Dr. Shakti P. C. National Research Institute for Earth Science and Disaster Resilience (NIED), Japan	TD405-1 14.00-14.15	**COMPARISON OF TWO LAND COVER SCENARIOS AND ITS EFFECT ON THE RUNOFF PROCESSES INSIDE THE MANDULOG RIVER BASIN, PHILIPPINES** Prof. Alan Milano Mindanao State University–Iligan Institute of Technology	TA150-1 14.00-14.15	**CLIMATE CHANGE AND LAND USE CHANGE EFFECTS ON WATER ACCOUNTING IN UPPER NAN SUB-WATERSHED** Miss. Sujira Sornsungnean Kasetsart University
TD439-1 14.15-14.30	**Assessment of satellite-based rainfall estimates over Japan** Dr. Hideyuki Kamimera National Research Institute for Earth Science and Disaster Resilience (NIED), Japan	TD431-1 14.15-14.30	**Deep Percolation Characteristics via Field Moisture Sensor Measurements in the Lower Yom and Nan Basin, Thailand.** Miss. Nittaya Kangboonma Chulalongkorn University	TD456-1 14.15-14.30	**PERCEPTION OF CLIMATE CHANGE AND ADAPTATION IN RURAL THAILAND** Dr. Kyoko Matsumoto The University of Tokyo, Japan
TD441-1 14.30-14.45	**Cross-Validation of Spatial Interpolated Rain Gage and Satelitte-Based Rainfall over Thailand** Mr. Nelson Stephen Ventura Chulalongkorn University	TD419-1 14.30-14.45	**THE CHARACTERISTICS OF SEDIMENT TRANSPORT IN THE UPPER AND MIDDLE YOM RIVER, THAILAND** Mr. Matharit Namsai Chulalongkorn University	TD432-1 14.30-14.45	**WATER QUALITY CHARACTERISTICS OF IONS ORIGINATING FROM SEAWATER AND MAN-MADE IN THE LOWER CHAO PHRAYA RIVER, THAILAND** Mr. Yusuke Horiuchi Toyama Prefectural University, Japan
				TD455-1 14.45-15.00	**ESTIMATION OF GROUNDWATER RECHARGE FROM GRACE SATELLITE AND LAND SURFACE MODEL** Mr. Daiya Shiojiri Kyoto University
Coffee Break (15 minutes)					

Programme of THA 2019 International Conference, Day 2 (Thursday – 24 January 2019)

Thursday – 24 January 2019					
Scope Session presentation					
Plenary session presentation Venue : SALON A		Plenary session presentation Venue : SALON B		Plenary session presentation Venue : JAMJUREE	
Chair	Dr. Atsamon Limsakul	Chair	Prof. Dr. K.S. Cheng	Chair	Dr. Kyoko Matsumoto
Briefing	Asst . Prof. Dr. Jerasorn Santisirisomboon	Briefing	Dr. Chokchai Suthidhummajit	Briefing	Dr. Venus Tuankrua
C02 15.15-15.35	Guest Speaker : New technologies and design of future urban water systems Ms. Katharine Cross International Water Association (IWA), UK	D07 15.15-15.35	Guest Speaker : FUTURE DROUGHT RISK ASSESSMENT IN CHANGING CLIMATE USING HYDRO-METEOROLOGICAL AND SOCIO-ECONOMIC INDICATORS Prof. Dr. Joo-Heon Lee Joongbu University, KOREA (KWRA)	TD463-1 15.15-15.30	Analysis of Local Community Awareness on Climate Hazards in Pursat Province, Cambodia Mr. Chhunleang Rorm Chulalongkorn University
TD445-1 15.35-15.50	Micro-Scale Flood Hazard Assessment in Phnom Penh City, Cambodia Miss. Naichy Sea Chulalongkorn University	TD424-1 15.35-15.50	Potential impact of severe weather on hydraulic performance of a field-scale wastewater treatment plant: A case study of baffle-based pond Mr. Saifhon Tomkratoke National Electronics and Computer Technology Center (NECTEC)	TD464-1 15.30-15.45	FORMULATION OF ADAPTATION MEASURES FOR FLOOD MANAGEMENT UNDER THE UNCERTAINTY OF FUTURE PROJECTION Mr. Hisaya Sawano Public Works Research Institute, Japan
TD448-1 15.50-16.05	A STUDY ON LOCAL KNOWLEDGE IN ADAPTATION TO LANDSLIDE DISASTERS IN SRI LANKA Mr. Uditha Akalanka Dasanayaka Nagaoka University of Technology	TD466-1 15.50-16.05	FLOOD HAZARD ASSESSMENT USING HYDRO-GEOSPATIAL TECHNIQUE: A CASE STUDY OF RIVER CHENAB FROM QADIRABAD TO TRIMMU IN PAKISTAN Prof. Dr. Tawatchai Tingsanchali Asian Institute of Technology	TD425-1 15.45-16.00	Geographically Weighted Regression Analysis Applied to the Establishment of Paddy Field Flooding Loss Functions Dr. LingFang Chang Agricultural Engineering Research Center
TD454-1 16.05-16.20	POLICY GUIDELINES ON DISASTER RISK REDUCTION FOR FLOOD PREVENTION AT KLONG YAN SUB-WATERSHED, SURATTHANI PROVINCE, THAILAND Miss. Siwaporn Promdaen Chulalongkorn University	TD430-1 16.05-16.20	VERIFICATION OF ARC GIS FOR FLOOD HAZARD MAPPING:A CASE STUDY OF CHOLBURI PROVINCE, THAILAND Prof. Dr. Tawatchai Tingsanchali Kasetsart University Sriracha Campus		
16.30-16.45	Summary Plenary session presentation Venue: LE CONCORDE BALLROOM				
16.45-17.00	Closing Remarks Venue: LE CONCORDE BALLROOM				
18.00	Farewell Party Dinner (For registration participant) Venue: Pool side meeting room (5th floor)				

Programme of THA 2019 International Conference, Day 3 (Friday – 25 January 2019)

Friday – 25 January 2019		
Technical Visit Venue : Royal Irrigation Department (RID)	Work shop I : Nexus Venue : Nilubon Room (3rd floor)	Work shop II : Downscaled MRI-GCM data applications Venue : Busakorn Room (3rd floor)

ASEAN Forum Programme (Wednesday – 23 January 2019)

Time	Wednesday – 23 January 2019
Topic :	**Executive Forum on Water Management under Climate Change and SDG**
Venue :	**Krisana Room**
Chair	**Dr. Apichai Sunchindah**
Briefing	**Dr. Supattra Visessri**
13.00	**Opening Remarks** **Dr. Apichai Sunchindah** Former ASEAN Foundation Secretariat
13.15	**Thailand Country Report 1** **Mr. Chaiya Phoungphotisop** Royal Irrigation Department
13.30	**Malaysia Country Report** **Mr. Ahmad Kamal Bin Wasis** Director of the Environment and Natural Resource Section, Ministry of Economic Affairs
13.45	**Lao PDR Country Report** **Mr. Singthong Phanthamala** Head of River Basin Planning and Development Division Department of Water Resources (DWR), Ministry of Natural Resources and Environment (MoNRE)
14.00	**Vietnam Country Report** **Ms. Nguyen Thi Thu Linh** Deputy Director General, Department of Water Resources Management
14.15	**Cambodia Country Report** **Mr. Huong Sunthan** Deputy Director General, Administrative Affairs of Ministry of Water Resources and Meteorology
14.30	**Coffee Break**
14.45	**Thailand Country Report 2** **Mr. Nirut Koonphol** Director, Bureau of International Cooperation
15.00	**Indonesia Country Report** **Mr. Pak Abdul Malik** Director of Irrigation and Water Infrastructure of BAPPENAS
15.15	**Philippines Country Report** **Ms. Snoofey Cabag** Policy Formulation Section, Policy and Programs Division, National Water Resources Board
15.30	**Myanmar Country Report** **Mr. Than Zaw** Deputy Director, Department of Meteorology and Hydrology
15.45	**Discussion on possible research issues**
16.45	**Summary of the session**
18.00	**Reception Dinner (For registration participant)** **Venue: Pool side meeting room (5th floor)**

ASEAN Forum Programme (Thursday – 24 January 2019)

Time	Thursday – 24 January 2019
Topic :	**Academic Forum on Researches on Water Management under Climate Change and SDG**
Venue :	**Krisana Room**
Chair	**Dr. Apichai Sunchindah**
Briefing	**Dr. Pongsak Suttinon**
09.00	**Presentation on Indonesia research 1** **Dr. Ignasius Dwi Atmana Sutapa** Research Centre for Limnology (LIPI)
09.15	**Presentation on Malaysia research** **Ir. Mohd Zaki bin Mat Amin** Director Water Resources and Climate Change Research Centre NAHRIM
09.30	**Presentation on Lao PDR research** **Mr. Saykham Sithavong** Deputy Head of Irrigation Department, Faculty of Water Resources, National University of Laos
09.45	**Presentation on Cambodia research 1** **Dr. Sarann LY** Head Department of Rural Engineering, Institut de Technologie du Cambodge (ITC)
10.00	**Presentation on Philippines research** **Prof. Alan E. Milano** MSU-Iligan Institute of Technology, Philippines
10.15	**Coffee Break**
10.30	**Presentation on Indonesia research 2** **Prof. Dr. Muhammad Syahril Badri Kusuma** Water Resources Eñgineering Research Group, Faculty of Civil and Environmental Engineering, Institut Teknologi Bandung
10.45	**Presentation on Vietnam research** **Dr. Vuong Bui Tran** Deputy Director of the Division of Water Resources Planning and Investigation for the South of Vietnam
11.00	**Presentation on Cambodia 2** **Dr. Chhuon Kong** Head of ITC Research Unit in Water, Environment. Institute of Technology of Cambodia
11.15	**Presentation of Myanmar** **Prof. Dr. Thein Tun** Ex. Rector of Cooperative Geography, Thanlyin
11.30	**Discussion and Summary of the session**
12.00	**Lunch Break** Venue: Fourth Avenue (4th floor)

ASEAN Forum Programme (Thursday – 24 January 2019)

Time	Thursday – 24 January 2019
Topic :	**Executive Forum on Water Management under Climate Change and SDG**
Venue :	**Krisana Room**
13.00-16.00	**Collaborative Discussion among ASEAN Plus**
Chair	**Assoc. Prof. Dr. Sucharit Koontanakulvong**
Briefing	**Dr. Piyatida Ruangrassamee**
13.00	**Japan case** **Dr. Tachikawa Yasuto** Kyoto University
13.15	**China case** **Dr. Yangbo Chen** Sun Yat-sen University, China
13.30	**Malaysia case** **Mr. Ahmad Kamal Bin Wasis** Director of the Environment and Natural Resource Section, Ministry of Economic Affairs
13.45	**Lao PDR case** **Mr. Singthong Phanthamala** Head of River Basin Planning and Development Division, Department of Water Resources (DWR), Ministry of Natural Resources and Environment (MoNRE)
14.00	**Vietnam case** **Ms. Nguyen Thi Thu Linh** Deputy Director General, Department of Water Resources Management
14.15	**Myanmar case 1** **Mr. Than Zaw** Deputy Director, Department of Meteorology and Hydrology
14.30	**Coffee Break**
14.45	**Korea case** **Prof. Dr. Kwansue Jung** Chungnam University, Korea
15.00	**Indonesia case** **Mr. Pak Abdul Malik** Director of Irrigation and Water Infrastructure of BAPPENAS
15.15	**Philippines case** **Ms. Snoofey Cabag** Policy Formulation Section, Policy and Programs Division, National Water Resources Board
15.30	**Cambodia case** **Mr. Huong Sunthan** Deputy Director General, Administrative Affairs of Ministry of Water Resources and Meteorology
15.45	**Myanmar case 2** **Dr.Nilar Aung** Pro-Rector of Yangon East University
16.00	**Summary of the session**
16.45	**Closing Ceremony (Joint closing ceremony for the THA2019 and ASEAN Forum)**
18.00	**Farewell Party Dinner (For registration participant)** **Venue: Pool side meeting room (5th floor)**

Introduction Speech

THA 2019 International Conference on Water Management and Climate Change towards Asia's Water-Energy-Food Nexus and SDGs (January 23, 2019, Swissotel Bangkok Ratchada, Thailand)

(1) Dear Air Chief Marshal Chalit Pukpasuk, the Privy Council of Thailand; President of Chulalongkorn University; the chairman of the THA2019 International Conference on Water Management and Climate Change towards Asia's Water-Energy-Food Nexus and SDGs; delegates from United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP), Pacific Water Research Centre, Canada and Office of the National Water Resources (ONWR), Thailand, management from water institutions, faculties from universities in ASEAN and in neighboring region and all honorable participants. I would like to report on the background of the THA2019 International Conference as follows:

(2) The THA conference series was initiated in 2015 by the Faculty of Engineering, Chulalongkorn University to address water management and climate change issues which has drawn interest from a large number of researchers over the world. In the THA2015, ASEAN Academic Network was formed and subsequently led to the establishment of a UNESCO Chair on Water, Disaster Management and Climate Change at Chulalongkorn University.

Two years later in 2017 when Chulalongkorn University celebrated 100th anniversary of its founding, the THA2017 International Conference on Water Management and Climate Change Towards Asia's Water-Energy-Food Nexus was organized to fulfill Chulalongkorn University's mission to be the "Pillar of the Kingdom".

Following on the success of the THA2015 and THA2017, the THA2019 International Conference on Water Management and Climate Change towards Asia's Water-Energy-Food Nexus and SDGs is organized as the third of the THA conference series. The main objective of the conference is to provide a platform for researchers, scientists, practitioners, and policy makers to share and present new advances, research findings, perspectives, and experiences in climate change, irrigation, emerging technologies, disaster management, and SDGs.

The conference consists mainly of four parts including oral presentation, poster exhibition, workshops and technical visit. 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 Digital Technologies in Water Management and Environment Towards Nexus and SDGs, 4) Disaster Management and Groundwater Management. Two workshops of Nexus and Downscaled GCM applications on the last day of the conference are newly introduced this year. The ASEAN Academic Networking is also a part of every THA conference series dedicating to the promotion of collaboration in research and education in ASEAN.

(3) Chulalongkorn University, in association with 8 national co-organizers and 9 international collaborative agencies has worked closely together to organize the THA2019 International Conference from 23rd to 25th January 2019. The 8 national co-organizers are the Thai Hydrologist Association (THA Hydro), Kasetsart University (KU) Kamphaengsaen Campus, Asian Institute of Technology (AIT), Royal Irrigation Department (RID), Department of Water Resources (DWR), Department of Groundwater Resources (DGR), Thailand Research Fund (TRF), and Office of the National Water Resources (ONWR).

(4) The THA2019 is highlighted by 3 keynote speakers including: first, Ms.Natasha Wehmer, Sustainable Urban Development Section, Environment and Development Division, United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP); second, Prof. Zafar Adeel, Pacific Water Research Centre, Canada; and third, Dr. Somkiat Prajamwong, Office of the National Water Resources (ONWR), Thailand. There are 21 invited session speakers.

(5) The THA2019 is expected to contribute to improved scientific understanding of climate change, NEXUS and SDGs from the presentations given by scholars and experts from several countries in different regions of the world and from the hands-on workshops. The THA2019 is also a forum for creating academic network for future collaboration.

(6) Next, I would like to invite Prof.Dr.Supot Teachavorasinskun, Dean of Faculty of Engineering and on behalf of the President of Chulalongkorn University to make a welcome speech for the THA2019 International Conference.

Welcome Speech

THA 2019 International Conference on Water Management and Climate Change towards Asia's Water-Energy-Food Nexus and SDGs (January 23, 2019, Swissotel Bangkok Ratchada, Thailand)

Given by
Prof.Dr.Supot Teachavorasinskun,
Dean of Faculty of Engineering, Chulalongkorn University
On behalf of Prof. Dr. Bundhit Eua-arporn, President of Chulalongkorn University

1) Dear Air Chief Marshal Chalit Pukpasuk, the Privy Council of Thailand; co-organizing agencies; collaborative agencies; esteemed delegates and management from water institutions, and all honorable guests, on behalf of the President of Chulalongkorn University, I, Prof.Dr.Supot Teachavorasinskun, Dean of Faculty of Engineering, Chulalongkorn University would like to convey to all of you participating in the THA2019 conference my heartfelt welcome. It's my privilege and pleasure on behalf of Chulalongkorn University to welcome you today to the THA 2019 International Conference on Water Management and Climate Change towards Asia's Water-Energy-Food Nexus and SDGs. We are delighted to have participants from many countries to participate this conference. That many of you have traveled long distances to be here serves as a reminder to us all how important water is.

2) Water is crucial natural resource. It is one of the basic needs of living organisms and the fundamental factors for economic and social development. Water management is a complex issue. Imbalance between limited water supply and increasing demand due to rapid population and economic growth has been a conventional issue for water and disaster management. A contemporary issue associated with climate change and uncertainty makes water management in present day more challenging than in the past. Natural disasters such as floods, typhoons, earthquakes, tsunamis, and volcanic eruptions commonly occurring in the Southeast Asia region have been intensified due to more severe climate variation and climate change.

3) Chulalongkorn University realized the importance of academic collaboration on addressing the water management and climate change issues, the THA conference was therefore initiated with an aim to serve as a public forum to promote continuous coordination and strengthen collaboration among academics, researchers, policy makers, and government executives in ASEAN countries to address more challenging water issue due to changing environment and to put forward research findings into operation. In 2015 the first THA conference on Climate Change and Water & Environment Management in Monsoon Asia and the UNESCO Chair in Water, Disaster Management and Climate Change were launched. The second THA conference in 2017 focused on Water Management and Climate Change Towards Asia's Water-Energy-Food Nexus.

4) The theme of the THA2019 conference is designed to match with on-going global trend. The THA2019 covers not only water management and climate change but also Water-Energy-Food Nexus and SDGs. The THA2019 pays particular attention to developing the skills and ability to address the problems of water and disaster management, participatory management, environmental management and sustainable development goals.

5) As a co-organizer, I hope that we will receive contributions from all participants through the presentations and discussion which are vital important for developing effective and practical measures against climate change. As noted in this conference, "Toward together" we can create better environment for all.

Opening Speech

THA 2019 International Conference on Water Management and Climate Change towards Asia's Water-Energy-Food Nexus and SDGs
(January 23, 2019, Swissotel Bangkok Ratchada, Thailand)

Given by Air Chief Marshal Chalit Pukpasuk, the Privy Council of Thailand

1) Good morning Ladies and Gentlemen, Dear Distinguished delegates, I am pleased to welcome you to the THA 2019 International Conference on Water Management and Climate Change Towards Asia's Water-Energy-Food Nexus and the ASEAN Academic workshop which are organized by Chulalongkorn University, in association with 8 national and 9 international collaborative agencies. It is high time that such an event took place to address emerging issues regarding climate change and water management and to foster research contributions. The list of registration reveals the diversity of participants from many countries around the world. As we are now in Thailand, I would like to take this opportunity to share with you the philosphy of water management in Thailand that are applied to the royal projects and able to support SDGs.

His Majesty the late King Bhumibol Adulyadej, the Symbolic "Father of Water Resources Management", recognized the importance of water, as he constantly reminded the public that "Water is life" as it is a basic necessity of life. His speech delivered at Chitralada Palace on 17th March 1986 was "...We must realize the importance of water. We need it to drink, for daily use and for agriculture. Where there is water, there is life. If there is water, we can survive. If there is no electricity, we can still survive. However, if there is no water but there is electricity, we will perish..."

2) Water is central to all aspects of life and is the core of sustainable development. Despite its fundamental role across all sectors, water is all too often managed in a fragmented manner. The lack or excess of water is not simply an issue for innovative technology and science to address. It could affect social equity and justice. Water management in the recent decade is particularly challenging due to a number of factors

such as competing demands on water arising from population growth and socio-economic development, extreme weather conditions, high natural variability and fluctuation in water demand and supply.

3) To address water management issues, knowledge exchange, technology transfer and collaborations in research are much needed. We all can help to move our community towards sustainability by focusing our research efforts around the 2030 Agenda for Sustainable Development Goals and attempting to explore better solutions for water-related problems specifically the impacts of climate change, disaster and other pressing challenges on Asia's water-energy-food nexus.

4) The philosophy of Sufficiency Economy conceived by His Majesty the late King Bhumibol Adulyadej can be considered as a solution for sustainability as it fits well with the SDGs. The philosophy of "Sufficiency Economy" or "The Middle Path" is to develop the ability to take appropriate conduct to create a balanced and stable development under changing environment. Sufficiency refers to three components including moderation, reasonableness and self-immunity. Moderation is reflected in the sense of not too much or not too little. Reasonableness means that all choices made should be justified by ethics, law justice, and social norms. Self-immunity is also known as resilience against the risks which arise from internal and external changes. His Majesty the late King Bhumibol Adulyadej's legacy, the Philosophy of Sufficiency Economy, is believed to help societies around the world deliver on the SDGs as it has been proven to be useful in Thailand.

5) The THA2019 provides a valuable opportunity for scientists, researchers, policy planners and decision-makers to discuss and share knowledge and experiences to seek for cutting-edge solutions for water management for our region and our world. I would like to thank both local and international participants attending this conference. I wish the THA2019 great success in advancing water-related research mission and I hope you have a fruitful discussion and rewarding experience in the THA2019. The THA conference series is expected to continue playing an important role in facilitating technical knowledge dissemination and networking in the future.

6) Now it is time to declare the THA2019 international conference officially open and hope that the conference will proceed towards the objectives set. Thank you and enjoy your stay in Thailand.

Summary of Press Meeting

THA 2019 International Conference on Water Management and Climate Change toward Asia's Water-Energy-Food Nexus and SDGs

23 January 2019, Swissotel le Concorde, Bangkok, Thailand

ASEAN was born in Thailand over 50 years ago and today comprises 10 countries and a population of six hundred million and is the sixth largest economy in the world. It has played a constructive role and gained the recognition of the international community. Therefore, assuming the ASEAN Chairmanship is an opportunity and an important duty. It is indeed an honor for Thailand and the Thai people and is something in which we should all take pride.

The theme of the Thai ASEAN Chairmanship is "Advancing Partnership for Sustainability".

Water, Energy, Food securities are the main conditions to meet the demand of socio-economic development in our region. This is why our partnership attend this activity to take mutual responsibility for our ASEAN.

In this press meeting, we invite experts from ASEAN member countries to share experiences and recommendations to address the water-energy-food issues to meet the ASEAN's demand.

The list of experts is shown as follow:

1. Prof. Alan E. Milano: MSU-Iligan Institute of Technology, Philippines
2. Ir. Mohd Zaki bin Mat Amin: Director Water Resources and Climate Change Research Centre NAHRIM, Malaysia
3. Sanya Saengpumpong: Expert, Royal Irrigation Department, Thailand
4. Prof. Dr. Sompong Klaynongsruang: Deputy Director, The Thailand Research Fund, Thailand
5. Dr. Pongsak Suttinon: Department of Water Resources Engineering, Chulalongkorn University, Thailand

All participants share their experiences and recommendations which are concluded as follow;

- Each ASEAN member country has a similar trend of increasing demands in water, energy and food to meet national socio-economic development under normal situation and during disaster period,
- We should share successful and unsuccessful experiences for knowledge sharing among ASEAN,
- Experts from the other countries outside ASEAN are needed to support coping capacity in our region
- Research and development are the key drivers to meet ASEAN's demand.
- We should keep this THA activity to maintain our partnership in sustainable way.

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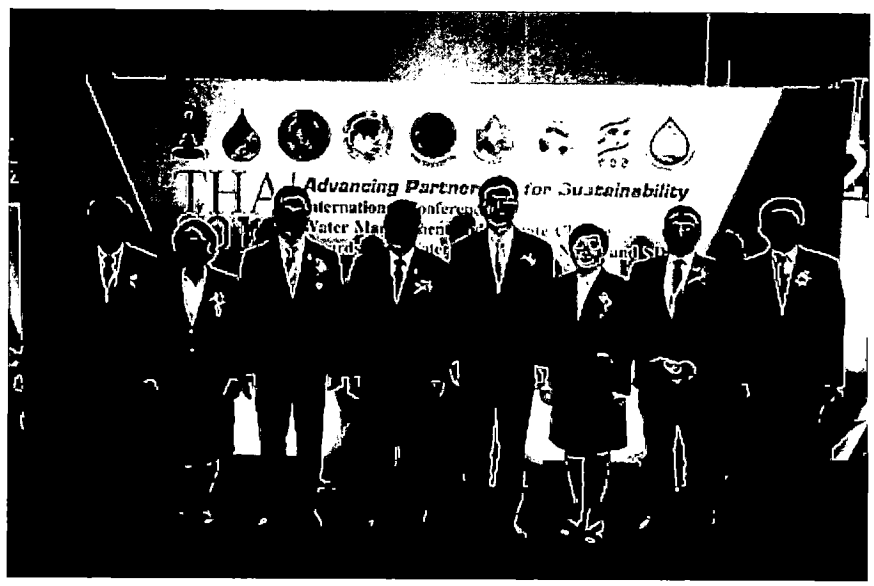
คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย ร่วมกับ สวก. กรมชลประทาน และ ภาคีเครือข่ายด้านน้ำ จัดการประชุมวิชาการนานาชาติประจำปี 2019 ว่าด้วยการบริหารจัดการน้ำและการเปลี่ยนแปลงสภาพอากาศที่มุ่งสู่ความมั่นคงด้านน้ำ พลังงาน อาหาร และเป้าหมายการพัฒนาที่ยั่งยืนในภูมิภาคเอเชีย หรือ THA 2019 International Conference on Water Management and Climate Change towards Asia's Water-Energy-Food Nexus and SDGs เพื่อเปิดเวทีให้นักวิจัย วิศวกร นักวิชาการ ระดับหัวกะทิในภูมิภาคอาเซียน ได้นำเสนอข้อมูลเกี่ยวกับผลงานวิจัย แลกเปลี่ยนความรู้แชร์แนวคิด และประสบการณ์ในด้านการบริหารจัดการน้ำ ชลประทาน การจัดการภัยพิบัติและสิ่งแวดล้อม ในมิติความสัมพันธ์ระหว่างน้ำ-พลังงาน-อาหาร เป้าหมายเพื่อการพัฒนาที่ยั่งยืน (SDGs) โดยมีนักวิจัยทั้งชาวไทยและตัวแทนจากประเทศสมาชิกอาเซียนให้ความสนใจเข้ามาร่วมอย่างคับคั่ง



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ธุรกิจ-เศรษฐกิจ สิ่งแวดล้อม

วิศวะจุฬาฯ ร่วมกับภาคีเครือข่ายด้านน้ำ ประชุมระดับนานาชาติ THA 2019

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คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย ร่วมกับ สวก. กรมชลประทาน และ ภาคีเครือข่ายด้านน้ำ จัดการ ประชุมวิชาการนานาชาติประจำปี 2019 ว่าด้วยการบริหารจัดการน้ำและการเปลี่ยนแปลงสภาพอากาศที่มุ่งสู่ความมั่นคงด้านน้ำ พลังงาน อาหาร และเป้าหมายการพัฒนาที่ยั่งยืนในภูมิภาคเอเชีย หรือ THA 2019 International Conference on Water Management and Climate Change towards Asia's Water-Energy-Food Nexus and SDGs เพื่อเปิดเวทีให้นักวิจัย วิศวกร นักวิชาการ ระดับหัวกะทิในภูมิภาคอาเซียน ได้นำเสนอข้อมูลเกี่ยวกับผลงานวิจัย แลกเปลี่ยนความรู้แชร์แนวคิด และประสบการณ์ในด้านการบริหารจัดการน้ำ ชลประทาน การจัดการภัยพิบัติและสิ่งแวดล้อม ในมิติความสัมพันธ์ระหว่างน้ำ-พลังงาน-อาหาร เป้าหมายเพื่อการพัฒนาที่ยั่งยืน (SDGs) โดยมีนักวิจัยทั้งชาวไทยและตัวแทนจากประเทศสมาชิกอาเซียนให้ความสนใจเข้ามาร่วมอย่างคับคั่ง

Session A
Climate Change and Uncertainty in Hydrology and Meteorology

GUEST SPEAKER: A01

CHANGES OF THE PRECIPITATION AND THE MONSOON TRANSITIONAL ZONE IN EAST ASIA: PAST AND FUTURE

WenCHEN[1], Jin-Ling PIAO[1], Wen ZHOU[2], Hans-F. GRAF[1], LinWANG[1], Joong-Bae AHN[3], and Alexander POGORELTSEV[4]

The monsoon transitional zone (MTZ) in East Asia is the transitional belt between humid and arid regionsand is characterized by sharp climate and biome gradients. This belt is considered to be "interface fragile" to natural disasters and climate changes. However, significant attention is not given to the variation of the MTZ in East Asia. Thus, there is an urgent need to address the precipitation variation and the associated MTZ changes, especially during rainy season.

A decadal change of summer rainfall in the MTZ of East Asia is observed around 1999. This decadal change is characterized by an abrupt decrease of summer rainfall of about 18% of the climatological average amount leading to prolonged drought in the region. Three different drought indices, the standardized precipitation index, the standardized precipitation evapotranspiration index, and the self-calibrating Palmer Drought Severity Index, present pronounced climate anomalies during 1999-2007, indicating dramatic drought exacerbation in the region after the late 1990s. This decadal change in the summer rainfall may be attributable to a wave-like teleconnection pattern from Western Europe to Asia. A set of model sensitivity experiments suggests that the summer warming sea surface temperature in North Atlantic could induce this teleconnection pattern over Eurasia, resulting in recent drought in the MTZ region.

With the CMIP5 simulation results, a focused and detailed survey of MTZ has been conducted. In the historical period, the MTZ experienced coastward migration with increasing aridity throughout MTZ. Furthermore, precipitation fluctuation mainly contributes to interannual variability of MTZ whereas potential evaporation behavior dominates its long-term trends. In global warming scenario period, there will be continuing southeastward displacement for the front edge but the opposite northwestward movement is projected for the rear one, as a consequence of significant drying trends in the humid zone together with regime shifts towards humid conditions in the arid zone. Moreover, interannual variability of MTZ is expected to become stronger, resulting in more frequent occurrences of extreme swings. Finally, it is noted that uncertainty arising from climate models dominates in the MTZ than dispersed emission scenarios, in contrast to the situation in humid and arid zones.

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GUEST SPEAKER: A02

FUTURE CHANGE ANALYSIS OF EXTREME FLOODS USING LARGE ENSEMBLE CLIMATE SIMULATION DATA

Yasuto TACHIKAWA*

Future change analysis of extreme floods in Japan using large ensemble climate simulation data is discussed. At first, a change of the magnitudes of probable largest-class floods caused by a historical typhoon is analyzed using typhoon track ensemble simulations combined with a pseudo-global warming experiment. Then, to estimate a change of probability distributions of extreme rainfall and floods, simulated river discharge using "Database for Policy Decision-Making for Future Climate Change, d4PDF" is analyzed. The d4PDF consists of large ensemble members of climate simulations for the 60-years historical simulations with 50 ensemble members and 60-years future simulations with 90 ensemble members. The magnitude of a largest-class floods equivalent to a 900-years flood is also analyzed. The study basins are the Ara River basin (2940km^2) in the Tokyo metropolitan area, the Shonai River basin (1010km^2) in the Nagoya area, and the Yodo River basin (8240km^2) in the Osaka and Kyoto area in Japan. The results reveal the clear increase of the magnitude of extreme rainfall and floods.

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GUEST SPEAKER: A03

DYNAMIC DECISION SUPPORT SYSTEMS BASED ON NASH BARGAINING SOLUTION FOR WATER RESOURCES MANAGEMENT IN A RESERVOIR-RIVER BASIN

Lai Sai Hin*, Mehdi Zomorodian, Mehran Homayounfar

Langat River Basin is a strategic catchment in Malaysia, providing water for important demand points including Kuala Lumpur, Klang Valley, Putrajaya, and Cyberjaya. However, the growth of demand, along with recent drought events has warned decision-makers about the reliability and vulnerability of the current water resources system. In this study, two dynamic models based on Nash Bargaining Solution (NBS) were developed to deal with conflict situations. In the first model, a continuous dynamic game model for water allocation in a reservoir system considering the randomness in both reservoir inflow and the rest of the network flow was developed. The second model combined a simulation-optimization modeling method based on coupled System Dynamics (SD) and Game Theory (GT). This model benefits from SD advantages in capturing dynamic behaviors of a system and existing feedback loops between system components during simulation. In order to identify the efficiency of the proposed methods, a case study was carried out at Langat river basin in Malaysia. Based on various reliability indices (Relibility, Resilience and vulnerability) calculated from results obtained, both models are capable of tackling conflict issues in water allocation under situations of water scarcity. The calibrated model was used to simulate for five different managerial scenarios between 2014-2035, and compared against their overall sustainability index (SI) and satisfaction level (SL). The results obtained from analyses showed that supply-oriented policies are temporary solutions, while combining demand and non-revenue water management can secure sustainable development for a more extended period in Langat River Basin.

Keywords: Water shortage, Water Resources Management, Decision support system, System Dynamics, Game Theory, Nash Bargaining Solution

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PAPER ID: TA101-1

ASSESSMENT OF RUNOFF SENSITIVITY TO CHANGES IN PRECIPITATION AT THE INDOCHINA REGION

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Reliable assessment of runoff is a key for the prediction and management of freshwater resources. Therefore, hydroclimate forcing datasets, e.g., precipitation and total runoff (ROF) using the output from the multiple-realization, single-model ensemble named "d4PDF", were obtained in this study. Due to lack of direct observation of the ROF, we first evaluated the validity of the present-climate d4PDF precipitation using the Taylor diagram. Generally, the model was able to reproduce the extreme indices with a respectable performance regarding pattern correlations (0.6-0.9) and the centered-pattern RMSE (0.5-1). The spatial distributions of correlations between seasonal climatology and intensity-based extreme indices of precipitation and associated ROF were found to have a strong relation, especially early monsoon (JJA) and late monsoon (SON) indices with the correlation coefficients up to 0.75-0.85 under a 5% significance level in several regions of Indochina. Finally, the runoff sensitivities, which are the relative change in ROF due to the change in various precipitation indices were discussed. The results showed that the elasticity of runoff to precipitation is greater than unity for 83-95% of land grid cells during annual and wet-season time scale, indicated a faster response of the ROF under changing climate.

Keywords: 4PDF, runoff generation, extreme indices

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PAPER ID: TA102-1

IRRIGATED WATER MANAGEMENT UNDER CLIMATE CHANGE SCENARIO USING WATER EVALUATION AND PLANING (WEAP) MODEL IN STUNG SRENG BASIN, CAMBODIA

Ratboren Chan , Chantha Oeurng*, Marith Mong

Stung Sreng is the most potential one to extract water for both domestic used and agricultural sector. But this basin face the management problem that can cause water scarcity. WEAP model was applied in this basin to assess irrigated water demand under climate change scenario. The current and future streamflow were generated from SWAT model. As the result, the reference scenario will define irrigated demand from 2018 to 2030 and found that the water demand is 679 MCM and unmet demand is around 95 MCM, respectively. There are only 2 irrigation schemes among 51 schemes that need most water demand around 150 to 200 MCM. Furthermore, the scarcity of water will face mostly in November and December around 35 to 60 MCM. The reference scenario will define irrigation demand from 2018 to 2030. The result generated from the model shows that irrigated water demand is 679 MCM and unmet demand 95 MCM similarly to current account scenario the water scarcity mostly occur in dry season (November and December). For climate change scenario, it indicates that the water demand and unmet demand of under the two RCPs RCP 2.6 and 8.5 (GISS-E2-R-CC mode) shows the slightly increasing trend of water and unmet demand compared to annual increase scenario. The peak of water demand in dry season is in March and November. In contrast, for the lowest demand was in May and June. In addition, the most scacity of water in this scenario is in November and December.

Keywords: WEAP model, Water demand, climate change scenario.

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PAPER ID: TA105-1

FUTURE CLIMATE PROJECTIONS WITH HIGH HORIZONTAL RESOLUTION MODEL FOR IMPACT ASSESSMENTS IN WATER SECTORS IN SOUTHEAST ASIA

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Future climate scenarios for impact assessments for the entire world have been provided with a Meteorological Research Institute (MRI) global climate model (GCM) with high horizontal resolution of 20 km (MRI-AGCM) under a research program, Integrated Climate Change Projection in Japan. Reliable impact assessments requires a precise physical-based model for each sector. Such a model often requires its high-horizontal-resolution forcing data such as meteorological variables, land cover, soil types, and river cross section. Therefore, we have provided the data of future climate scenarios for impact assessments for foreign impact assessment researchers and investigated impact assessments on water resources with collaboration with impact assessment researchers. First, we evaluated a present-day climate simulation in Southeast Asia with MRI-AGCM against observations and obtained good reproducibility of the present-day climates. Indeed, future changes in surface air temperature extreme indices are projected to increase in the entire Southeast Asia, but future changes in precipitation extreme indices is projected to vary with area even within Southeast Asia. Five day rainfall totals is projected to increase in more than half of land area of Southeast Asia with high confidence and to decrease in spotty areas scattered in Southeast Asia with less confidence. We also assessed water resources in Chao Phraya River in a late 21st century under SRES A1B and obtained a peak of river discharge at Nakhon Sawan located in the central region in September, a delay of one month after the maximum monthly mean precipitation. The position of MRI-AGCM in the CMIP5 multi-model ensemble projections are also discussed.

Keywords: future climate, global climate model, impact assessments

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PAPER ID: TA106-1

ASSESSMENT OF RUNOFF GENERATION USING THE SIMPLE BIOSPHERE MODEL WITH URBAN CANOPY FOR UPPER CHAO PHRAYA RIVER BASIN, THAILAND

Teerawat RAM-INDRA*, Yasuto TACHIKAWA, Yutaka ICHIKAWA, and Kazuaki YOROZU

The upper Chao Phraya river basin is consisting of four river basins: Ping, Wong, Yom, and Nan which play an essential role essential water to the central part of Thailand. Each sub-basin has a variety of topography from mountainous area to flat plain. It is usually difficult for field measurement with complex terrain to directly measure the land and atmosphere interaction. The land surface model (LSM) is an alternative way to provide that information. In this study, the runoff simulated by a land surface model named Simple Biosphere Model with Urban Canopy (SiBUC) for the regional scale of the upper Chao Phraya River Basin. The forcing data are gathering from observation, reanalysis, and satellite estimation. A kinematic wave routing model was applied for the runoff product and analyzed at representative discharge observation stations for the upper Chao Phraya river basin. The validation is needed to test the performance of the model in the study area. The result could provide more understanding of the characteristic of runoff in the upper Chao Phraya river basin and should serve as the reference runoff generation data in the future research.

Keywords: Land surface model, Upper Chao Phraya River basin, Runoff generation

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INVESTIGATING THE EFFECT OF INITIAL SOIL MOISTURE ON RIVER DISCHARGE USING PSEUDO-DISCHARGE DATA GENERATED BY A DISTRIBUTED HYDROLOGIC MODEL

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The initial condition of soil moisture is negligible for river discharge simulation. In this study, the effect of initial soil moisture on river discharge was investigated. The target of this study was the upper part of Bhumibol dam catchment in Thailand. Throughout statistical correlation test for JRA-55 atmospheric reanalysis data and CHIRPS satellite based rainfall data, it was assumed that monthly atmospheric fields in rainy season didn't have significant autocorrelation. Therefore, a log-term atmospheric data was generated by recombining atmospheric data between August and September. And then, a long-term pseudo-discharge data was generated utilizing a distributed hydrologic model using recombination atmospheric data. Annual maximum daily river discharge from a pseudo-discharge data was evaluated by comparing the river discharge data generated by original atmospheric data and a distributed hydrologic model. It was found that significant difference was not detected with 10% level between a CDF from the former data and that from the latter data. Annual maximum daily river discharge from a pseudo-discharge data could be categorized into two groups. First one was the data using same rainfall, another one was the data using same initial soil moisture. Analyzing each data, it was estimated that the effect of rainfall on river discharge was 590 cubic meter per second and the effect of initial soil moisture was 160 cubic meter per second.

Keywords: river discharge, soil moisture, distributed hydrologic model

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OVERVIEW OF DYNAMICAL DOWNSCALING OF CLIMATE SIMULATIONS OVER SOUTHEAST ASIA IN MRI

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Several researchers are invited to MRI in order to conduct collaborative researches between the institutes in Southeast Asia and MRI every year. The experiments of dynamical down scaling have been conducted by using the Non-hydrostatic Regional Climate Model (NHRCM) in each country. NHRCM is derived from the non-hydrostatic model used operationally for weather forecasting by the Japan Meteorological Agency. NHRCM has high performance for reproducing the Japanese climate and the calculation results are used for many official reports published by Japanese Ministries. However, the reproducibility of the NHRCM varies from country to country. In this study, NHRCM is used to dynamically downscale climate projections from the 20 km resolution MRI Atmospheric General Circulation Model (MRI-AGCM3.2) over Southeast Asia at very high resolution (from 2 to 5km) for the present climate (1981-2000) and far-future climate (2080-2099) under the RCP 8.5 scenario.

Keywords: regional climate model

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CALIBRATION, VALIDATION AND UNCERTAINTY ANALYSIS OF SWAT MODEL FOR PREDICTING RESERVOIR INFLOW IN UMIAM WATERSHED, MEGHALAYA

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The prediction of inflow to a reservoir is of utmost importance for the optimal operation of the reservoir under the climate change scenario. Umiam basin is of great significance to the Meghalaya State of India as it serves five major reservoirs for generation of hydropower. This study aims to calibrate and validate the Soil and Water Assessment Tool (SWAT) model for Umiam watershed in Meghalaya, India for predicting reservoir inflow and to quantify the uncertainties. The SWAT model was established for Umiam basin and the SUFI-2 algorithm was used to perform calibration, validation and uncertainty analysis of the model. The model was calibrated using observed discharge for the period 1979 – 1995 and validated for the period 1996-2000 on monthly basis. The sensitivity analysis shows that the parameters such as Curve Number, Groundwater Delay Time, Groundwater Revap Coefficient, Soil Evaporation Compensation Factor, Threshold Depth in Shallow Aquifer for Revap to Occur, Threshold Depth of Water in Shallow Aquifer for Return Flow to Occur and Baseflow Alpha Factor are very sensitive ($p < 0.05$). The streamflow simulated by the model showed a good correlation with the observed data with R2 values of 0.96 and 0.86 for calibration and validation periods respectively. From this study, it can be concluded that SWAT model can be used predict reservoir inflow in Umiam Watershed.

Keywords: Sensitivity; Uncertainty; SWAT-CUP.

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A STUDY ON BIAS CORRECTION METHOD FOR RUNOFF GENERATION DATA BASED ON REFERENCE DATA CREATED BY LAND SURFACE MODEL

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Yutaka Ichikawa
Yasuto Tachikawa

Climate change has a great influence on water cycle and water resources prediction. Generally, General Circulation Model (GCM) is used for assessing the impact on natural disasters such as floods and draughts due to climate change. To improve the reliability of future climate prediction by GCM, it is effective to correct the bias of that output. In this study, bias correction was performed for MRI-AGCM3.2S 3-hourly runoff generation data from 1982 to 2001, by applying Quantile-Quantile Mapping (QQM) method based on reference data created by the land surface model SiBUC. The target area was the Kyushu Island, Japan. Due to an unavailability of runoff generation observation, the land surface model SiBUC was utilized for creating reference runoff generation data by using meteorological data such as APHRO_JP precipitation data and JRA-55 reanalysis data. The effect of the bias correction was evaluated by calculating the river discharge utilizing river routing model, 1K-FRM. As a result, the river discharge simulated using bias-corrected runoff generation data showed an improvement compared with that simulated using the original one. However, it was confirmed the river discharge simulated using bias-corrected runoff was overestimated compared with that using reference data especially on high flood events. Therefore, QQM method was applied for high runoff generation data and low data independently by setting threshold values for reference data and original data, respectively. The overestimation result was improved by this advanced approach.

Keywords: Climate change, Bias correction, Runoff generation data

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COMPARISON OF PHYSICS-BASED AND DATA-DRIVEN MODELS FOR STREAMFLOW SIMULATION OF THE MEKONG RIVER

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In recent, the hydrological regime of the Mekong River is changing drastically due to climate change and haphazard watershed development including dam construction. Information of hydrologic feature like streamflow of the Mekong River are required for water disaster prevention and sustainable water resources development in the river sharing countries. In this study, runoff simulations at the Kratie station of the lower Mekong River are performed using SWAT (Soil and Water Assessment Tool), a physics-based hydrologic model, and LSTM (Long Short-Term Memory), a data-driven deep learning algorithm. The SWAT model was set up based on globally-available database (topography: HydroSHED, landuse: GLCF-MODIS, soil: FAO-Soil map, rainfall: APHRODITE, etc) and then simulated daily discharge from 2003 to 2007. The LSTM was built using deep learning open-source library TensorFlow and the deep-layer neural networks of the LSTM were trained based merely on daily water level data of 10 upper stations of the Kratie during two periods: 2000~2002 and 2008~2014. Then, LSTM simulated daily discharge for 2003~2007 as in SWAT model. The simulation results show that Nash-Sutcliffe Efficiency (NSE) of each model were calculated at 0.9(SWAT) and 0.99(LSTM), respectively. In order to simply simulate hydrological time series of ungauged large watersheds, data-driven model like the LSTM method is more applicable than the physics-based hydrological model having complexity due to various database pressure because it is able to memorize the preceding time series sequences and reflect them to prediction.

Keywords: LSTM, Mekong River, SWAT

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CHARACTERISTICS OF RIVER DISCHARGE SIMULATION USING NHRCM 5KM OUTPUT BY A DISTRIBUTED HYDROLOGIC MODEL IN THAILAND

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A river discharge estimation using a detailed projection of climate data and hydrologic model is important to make a basin-level assessment under a climate change impact. Recently, a result of a first version of NHRCM 5km-spatial resolution is available for Thailand area, provided by JMA/MRI. The objective of this research is to evaluate river discharge simulated by using the NHRCM 5km output. Before the river discharge simulation is performed, a 20-years-average NHRCM 5km rainfall was verified with APRHODITE observation data. It was found that NHRCM 5km rainfall was underpredicted in the most of Thailand region. However, some area in the northern region, which almost corresponds to Bhumibol dam catchment, was overestimated, particularly in the beginning of rainy season. Hence, it showed a better accuracy. After that, the river discharge was simulated using NHRCM 5km output as forcing data by a coupled of a land surface model SiBUC and a flow routing model 1K-FRM. The simulated river discharge was evaluated with the observed inflow data. The 20-years-average monthly river discharge showed an overestimated result during rainy season. This is consistent with the rainfall analysis, but only the total amount of rainfall could not explain the reason of overestimation. The analysis of heavy rainfall amount (more than 20 mm/day) showed a large number of events during rainy season, which might be the reason of overestimated river discharge.

Keywords: NHRCM 5km, distributed hydrologic model, river discharge

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A NEW APPROACH OF RAINFALL FREQUENCY ANALYSIS USING EVENT-MAXIMUM RAINFALLS

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Frequency analysis is a crucial step in hydrological engineering design. By estimating the probability distribution of annual maximum rainfalls of a specific duration, the exceedance probability and average recurrence interval, i.e., return period, of certain rainfall depths can be calculated. Annual maximum series (AMS) is most widely used for rainfall frequency analysis. By choosing the maximum rainfall in each year and regarding each year as a "block", the distribution of annual maximum rainfalls could be approximated by the Generalized Extreme Value (GEV) distribution, according to the Extremal Type Theorem. However, two concerns may arise when using AMS. AMS of specific durations were selected without considering rainfall events and thus AMS may be composed of rainfalls of two or more separated storm events, particularly for AMS of longer durations. As the result, frequency analysis using AMS tends to overestimate rainfall depth. However, in reality, such AMS rainfall amounts might not result in severe flooding since flood flow of the first storm could have receded before the beginning of the second storm. The second concern is the assumption of annual maximum rainfall distribution. According to the Extremal Type Theorem, the block size (number of events in each year) should be the same for AMS to be approximated be the GEV distribution. This is obviously not the case in the real world. The annual number of storm occurrences is not a constant, so the GEV approximation of AMS rainfalls is not theoretically granted. Therefore, we propose an event-maximum-rainfalls (EMR) based approach for frequency analysis. For any given design duration, we firstly extracted event-maximum-rainfalls of individual storm events by considering the minimum inter-event time of different storm categories including Meiyu, typhoons, convective storms, and winter frontal rainfalls. Annual counts of storm events and event-maximum rainfalls were modeled by the Poisson distribution and Pearson Type III distribution, respectively. For each storm category, a storm-type-specific mixture distribution of annual maximum rainfalls was then derived. Finally, the cumulative distribution function of the over-all (considering all storm types) annual maximum rainfalls was obtained from the storm-type-specific mixture distributions. Stochastic simulation was conducted to demonstrate the proposed EMR-based approach. The EMR-based approach is superior to the traditional AMS-based approach in terms of the biasedness and mean squared error. The EMR-based approach is particularly useful in situations of short record length and outlier presence.

Keywords: Event-maximum series, annual-maximum series, frequency analysis.

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SEASONAL STREAMFLOW FORECASTS BASED ON PHYSICAL MODEL FOR CHAO PHRAYA RIVER BASIN IN THAILAND – INVESTIGATE THE EFFECT OF INITIAL DAY FOR PREDICTION ON STREAMFLOW FORECAST

Wongnarin KOMPOR*, Natsuki YOSHIDA, Sayaka YOSHIKAWA, Shinjiro KANAE

Seasonal forecasts of river flow is crucial for river management in Thailand. The forecasted data can support water manager to operate reservoir more effective. The current status of seasonal climate forecast studies shows the evidence that the ability of a forecast will lower during spring season (February to May), which called spring predictability barrier (SPB). However, there are still no evidence on how much of effect from lower forecast skill during spring in seasonal forecast data to seasonal streamflow forecast. Thus, this study aims to verify the effect of SPB on a streamflow forecast. This study presents the development of a seasonal streamflow forecast dealing with a physical model-based system to produce probabilistic seasonal streamflow forecasts in Chao Phraya river basin. The hydrological model, H08 model, is forced with observed meteorological dataset (1981-2004) to verify the model accuracy. The hindcast is simulated using bias-corrected output of a seasonal rainfall forecast provided by previous study. In current study, the ability to forecast is compared with observed river discharge and simulated river discharge from H08 model. Last, we verify the accuracy of seasonal streamflow forecast due to the effect of SPB. Overall, results show that the hindcast simulation have a good agreement with observed river discharge and simulated river discharge except the initial starting month to prediction during spring (February to May). The accuracy during the effect of SPB is dramatically drop when compare to other period. This study recommends that the prediction during spring period should be avoided predicting for more than 1 month.

Keywords: Seasonal Streamflow Forecasts, Spring Predictability Barrier, Seasonal Rainfall Forecasts, Hydrological Model

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STATISTICAL CHARACTERISTICS OF RAINFALL IN THAILAND USING GRIDDED DATA DURING 1981-2017

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BOONLERT ARCHVARAHUPROK***

Spatially interpolating pointed rainfall and making it gridded is one of the important methods for grasping the spatial characteristics. However, it is well known that the characteristics of rainfall data may be different depending on the gridding interpolation method.
The purpose of this study is to clarify the long term trend of rainfall in Thailand using the gridded data set produced by the Thai Meteorological Department (TMD). This study used the rainfall gridded data obtained by interpolating the point rainfall data observed by the TMD during 1981-2017 into a 0.5 degree grid using the Kriging method. The number of rainfall stations used varies from year to year.
Annual maximum daily rainfall, monthly rainfall and annual rainfall were analyzed the long term trend using the Mann-Kendall test which is one of the nonparametric trend tests. As the result of the trend test, Chumphon, Lamphun, Nakhon Sawan and Buriram Provinces had the significant positive trend of annual maximum daily rainfall ($p<0.05$, $p<0.01$). The coastal area of Chachoengsao Province had the negative trend significantly ($p<0.05$). Monthly rainfall in January had the negative trend over the whole Thailand. Annual rainfall had the positive trend in many regions. Especially the Northern, North-Eastern and Southern area had the significant positive trend. On the other hand, the Eastern area had negative trend with no significance.
10-, 30-, 50- 100-year return periods of daily rainfall were estimated using the Generalized Extreme Value distribution. As the result, the east side of the Southern region had remarkable rainfall data.

Keywords: Generalized Extreme Value distribution, Mann-Kendall test, Thailand

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CALIBRATING LAI PARAMETER WITH REMOTE SENSING DATA FOR SIMRIW-RS IN THAILAND

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Rice is a major industrial crop in Thailand and has been cultivated country-wide. An ability to estimate rice production on a regional scale is therefore imperative for adaptation plan to climate change. For example, agricultural zoning can be adopted to optimize among locale characteristics, farmer practices, water resources, and expected yields. Recently, a simulation model called SIMRIW-RS has been validated for rice yield estimation based on practical parameters, especially accurate LAI values in early stage. This paper presents a validation of SIMRIW-RS using measured LAI parameter and a methodology to incorporate remote sensing data products (NDVI and EVI2) into SIMRIW-RS model by means of calibrated LAI parameter. Based on field data collected in Nongchok District in NE-Bangkok during rainfed crops in 2017-2018, our results show that the model with measured LAI values can simulate LAI parameter for the entire crop with RMSE less than 1.0, and consequently achieve simulated yield with mean percentage error (MPE) around 2%. With calibrated LAI values based on NDVI, the model exhibits comparable performance with measured LAI whereas those based on EVI2 can achieve lower performance. This work concludes that SIMRIW-RS can be adapt to Thai rice, and NDVI product from remote sensing data in early stage can be used to provide field-to-field variations for SIMRIW-RS to work on a regional scale.

Keywords: EVI2, LAI, NDVI, regional scale, remote sensing, yield estimation

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IMPLEMENTATION OF NAYS2DFLOOD MODELING FOR INTEGRATED FLOODPLAIN/STORMWATER MANAGEMENT : CASE STUDY IN SUKHUMVIT AREA, BANGKOK, THAILAND

Sanit Wongsa*
Varameth Vichiensan
Napaporn Piamsa-nga
Shinichiro Nakamura

Flooding in urban areas is an inevitable problem for many cities in the world. In Thailand, Bangkok has serious problems related to urban flooding. The situation was highlighted in May 2017, when residences experienced ankle to knee-deep flood water on the streets. Daily activities in parts of the city were nearly paralyzed and heavy traffic jams occurred due to stagnant water on the streets. The study has depended on a combined approach of physically based modeling and GIS. The architecture of the software consists of 3 functions: pre-processor, post-processor, and solver. Nays2DFlood is a flood flow analysis solver that relies on unsteady 2-dimensional plane flow simulation using boundary-fitted coordinates1 as the general curvilinear coordinates. The urban drainage is structured by Nays2DFlood software for the basis of two networks, one simulating the two-dimension free-surface flow over the streets and one for the pumping/canal/pipe system. The interaction between street and pumping/canal/pipe system is modeled in a simple way. In 2017, ADAP-T project carried out a pilot study about urban flooding and adaptation modeling for Sukhumvit area, Bangkok Metropolitan. This study is performed as an extension and improvement of pilot study in terms of analyzing drainage system on effect of flood hazard, vulnerability, risk map and adaptation under the issue of climate change in Sukhumvit area, Bangkok, together with suggestion of alleviation scenarios to relieve flood problems.

Keywords: Urban flooding; Climate change adaptation, iRIC software

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IMPACT OF HEAVY RAINFALL CAUSE BY CLIMATE CHANGE ON URBAN AREA IN BANGKOK, THAILAND

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This paper This paper describes benchmark testing of two-dimensional (2D) hydraulic models (Nays2D Flood) in terms of their ability to simulate surface flows in a densely urbanized area. The model are applied to a 22.595 km2 urban catchment within the city of Whattana – Klongtoey Districts. The purpose of this research is to study the capacity of current drainage system by Nays2D Flood. It is used to simulate a flood event that occurred at this site on 16th May, 2017, There was rain 90 millimeters within 3 hours which caused flooding in some area. And adapted to simulate under heavy rainfall cause by climate change. An identical numerical grid describing the underlying topography is constructed for model, using a DEM (Digital Elevation Model) from Land Development Department (LDD) and grouping building in study area. Procedure is commencing by studying existing drainage system, The calibration of parameter which effect on simulation model such as, a runoff coefficient = 0.35, a coefficient of Manning's n = 0.02. The result show that the terrain data available from DEM systems are sufficiently accurate and resolved for simulating urban flows. The existing drainage system could not achieve the design rainfall. Case of present, flooding in Asokmontri Sukhumvit and Rama 4 road, depth of flood 15-20 centimeters, and duration about 1-3 hours. Under projected climatic change scenarios, the results of flood depths, duration and areas are increased from present condition more than 1.5 - 2.0 times in the study area.

Keywords: heavy rainfall, climate change, urban area

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EFFECT OF CLIMATE CHANGE ON WATER MANAGEMENT IN LOWER CHAO PHRAYA RIVER

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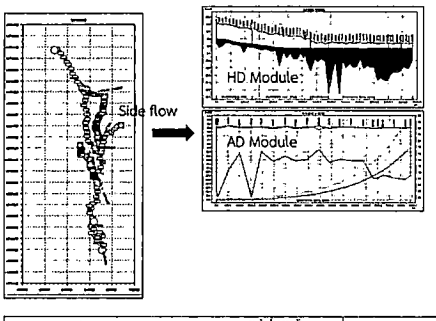
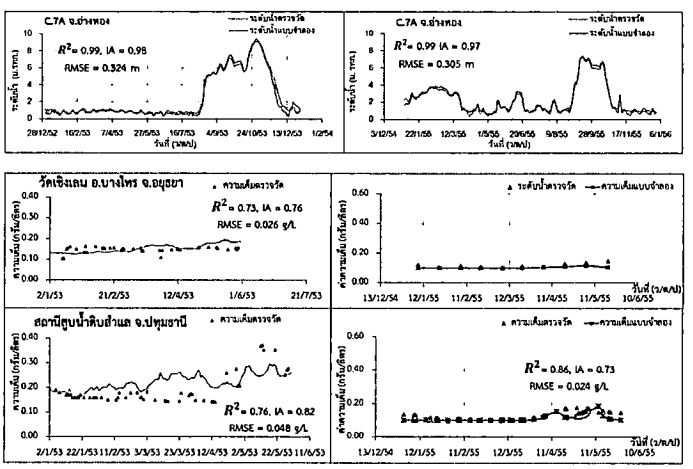
Climate change causes serious risks to the well-being of nature and people all over the world. Within the estuaries, sea water can be the important controls of water level, salinity and coastal erosion. The objective of this study is to evaluate the effect of climate and sea level changes on water management in lower part of Chao Phraya River, by using MIKE11 model. The study covered the area from Chao Phraya Dam (barrage), Chai Nat Province to the river estuary at the Gulf of Thailand, Samut Prakan Province. The model was divided into two parts, hydrodynamic (HD) module and advection-dispersion (AD) module. Calibration of each part was done by adjusting its important coefficients. It was observed that the Manning's coefficient (n) and coefficient dispersion of mass were in the range of 0.025-0.040 and 800-1,600 m^2/s, respectively. The results of comparison between models and observation data revealed order of forecasting error (R^2) in the range of 0.93-0.99 for water level and 0.73-0.86 for salinity. For model application, the RCP2.6 and 8.5 scenario from IPCC report were simulated, sea water level rising in were 0.44 and 1.18 m (in the year of 2100), respectively. Maximum salinity at Samlae Station were 0.33-0.67 g/l, the value of 0.25 g/l exceeding standard and the pointed tip of salinity was at Ko rain sub-district, Ayutthaya Province. Results of this study can be used as guidelines for the management of water resources and agriculture of the Chao Phraya River Basin.

Keywords: Global Warming, Sea water level change, Chao Phraya River, MIKE11 Model





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ESTIMATING PROBABILITY DISTRIBUTION OF BENEFIT FROM FLOOD CONTROL PROJECTS

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Yutaka Ichikawa, Kazuaki Yorozu**

Frequencies of severe flood events are expected to increase due to a changing climate. Therefore, it becomes more and more important to implement suitable flood defenses based on quantitative benefit analysis of flood control projects such as dam construction and embankment. In general, the benefit from flood control projects is defined as the sum of expected value of annual reduced damage cost over the evaluation years, considering discount rate of each year. Since flooding is low-frequency events especially in the highly protected areas, it is highly uncertain whether actual reduced damage cost is distributed around its expected value, i.e. the probability with which benefit calculated from the expected value does not necessarily occurs frequently. The probability distribution of reduced damage cost would provide more comprehensive information for decision making. This study redefined benefit from a flood control project as a reduced damage cost, which is actually a random variable, and developed its probability distribution by applying extreme rainfall generation. Then, we demonstrated the presented method under several project scenarios. The estimated probability distribution was skewed leftwards, and had a long tail. It reveals large variability of reduced damage cost. From the probability distribution, we can extract several statistics in addition to the expected value, which provide more information to discuss the characteristics of actual reduced damage cost by flood control projects.

Keywords: benefit from flood control projects, probability distribution, uncertainty

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CLIMATE CHANGE IMPACT ON RAINFALL PATTERN IN BANGKOK METROPOLITAN REGION

Shotiros Protong

The extreme rainfall trends in Thailand frequently occurred during the past decades. The climate change problems have caused extreme monsoons and tropical cyclones, with heavier rainfall leading to floods and inundations in cities. This research will focus on the comparison of rainfall pattern maps, between both the observed rainfall (1980 – 2017) and the modelled rainfall (2000 – 2050), are supported on Arc GIS software version 10.3.

Average observed rainfall data are recorded by the Thailand Meteorological Department (TMD) during the 1980-2017 period. Metropolitan region consists of Nakhon Pathom, Pathum Thani, Nonthaburi, Samut Prakan and Samut Sakhon provinces. Rainfall pattern is described by interpolation using the rain stations covering fifteen provinces of the central part of Thailand namely, Nakhon Pathom, Nonthaburi, Pathum Thani, Samut Prakan, Samut Songkhram, Nakhon Sawan, Ang Thong, Phra Nakhon Si Ayutthaya, Kanchanaburi, Ratchaburi, Chai Nat, Lopburi, Saraburi, Sing Buri and Suphan Buri. The interpolation is used for this case because there are only four rain stations in Bangkok Metropolitan region. The achievement of interpolation which is a part of Arc GIS 10.3, is used to estimate the rainfall values. In general, the rainfall values are usually high in the rainy season (mid-May to October), but this approach calculates the wet days all through the year, due to the probability of flood and inundation corresponding to heavy rainfall not only in the rainy season but also in other seasons. The rainfall values should be calculated for the rainfall intensity (defined as mm of rainfall per one hour) for the natural disaster analysis. To address the research objective, knowledge and study result in rainfall pattern impact due to climate change show in terms of the rainfall intensity classification. It leads to investigate the disaster risk, vulnerability and adaptation plans for water resources management in the future.

Keywords: rainfall intensity, observed rainfall, modelled rainfall and Arc GIS 10.3

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SUGGESTIONS PROSPECT OF DISCHARGE AT DAECHEONG AND YONGDAM DAM WATERSHED UNDER RCP SCENARIOS USING SWAT MODEL

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In this study, the future expected discharges are analyzed at Daecheong and Yongdam Dam Watershed under Future Greenhouse Gas Scenarios based on RCM with 1km spatial resolutions from Korea Meteorological Administration(KMA). HadGEM2-AO, which is the climate change prediction model that KMA recently introduced is used for this study. The runoff is simulated using the ArcSWAT model form 1988 to 2010. The simulation is in good agreement with measured data at the Yongdam Dam and Daecheong Dam showing R^2 of 92.25% and 95.40% respectively. Using the average discharge from 2001 to 2010 as a baseline, the simulated annual average discharge increased by approximately 47.76% and 36.52% under the RCP4.5 scenario and RCP8.5 scenario respectively for the form 2011 to 2100.

Keywords: SWAT, Climate Change, RCP Scenario

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UNCERTAINTY IN RUNOFF ESTIMATION FOR A CATCHMENT OF THE THA CHIN RIVER'S UPPER PLAIN IN CHAI NAT PROVINCE, THAILAND

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The Huai Khot sub-watershed was chosen to study the runoff production to the upstream of the Huai Khot Wang Man diversion canal from 2007 to present. It is a catchment of the Huai Khun Kaew watershed, which is a lack of the hydrological observation data as the prediction in ungauged basin (PUB). It locates the upper plain of the Tha Chin river basin in Uthai Thani and Chai Nat provinces, Thailand. The soil and water assessment tool (SWAT) and the hydrological modeling system (HMS) were applied to the simulation of the hydrological response unit productions and daily streamflow. The results of runoff production from both models were compared to the observed data at the hydrological observation station downstream end of the Huai Khun Kaew watershed. The results of both models fitted to the Nash and Sutcliffe efficiency (NSE), correlation (R^2), and the root mean square error (RSME). Therefore, these models can be applied as an efficient water management of the existing diversion canal to the beneficial area in the Nong Mamong district, Chai Nat province.

Keywords: Streamflow estimation, ungauged catchment, Tha Chin Basin

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A STUDY ON THE HYDRAULICS ESTIMATE OF TAMSUI RIVER UNDER CLIMATE CHANGE

Chih-Tsung Huang[1], Wei-Cheng Lo[2*], Meng-Hsuan Wu[3], Chen-Min Kuo[3]

This study aims to discuss the influence of CMIP3(A1B) and CMIP5(RCP8.5) climate change scenarios on flood analyses. Urban flood disasters have become a serious problem for city and river management worldwide, especially under the changing climate. This research discusses the influences of rainfall, discharge and flood stage in Tamsui River under different climate change scenarios. The downscaling rainfall data of CMIP3 and CMIP5 are provided by TCCIP (The Taiwan Climate Change Projection and Information Platform Project) and are used for frequency analysis to generate the 2-day max rainfall of a 200-yr return period. Then, the 200-yr 2-day max discharges of each section of Tamsui River are calculated using the unit hydrograph method. The 200-year 2-day discharges were used as inputs into the HEC-RAS hydraulic model to calculate flood stage. The results showed that compared to CMIP3 scenario, the CMIP5 scenario shows a 1%~5% increase in rainfall, 4%~6% increase in discharge, and 1%~3% increase in flood stage.

Keywords: climate change, HEC-RAS, flood stage

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OPTIMAL RESERVOIR OPERATIONS UNDER INFLOWS UNCERTAINTY IN NAM NGUM RIVER BASIN USING MIXED-INTEGER NONLINEAR PROGRAMMING

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Optimal reservoir operation is crucial, especially for large multi-purpose reservoirs. The reservoir operation is very complex and challenging subject to increasing water demands, reservoir inflow, and climate uncertainties. Nam Ngum 1 (NN1) Hydropower plant is one of the key hydropowers in the energy sector in Laos. This research aims to maximize the hydropower production under the impact of reservoir inflow uncertainty. To assess the effects of inflow uncertainty, Autoregressive Integrated Moving Average (ARIMA) model was applied for this study. The best candidate model for each configuration was selected based on Akaike Information Criterion (AIC). The NN1 reservoir operation optimization was formulated using Mixed-Integer Non-linear Programming (MINLP) technique. The inflow from ARIMA model was analyzed comparing with the observed data. The total annual and monthly power production from different dependable inflow conditions was focused. ARIMA (2,1,3) model was selected for monthly reservoir inflow forecasting. The model was able to capture better low flow and high flow characteristics of the system based on the statistical testing. The optimization results demonstrated that the annual hydropower production can be increased 12.25%.and 2.22 % from observed and simulated inflow respectively. The operations can be used as a guideline for water allocation in the Nam Ngum River basin.

Keywords: Optimal reservoir operation, Inflow uncertainty, Time series model, MINLP technique.

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EVALUATION OF ECONOMIC DAMAGES ON RICE PRODUCTION UNDER EXTREME CLIMATE AND AGRICULTURAL INSURANCE FOR ADAPTATION MEASURES IN NORTHEAST THAILAND.

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Desell Suanburi, Naruekamon Janjirauttikul, Weerakaset Suanpaga**

In northeast Thailand, the ratio of irrigated agricultural land was only 7.6% and others were rain-fed so that climate change makes agricultural production more unstable and also makes crucial damage to the societies and economics in rural area. To mitigate these issues, it is desirable to develop and disseminate enhanced adaptation systems. In this study, we focused on weather-index insurance for climate change adaptation measure. Firstly, we evaluated how affect the rainfall amount and patterns on rice production through regression analysis by using the meteorological and agricultural statistic data from 1985 until 2004. The production of wet season rice had positive relationship(R>0.2, Slope>0.2) with 3 month accumulated rainfall (Jun-Aug) in 11 provinces. As a result, employed rainfall index was suitable for accurate estimation of rice production in wet season. Secondly, household survey was conducted to grasp farmer's conditions of water use, cultivation, income balance. And then, economic loss by weather-induced agricultural damage was estimated and impact on farmer's household income was evaluated by using the agricultural statistic and rice price data from 1981 until 2013. Recently, agricultural economic loss of around 600 million Baht was often occurred in northeast Thailand. However, farmers household income mostly relied on non-agricultural sector so that agricultural economic loss was less than 10% of their annual income. Current weather index was designed by 4-30 years return periods in Khon Kaen province and that also might be the one of the barriers of insurance sales.

Keywords: Agricultural damage, household survey, risk assessment, climate change adaptation

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ASSESSMENT OF NEAR-REAL-TIME SATELLITE-BASED PRECIPITATION OVER THAILAND

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Satellite-based precipitation products are publicly available and provide continuous series of high temporal and spatial resolution especially for regions with limited rain gauge. However, satellite-based precipitation is derived from microwave, near infrared and radar signals thus they normally contain bias. Thailand located in the tropical zone and has been affected by floods and droughts frequently. Precipitation data are thus very important in assessment of water-related disasters. Although there is a good rain gauge network in Thailand, in many parts of the country, there is still quite limited number of rain gauge, for example mountainous areas in the norther part and east coast area. This study aims to statistically evaluate two near-real-time satellite-based precipitation products, including GSMaP_NRT and PERSIANN-CCS during 2001-2014. GSMaP_NRT is hourly product with 0.1 x 0.1 degree and 4-hour latency while PERSIANN-CCS is hourly product with 0.04 x 0.04 degree with 1-hour latency. Compared to the Thai Meteorological Department rain gauge data (TMD), the two satellite-based precipitation products depict the spatial distribution well, with underestimation in monthly and annual rainfall especially in the east coast river basin and the southern parts of Thailand. The daily comparison depicts different trends in each river basin. Further adjustment to reduce bias of the satellite-based precipitation would be implemented.

Keywords: satellite-based precipitation, GSMaP_NRT, PERSIANN-CCS

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RECONSTRUCTION OF THE GREAT FAMINE OF WESTERN INDIA USING HISTORICAL RAINFALL AND GLOBAL REANALYSIS DATASETS: CHALLENGES AND UNCERTAINTIES

Seemanta Sharma Bhagabati [1]*, Akiyuki Kawasaki[2], Michihiro Ogawa[3]

The Deccan Plateau in Western India has a semi-arid climate. Historically, the region has experienced multiple hydrological disasters, affecting the agriculture and thereby the peasants' life. The region suffered extensive water scarcity during the Great Famines between 1876 and 1878. According to the British India's Famine Commission, the total fatality crossed the 5 million mark, however the actual numbers are supposed to be way more than that. Although there has been some statistical analysis of the event, spatial analysis including the extent and severity has not been conducted. In this research, using hydrological modelling as a tool, we try to reconstruct the hydrological conditions. As input data, historical daily rainfall data and reanalysis datasets for meteorological data are used. Different reanalysis datasets have different levels of accuracy/uncertainty. To overcome this issue, the mean of multiple reanalysis datasets has been used. The results allow us to visualize the disaster extent and have a better understanding of the Great Famine.

Keywords: 19th century, Drought, Historical analysis

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INTERESTING CHARACTERISTICS OF STATISTICS IN PRECIPITATION EXTREMES IN MAJOR RIVER BASINS OF JAPAN USING A LARGE ENSEMBLE OF CLIMATE SIMULATIONS "D4PDF"

Shigenobu TANAKA

Climate change impact has recently attracted strong public attention every time severe water-related disaster occurs. Generally, very infrequent events such as the event which occur once in 100 years are estimated based on the extreme value theory with annual maximum series or peaks over threshold which is sufficiently large. In this study, it is focused that the relationship between statistic characteristics, mean and standard deviation of annual maximum daily rainfall R1d and probability distribution function of extreme value theory. Usually extremes such as annual maximum series have wide range of variety and one has to conduct frequency analysis on each data set for estimating extrapolating extremes. Gumbel distribution is a two-parameter distribution and the parameters are closely related with the statistics; mean and variance. The characteristics of mean and variance are examined for the past and the future experiment of "Database for Policy Decision-Making for Future Climate Change" (d4PDF) in major six river basins in Japan. The d4PDF is a large ensemble of climate simulations with 20 km grid size. The past experiment consists of 50 ensembles of 60 years and the future of 90 ensembles of 60 years. As a result, it is found that the values of coefficient of variance of R1d in the river basin are distributed in a rather limited range and then, we can use this relationship in estimation of return levels without conducting frequency analysis. Further, the relationship also provides a hint of bias correction of "ensemble climatic data" such as d4PDF.

Keywords: climate change, d4PDF, precipitation extreme

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JOINT PROBABILITY FOR FLOOD RISK ASSESSMENT IN YOM RIVER BASIN

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In consideration of appropriate measures for flood mitigation, annual maximum flow data are very important. Yom River Basin has experienced floods frequently due to its topography of mountainous area in the upper basin and low-lying area in the lower basin as well as lack of major reservoirs in the basin. In flood risk assessment using flood frequency analysis, distribution function of annual maximum flow and estimated parameters of the distribution need to be determined. This study aims to compare three methods of parameter estimation in identifying appropriate method for Gumbel distribution function of peak flows of five flow stations in Yom River Basin. The parameter estimation methods are method of moments, maximum likelihood, and L-moments. For goodness-of-fit test, two methods: chi-square test and L-moment ratio diagram were also compared. It was found that the Gumbel distribution is best fitted to the annual maximum flow data in the Yom River Basin with the L-moments method to estimate the parameters. Further, a joint probability of annual maximum flow among stations is developed using a semi variogram to estimate a covariance function. The joint probability is useful for planning and considering efficient flood mitigation measures.

Keywords: flood, joint probability, Yom River Basin

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ADAPTATION STRATEGIES FOR RAINFED RICE PRODUCTION UNDER CLIMATE CHANGE SCENARIOS IN THE SONGKHRAM RIVER BASIN, THAILAND

Siriwat Boonwichai* and Sangam Shrestha

This study investigates the potential impacts and adaptation strategies on rainfed rice production under climate change scenarios in the Songkhram River Basin, Thailand. DSSAT crop simulation model was used to project the future rice production (KDML105 rice variety) based on an ensemble of four Regional Circulation Models (RCMs) for 2030s (2020-2044) under RCP4.5 and RCP8.5 scenarios. The projection of future climatic conditions shows an increasing trend in both maximum and minimum temperatures. Maximum and minimum temperatures are expected to rise by 0.9 °C under RCP4.5 scenario, and 1.0 and 1.1 °C under RCP8.5 scenario, respectively. Crop water requirement may be higher by 16 and 17% under RCP4.5 and RCP8.5 scenarios respectively. Temperature rise combined with uncertainties in rainfall may result in water deficits which may increase by 4 and 5% under RCP4.5 and RCP8.5 scenarios, respectively. A pond capacity (600 m^3) is enough to store water for one ha of rice field to meet the potential rice yield during rainfed rice season. The results of this study are helpful to policymakers in understanding the potential impacts of climate change, and the application of adaptation strategies for water and rice sectors in the basin.

Keywords: Adaptation, Climate change, Rice yield

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MERGED SATELLITE AND GROUND-BASED PRECIPITATION PRODUCTS FOR EVALUATION OF VERY HIGH RESOLUTION RCM SIMULATIONS OVER CAMBODIA

Theara Tha[1] and Piyatida Ruangrassamee[2]*

Rainfall data are a crucial input for hydrological modelling and water resource planning and management studies. The need for dense and long time series data is, however, a challenging issue. In this case, merged satellite and ground-based rainfall products play a significant role as the alternative rainfall data sources. Numerous rainfall products are available, and their accuracy and performance are different over various regions. This study aims to investigate the performance of two high-resolution grid-based merged rainfall products, APHRODITE and PERSIANN-CDR. The rainfall products are compared with rain gauge data acquired between 2001 and 2007 on a point-to-pixel basis at monthly and annual timescales. Statistical indicators (CC, RMSE, Bias), scatter plot analysis, and descriptive statistics are used as the evaluation methods. This study also tests the capability of the rainfall products in capturing extreme rainfalls through extreme rainfall indices including PR99, RX1D, and RX5D, which are 99th percentile rainfall, maximum 1-day, and maximum 5-day rainfall, respectively. Furthermore, rainfall simulations from a very high resolution RCM with 5 km resolution, namely NHRCM developed by MRI, Japan are compared with the two merged rainfall products over Cambodia. Compared with the rain gauged data, APHRODITE shows underestimation trend while PERSIANN-CDR shows both under and overestimation. The comparison of MRI NHRCM rainfall simulations shows underestimation trend.

Keywords: Merged satellite-gauge, extreme rainfalls, RCM

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ASSESSMENT OF CLIMATE CHANGE IMPACTS ON EXTREME FLOOD AND DROUGHT IN YOM AND NAN RIVER BASINS

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Climate change effects will be intensified continuously and become a severe problem on future water resource management. A majority of people is anxious about the damage caused by this problem. Thailand always suffers from flood and drought disasters which are intensified by climate change especially in the Yom and Nan River basins. Flood and drought in Yom river basin is more pronounced than others river basin because of without the large dam or reservoirs. This study aims to assess the impacts of climate change on extreme flood and drought events in the Yom and Nan River basins. The climate change are considered from rainfall and temperature predicted by Global Climate Models (GCMs). These climate variable are adjusted by using a bias correction method called the shifting and scaling method. A hydrological model is used for river runoff simulation under climate data. The model is validated by comparing the simulated results with observed data. For analysis of extreme events, we calculated the Standardized Precipitation Index and (SPI) and Standardized Runoff Index (SRI) for each sub-basin.

Keywords: Climate change, Yom and Nan River basins, Extreme event

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IMPACTS OF CLIMATE AND LAND USE CHANGES ON SOIL EROSION AND SEDIMENT YIELD IN NAN RIVER BASIN, NORTHERN THAILAND

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Most researchers were interested in impact of soil erosion on environment but research about sediment is not widespread and scarce due to limitation of the measurement data that necessary for estimation. This study investigates the impacts of climate and land use changes on soil erosion and sediment in Nan river basin in north of Thailand which potential of soil erosion and sediment become obvious recently. We estimate soil erosion and sediment by RUSLE, SDR, and sediment transportation model including calibrated and validated model based on land use type. After calibration, we used climate data for 2080–2099 and land use data projected by the CLUE model to estimate future soil erosion and sediment. In addition, to understand the impacts of climate and land use changes on sediment, we analyze potential of sediment inflow to reservoir from several climate and land use change scenarios. We found the change of land use has significant impact to soil erosion and sediment in Nan river basin more than climate change. The results suggest that proper land management can decrease the potential of soil erosion, slow down the increasing of amount of sediment in the river event during extreme precipitation, and reduce the potential of sediment inflow to the reservoir. This analysis can be useful in designing optimal land use that is effective for reducing soil erosion damages and decreasing sediment accumulation in the river including planning to mitigate the impact of climate change in the future.

Keywords: Climate change, land use change, soil erosion, sediment

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DEVELOPMENT OF FUTURE CLIMATE SCENARIO BASED ON MULTI GCMS OF CMIP5 AND RAIN GRIDDED DATA OBSERVED BY MULTI-AGENCIES IN THAILAND

Masashi KIGUCHI*[1], Ruthaikarn BUAPHEAN[2], Aphantree YUTTAPHAN[2], Boonlert ARCHEVARAHUPROK[2], Eiji IKOMA[3], and Taikan OKI[1,4]

A bias corrected future climate scenario is developed using multiple General Circulation Models (GCMs) outputs of CMIP5 (Coupled Model Intercomparison Project Phase 5) and rain gridded data observed by Thai Meteorological Department (TMD), Royal Irrigation Department (RID), and Department of National Parks, Wildlife and Plant Conservation (DNP) in Thailand during the period from 2080 to 2099. This dataset enabled us to conduct a projection considered spread in projections derived from multiple GCMs. Multiple performance-based projections were obtained using correlation of monsoon rainfall between GCMs and several agencies observations. Because these three agencies (TMD, RID, and DNP) observation network covered mainly plain, area of along river, and mountainous region, respectively, it could avoid to underestimate when we use only TMD and RID dataset as usual. Our results highlight the importance of appropriate evaluation for the performance of GCMs, and the impact assessment to climate change.

Keywords: climate change, general circulation model (GCM), driving dataset

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CLIMATE CHANGE AND LAND USE CHANGE EFFECTS ON WATER ACCOUNTING IN UPPER NAN SUB-WATERSHED

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Climate change is causes air temperature and rainfall intensity change affected to rainfall amount and total streamflow. Moreover, Land cover/land use change continuous affected to environment especially head of watershed in parts of quantity and timing. The study on climate change and land use change effect on water accounting in upper Nan sub-watershed. In this context, our study aimed to assess spatial and temporal water accounting in present and future under climate change and land use change of upper Nan sub-watershed. The daily climate data for calculating monthly runoff using SWAT model. Then, the estimating of runoff will be calculated water accounting in present and future.

The result of sensitivity analysis shown that the CN2 was the most sensitive parameter, followed by ESCO and Sol_AWC. The SWAT model produced an acceptable performance for calibration and validation, yielding Nash-Sutcliffe efficiency (NSE) value with 0.85 and 0.72, respectively. Annual streamflow about 854.3 m^3/s at present. The greenhouse gas (GHGs) emission scenarios increase the Streamflow variations to 19.2% from RCP8.5 and decrease 8.4% form RCP4.5. The forest that increases 3 and 10% scenarios increase the streamflow variations to 3.6 and 9.4, respectively. Annual water accounting which present, RCP4.5 and RCP8.5 were negatively valued at all with different variations to 29.7, 41.6 and 8.8%, respectively. It was found that the GHGs emission scenarios had influent to streamflow and water accounting.

Keywords: Climate change, Land use change, Water accounting, Upper Nan sub-watershed

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EFFECT OF LAND USE CHANGE ON HYDROLOGICAL SERVICES IN NA LUANG SUB-WATERSHED, WIANG SA DISTRICT, NAN PROVINCE, THAILAND

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Nowadays, deforestation of headwater in Nan province have been a big problem of land use change and encroachment area to expand the maize production area and contract farming such as rubber plantation. There were reducing the ability of soil water storage and affecting to increase runoff and sediment yield in stream which is hydrological services from watershed. Hence, hydrological services should be evaluating and forecast using SWAT model in forest and maize sub-watershed. This study divided into three scenarios including SC1: land use in 2013, SC2: land use in 2016 and SC3: trends scenarios. The results show total forest area loss in Na Luang sub-watershed during 2013-2016 was 205.34 ha (20% of the forest cover in 2013) and increasing 176.89 ha in maize area (40% of the maize cover). Water and sediment yield in sub-watershed show significant (R^2 = 0.62) when compared with observed data. Both land use changes have greater impact on the increasing of annual runoff than sediment yield. Nevertheless, land use which has mostly forest cover still provide water use in agriculture in dry season rather than mostly maize cover area. The results obtained in this study can provide information for land use and water resource planning in small sub-watershed as well as soil and water conservation on highland.

Keywords: Land use change, hydrological services, Nan province, SWAT model

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NATURE-BASED SOLUTION FOR FLOOD MANAGEMENT AT NONG SUA DISTRICT, RANGSIT CANAL, THAILAND

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The Nature-based Solution is inspired and supported by nature and use, or mimic, natural processes to contribute benefit back to ecological process and water cycle by improved management of water. A concept of "Room for a river" is one of nature-based solution for water management to be examined at a Nong Sua district, Rangsit area with 1,738 Rai. The study area existed for 100 year with irrigation canal systems in order to distribute water for farmer. In addition, this area has traditional furrow for orange farm and changed to palm oil instead due to plant phytopathy. In 2011, the great flood occurred in Thailand; the Rangsit area had not much damage. The objective of present study is to quantify the effectiveness of a high water channel concept for flood management and assessment of de-acidification of soil from normal water operation and management in the area.

High water level concept is applied . It can control amount of diverged water in furrow while traditional flood pain can not. The Nature-based Solution for high water channel was quantified by conducting modeling approach with MIKE 11. The hydrodynamic flow and effectiveness of the capacity of the furrow area for water storage is determined in Western Raphipat canal during peak crisis water level in October 2016. The storage capacity of furrow was computed and estimated to be 753 m3/Rai or 1.3 MCM. The computational results showed that diverting water from Western Raphipat canal into Rangsit community area reduce peak water level 34 cm same as recorded one. The model is then used to optimize nature base solution extending concept to nearby area and increases inflow. It is proved that the nature-based solution for high water channel, can be applied in district without any new construction of flood control structures.

Soil in study area has pH less than 4.6. Irrigated water quality released from Pasak River to Rangsit area is alkaline water with Calcium Carbonate. When Neutralization process occurs, it reduces the acidity of water. Field measurement on site show that pH of water is appropriate between 7 to 8. It leads to the improved quality of soil and water in the area, and can be appropriately utilized for cultivation and other activities.

Keywords: nature-based solution, high water channel concept, flood management, acidity soil

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EVALUATION OF SEMIVARIOGRAM MODELS IN THE STUDY OF SPATIAL INTERPOLATION OF SOIL SALINITY: A CASE STUDY OF CHAO PHRAYA AND THA CHIN LOWER BASINS, THAILAND

Kanoksuk Chankon[1]*, Sanwit Iabchoon[1], Amnat Chidthaisong[2] and Pariwate Varnakovida[1]

Sea level rise accelerated by climate change is one of the concerns in causing sea water intrusion and salt contamination in surface and ground water and soil. Data compilation and synthesis in the past have indicated that the sea levels in the Gulf of Thailand have been rising at 3-5 mm/year. This study evaluates several semivariogram models for the study of spatial distribution of soil salinity in main central basins of Thailand. Soil salinity tests were carried out in Chao Phraya and Tha Chin lower basins alongside of the Gulf of Thailand. Study area is approximately 4,900 km2. Soil salinity measurements were performed in 2018 at two levels of depth at 30 and 100 cm. Line transect sampling method was used to determine the location of measuring points. Each of measuring points was about 10 km apart. Totally 40 sampling points across the basins were selected. Suitable semivariogram model was selected from a comparison result of geostatistical analysis. Four models of semivariogram were compared: circular, spherical, exponential and gaussian. Kriging interpolation method was used for estimation of soil salinity values of unknow point. Soil salinity in these area range between (EC) 0.02-3.83 mS/cm at 30 cm and 0.08-4.00 mS/cm at 100 cm, respectively. There is a clear gradient of soil salinity at both depths; higher along the shore (>2.00 mS/cm) and gradually decreases towards inland (0.08-2.01 mS/cm at 50-100 km from the coastline). Evaluation of semivariogram models performance reveals that the smallest error in the estimated value of soil salinity for 30 cm level were observed for the Gaussian model with RMSE is 0.92, and the exponential model yields smallest error for 100 cm level (RMSE = 1.10).

Keywords: soil salinity, kriging, spatial interpolation, Chao Phraya and Tha Chin river basin, sea level rise

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DISTRIBUTION OF POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) IN SOILS FROM KING GEORGE ISLAND, ANTARCTICA

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Over the past few decades, the impact of industrialization on dispersions of persistent organic pollutants (POPs) has been globally investigated in different continents. In 2001, Stockholm Convention on POPs was officially agreed as an international environmental treaty and signed by 128 countries. Polycyclic aromatic hydrocarbons (PAHs) are categorized as POPs and have been globally characterized in different terrestrial soils. It is important to note that PAHs are a large group of organic compounds, as a class of pollutants generated from incomplete combustion of organic materials such as fossil fuels. PAHs in soil have been widely concerned because of its carcinogenicity and mutagenicity. It is also worth mentioning that PAHs has high hydrophobic property and strong partitioning with particle surfaces and thus can be accumulated in soils for comparatively long period. According to our best knowledge, the number of publications associated with PAHs in terrestrial soils collected from Antarctica is strictly limited.

Overall, this study aims to conduct both qualitative and quantitative analysis of 15 PAHs including Phenanthrene, Anthracene, Flouoranthene, Pyrene, 11HBenzo[a]Fluoranthene, 11HBenzo[b]Fluoranthene, Benzo[a]Anthracene, Chrysene, Benzo[b]Fluoranthene, Benzo[k]Fluoranthene, Benzo[a]Pyrene, Benzo[e]Pyrene, Benzo[g,h,i]Perylene, Dibenzo[a,h] Anthracene and Indeno[1,2,3-cd]pyrene in soil samples from King George Island, Antarctica. Terrestrial soil samples were extracted by using soxhlet extraction with dichloromethane (DCM) and subsequently fractionized by using different polars of solvents. In this study, Gas Chromatograph-Mass Spectrophotometer (GC-MS Shimadzu QP2010) was carefully selected for determinations of PAHs.

Keywords: Polycyclic aromatic hydrocarbons (PAHs), Soils, King George Island

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ACCUMULATION OF POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) AND CARBON COMPOSITION IN LAKES SEDIMENTS CORE IN THALE NOI, PHATTHALUNG

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It is well known that fossil fuel combustions coupled with agricultural waste burnings responsible for the emissions of carbonaceous compositions affecting the global climate system. During the past few decades, the influences of organic carbon (OC) and elemental carbon (EC) on both positive and negative impacts on global temperature have been consistently studied in various places.
Black carbon (BC) is considered as a major cause of "heating affect" as triggered by the absorption of sunlight. BC has been reported as the second cause after greenhouse gases affecting the climate system. Previous studies have been focused on the chemical characterizations of OC/EC in lake sediments mainly for reconstructing the paleo-extreme atmospheric events (e.g. forest fires, volcano eruption).

This research aims to study about accumulation of 15 PAHs ($\sum PAHs_{15}$) and measure OC/EC in the sediment from Thale Noi, for finding relationship and difference of element that use to indicate sources in sediment since in the past to now by depth respectively. Extraction sediment by using Soxhlet method, use dichloromethane (DCM) as soluent and then take to measurement intensity by GC/MS, analyze OC/EC by thermaloptical method. If found that accumulation of PAHs had moderatety contaminated and intensity of OC/EC had low level. The diagnostic ratio plots Ind/Ind+B[g,h,i]P, B[a]A/B[a]A+Chry) and OC/EC implicated that most of the potential sources of PAHs may be originate from the incomplete combustion of petroleum product.

Keywords: Polycyclic Aromatic Hydrocarbons (PAHs), Organic Carbon (OC), Elemental Carbon (EC),

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Session B
Participatory Management and Technologies for Water and Irrigation Projects

GUEST SPEAKER: B01

PARTICIPATORY APPROARCH IN ADAPTIVE WATER MANAGEMENT AND RURAL DISASTER PLANNING BY IRRIGATION GATE OPERATION

Takao MASUMOTO*

Taking the Nam Cheng River basin as an instance of flood-prone areas during rainy seasons, the relation between irrigation gates management specifically for water supply during dry seasons and floods during water-rich seasons is examined by modeling runoff, flooding processes and gate operations through the DWCM-AgWU Model (a Distributed Water Circulation Model incorporating Agricultural Water Use). In particular, technological transfer stages in trials there lead to the products of adaptive water management and rural disaster planning evoking local managers of irrigation facility control and relevant farmers and inhabitants.

The target basin (457 km^2) covers one of the tributary in the Nam Ngum River system and low-lying paddies extends where the Chim and Ping Rivers join and annually repeated floods occur. Irrigation gates are situated at the end of the river basin to secure water for rice cultivation during dry seasons. In addition, they have the function to prevent the reverse flow from the Nam Ngum River, but they eventually have caused frequent floods in low-lying areas. This direction was obtained by the analyses; namely, 1) stage of field surveys and a model development, 2) Specification stage of flood causes, 3) Introduction stage of new observation facilities and modified gate operations, 4) Development stage of flood prevention guidelines. As a result, the utilization of models turns out to be very effective means for several analyses in areas with the lack of fundamental data as shown in the target area, in that the estimated values through the models would be utilized as quasi-observation data, such as temporal and spatial estimates of river discharges and water levels.

In conclusion, based on our studies progress of the 4 years term, due in part to our 7 visits to the site and 4 seminars, the proposals for adaptive water management and rural disaster planning resulted in mutually ones deepened by local managers as well as experts, not a one-sided technological transfer just from experts.

Keywords: DWCM-AgWU model, Irrigation gate, Adaptive water management

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GUEST SPEAKER: B02

Migration and Collective Action: Evidence from China

Eduardo Araral*

Over the past three decades, scholars have studied the effects of more than three dozen factors on collective action in the commons but little is known about the effects of rural to urban migration. We examine this question with the case of China, which has the world's most extensive levels of rural to urban migration. Using OLS, Logit and Probit models and data from a survey of 1,780 households from 18 provinces, we find that migration has a statistically significant adverse effect on collective irrigation controlling for a large number of theoretically relevant variables. The effects of migration on collective action in the commons are possibly mediated by a number of factors frequently identified in the literature, including leadership, social capital, sense of community, economic heterogeneity, and dependence on resources. We speculate that massive out migration partly explains the significant drop in the use of collective canal irrigation and exacerbated the significant increase in groundwater irrigation since the start of reforms in 1980s. These findings have important policy implications for commons governance in China given that massive rural to urban migration will continue in the next decade. Because of the increasing rural to urban migration worldwide especially in developing countries, the findings could also partly explain the deteriorating state of rural village infrastructure, natural common pool resources and ecological systems in many developing countries.

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GUEST SPEAKER: B03

DISASTER IRRIGATION AND WATER MANAGEMENT TOWARDS NEXUS (WEF) AND SUSTAINABLE DEVELOPMENT GOALS

Leong Ching*

Flood models predict that people who experience small and medium sized floods cope better than those who have experienced no floods at all (e.g., those who have the benefit of infrastructure that shield them from such floods.)

These communities will then be highly vulnerable when large floods strike because they have little adaptive power. This paper shows that this binary effect need not be true—by conducting a micro-level narrative analysis in flood prone communities in Assam, India, we find that while the "memory effect" of floods does decrease vulnerability in some instances, such memory effects do not always obtain.

The paper therefore suggests four distinct groups of flood responses: Aside from the well-established "memory" and "levee" effects, there are two other groups which may resist either effect. Our analysis finds four distinct narrative types: the Hardened Preparer, the Engineer, Discontent, and the Pessimist.

This paper put forward an explicitly socio-hydrological conception of resilience which takes into account the role of sociological indicators such as narrative types and perceptions. Such contextual understandings and narrative types can form the basis of generic resilience indicators which complement the anticipated outcomes of socio-hydrologic models generally. The session will also touch more generally on the irrationalities of collective environmental behaviors.

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FLOODING MONITORING AND FLOOD INUNDATION ANALYSIS MODEL UGING UAV

Mikyoung Choi*, Geunsang Lee and Kwansue Jung

The increase in the frequency and intensity of heavy rains caused by climate change is causing casualties and property damage from massive flooding. In order to reduce flood damage, an unstructured measure is being taken to calculate flooding inundation areas and to produce flooding maps through numerical analysis. The FLUMEN numerical model is used to calculate flooding areas in Korea. However, flood analyses using numerical models have limitations in verifying and comparing actual phenomena. Recently, unmanned aerial vehicle (UAV) technology has been actively studied to acquire three-dimensional terrain data. In this study, DSM data created through monitoring using UAV before and after flooding is used as numerical model data to improve accuracy of verification by comparing actual flood phenomena with simulating FLUMEN numerical models.

Keywords: UAV, flooding monitoring, FLUMEN, inundation analysis

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KNOWLEDGE GAP BETWEEN TECNICAL EXPERTS AND REFLECTIVE PRACTITIONERS REGARDING FLOOD SUFFERES' LIVE BACK IN ORDER – CASES IN JAPAN

Yoko Matsuda*

Even though well-considered flood management is installed, flood disasters may happen. In the past decade, Japan has experienced flush floods, landslides, and dike breaks in different parts of the country. Especially in 2018, the western Japan was suffered by the record-breaking heavy rain disaster which killed 224 people, in 15 prefectures. However, the basic procedures for flood suffers to live their lives back in order are not officially documented ever, probably because it must cover multiple expertise including residential structure, local administration, insurance and sanitation, which we can hardly bridge this knowledge gap in a bureaucratic social system.

The paper discusses reasons and appropriate policies from detailed and prolonged observation as a field worker of a disaster-relief non-profit organizations. In addition, a challenge of collaboration between technical experts and field workers to conquer the knowledge gap.

Keywords: build back in order, knowledge gap, case studies

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Session C

Emerging/Digital Technologies in Water Management and Environment Towards Nexus (WEF) and SDGs (Big Data, IoT)

GUEST SPEAKER: C01

TREATING WATER TO APPROPRIATE STANDARDS FOR DIFFERENT USES AT THE WEF NEXUS

Andrew Dansie*

Real-time water quality monitoring data is being increasingly used for real-time responses to water management and has applications for potable, agricultural and environmental water uses. Application of such automated technologies offers opportunity to create efficiencies in water management as part of the water treatment cycle. In Australia researchers from UNSW-GWI were part of the innovative Western Sydney Recycled Water Initiative (replacement flows) to deliver highly treated wastewater to the Hawkesbury-Nepean River. The river catchment surrounds Sydney, a city of over 5 million people, with natural vegetation in the catchment significantly cleared for housing, agriculture and industry. With an expanding Sydney population and impacts of climate change, the problems facing the Hawkesbury-Nepean are escalating. The replacement flows initiative allowed drinking-quality reservoir water upstream to be reserved for urban use rather than released as environmental flows. The automated water monitoring that informed real-time water management responses allowed for efficient and suitable allocation of water for different end-users. Competing water uses at the WEF nexus can be more efficiently managed by allocating water of varying qualities that is suitable for human, agricultural, industrial or environmental use. Real-time automated monitoring can assist this management as well as proactively account for monsoon and flood storage needs within catchment-wide management of WEF water resources.The lessons learned in the Hawkesbury-Nepean River Catchment are highly suited to Asia similarly highly-populated and climate change-impacted river basins.

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GUEST SPEAKER: C02

NEW TECHNOLOGIES AND DESIGN OF FUTURE URBAN WATER SYSTEMS

Katharine Cross

The demand for water worldwide has increased substantially over the past decades. Increasing prosperity comes with the challenge to provide a growingurban population with safe quality freshwater. At the same time, the global market for wastewater recycling and reuse reached nearly US$12.2 billion in 2016 and is estimated to reach US$22.3 billion by 2021. This market expansion is in response to a growing demand from cities and industry for water against a backdrop of increased urbanisation, population growth and climate variability. To address these challenges and opportunities requires advanced treatment technologies, a focus on innovation and advancing technology.

The water industry, and in particular urban water utilities, needs to adapt to meet the emerging demands of a dynamic, highly deregulated and competitive environment with the context of a changing climate. Water 4.0 is the era of cyber-physical systems, digitalisation and big data where software, sensors, processors, communication and control technologies are increasingly integrated, to deliver sustainable and resilient water management in an increasingly changing, complex and uncertain world.

The opportunity for digital water technologies is especially promising for water professionals in emerging economies. The cost of centralised water and wastewater systems in rapidly expanding cities can be prohibitive and as a result, emerging economies can develop and manage off grid and localised water systems from scratch, much as the competitive mobile (and now smart) phone access allowed billions of isolated individuals to "leapfrog" the old world of monopoly controlled fixed landlines. Dynamic and data-driven (as opposed to mechanistic) models can help integrate and optimise smart pumps, valves, sensors and actuators; each device can "talk" to each other, or for that matter to a customer's iPhone, and send real-time information to be accessed and shared via the cloud.

Digital water technology adoption requires the engagement and commitment of incumbents, start-ups and entrants from other sectors. Water professionals often lack information technology skill sets and the perspective to appreciate what is possible, while technology entrepreneurs may not understand the nuances of complex water systems affected by multiple factors. By collaborating, urban resilience will emerge faster and smoother.

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GUEST SPEAKER: C03

URBANIZATION AND ITS IMPACT ON FLOOD RESPONSES

Yangbo Chen*

Urbanization is the world development trend for the past century, and the developing countries have been experiencing much rapider urbanization in the past decades. In the Pearl River Delta area of southern China, the rapidest urbanization in china has been observed for the past four decades, and dozens of highly urbanized watersheds have been appeared. Urbanization brings many benefits to human beings, but also causes negative impacts, such as increasing flood risk. Impact of urbanization on flood response has long been observed, but quantitatively studying this effect still faces great challenges. For example, deriving the urbanization pattern in the past, setting up an appropriate hydrological model representing the changed flood responses and determining accurate model parameters are very difficult in the urbanized or urbanizing watershed. In this study, a multiple classifier system (MCS) for estimating land use/cover(LUC) changes by utilizing satellite remote sensing images is proposed first, which combines advantages of different learning algorithms. With this algorithm, the LUC of the central area of Pearl River Delta area, including Guangzhou, Shenzhen and Dongguan from 1987 to 2015 at roughly every 3 years was estimated by using the Landsat satellite images, and the urbanization pattern is analyzed. Then, a physically based distributed hydrological model, the Liuxihe Model is developed for simulating the hydrological processes of the urbanized watershed. A model parameter optimization and updating strategy is proposed based on the remotely sensed LUC types, which optimizes model parameters with PSO algorithm and updates them based on the changed LUC types. Several watersheds in the highly urbanized area of the Pearl River Delta area were studied for this purpose. The LUC changes in these watersheds was first analyzed, and then the Liuxihe model was set up in these watersheds with parameters optimized and updated with the changed LUCs. Hydrological processes was simulated with the established model and parameters in different time periods, and the flood response changes was derived. The results show urbanization has big impact on the watershed flood responses, the peak flow increased a few times after urbanization which is much higher than previous studies in western countries.

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GUEST SPEAKER: C04

MULTI-SCALE WATER-ENERGY-FOOD NEXUS IN ASIA

Makoto Taniguchi*

Water, energy, and food are the most fundamental resources for human beings and sustainable society, and tease resources are interlinked each other. Therefore, we need integrated management and governance for the water-energy-food (WEF) nexus by increasing synergies andreducing trade-offs among the three resources. In addition to these, three resources are connected in multi-spatial scale, such as local, national, regional and global, through food and energy trades, therefore we need multiscale analyses for sustainable resources management. Water footprint and energy footprints though food trade are one of the tool for understanding how each area is inter- and intra- connected on WEF nexus. Belmont Forum SUGI project "METABOLIC" are going to establish three databases of resources, interlinkage, and scenario in multi-spatial scale including Kyoto city, Kyoto prefecture, Kansai area with 7 prefecture, Japan, and Asia. A nexus model to analyze the change of the nexus structure has been made, and assessment of the changes in three resources, carbon emission, environmental and economic impacts are analyzed.

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GUEST SPEAKER: C05

CONSERVATION, PROTECTION AND AUGMENTING WATER RESOURCES IN PERI-URBAN AND RURAL AREAS – TOWARDS BETTER GOVERNANCE AND MANAGEMENT AT LOCAL LEVEL USING MODERN DIGITAL TECHNOLOGIES.

Lawrence Surendra*

Management of Water resources in terms of managing scarcity and over-abundance as in flood situations that can lead to disasters poses multi-dimensional challenges to planners, policy makers and local government officials. Equally so, for researchers and academics who wish to contribute to shaping public policy for better water management and in handling the Water-Energy Food Nexus in Asia. Water is not just quality or quantity. Water has many dimensions, not only as a public good and private good but as public water, private water and as common property resources. Managing this complexity of water as a resource and more so when it is entangled with social and political systems at the local level makes it even more difficult to achieve efficient water resources management. Technology and its applications, especially the use of ICT, satellite data and IOT technologies have great potential to make a significant contribution.

According to UN-ESCAP sources and estimates of the Asian Development Bank (ADB), the Asia and Pacific region requires $800 billion, or $53 billion annually, in investment over the period 2016–2030 to meet water and sanitation infrastructure needs. This includes the costs of climate proofing to ensure that infrastructure is resilient to the projected impacts of climate change. from a Water-Food-Energy (WEF) nexus, ensuring water for food security, supply of clean drinking water to all, managing water and sanitation in a manner so that critical water sources and resources are not threatened is vital. Equally critical is ensuring that improper and inadequate sanitation does not damage and destroy water sources especially in peri-urban and rural areas not only during normal times but also in times of disasters such as droughts and flooding.

This requires critically good governance and promoting good practices and accountability mechanisms at the local level. Shaping public policy especially for local governments is necessary since national level and state level policy alone cannot address specific ecosystem conditions and local characteristics of water resources, its supply and management. Post-disaster situations be it droughts or flood clearly show that if disaster prevention and risk reduction approaches at national level had been built up bottom up, both disasters and their after effects could be minimised.

For all these dimensions technology and use of technology, especially combining remote sensing technology with modern drone technologies ICT, satellite data and IOT can make a major contribution by providing a cloud based decision support system which can utilizes a framework of microwave satellite observations. Such technology will be used in two peri-urban areas that are situated in dry land farming areas and one rural area in a water abundant area, in the state of Karnataka to demonstrate how integration of such approaches using technology for policy development and management of water governance and management, can enhance efficient water use management and contribute to disaster preparedness as well. Our paper will elaborate on the field level applications of ICT, satellite image and IOT to be undertaken as well as how our work can benefit from partnerships with rich knowledge resources that have been accumulated in the work of the Water Resources System Research Unit of Chulalongkorn University and the contributions to Water Resources management made by UN-ESCAP and UNESCO.

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GUEST SPEAKER: C06

SPATIO-TEMPORAL MAPPING OF WATER CONSUMPTION AT PUBLIC INSTITUTIONS: CASE OF UNITED ARAB EMIRATES (UAE) UNIVERSITY

M. M. Yagoub and Tareefa Al Sumaiti, LatifaEbrahim, Yaqein Ahmed, Rauda Abdulla

Large portion of human activities take place within buildings. Therefore, if energy and water consumption are minimized in buildings this will help in reducing climate change. UAE demarcated water in its vision 2021 as one of the areas that need more researches. This is because water is one of the basic human needs and the country spends millions of dollars every year in desalinating and transporting water to various cities and villages across UAE. Therefore, efforts could be done at individual and institutional level to optimize water usage and consequently save money and environment.

In this study, indoor water consumption at UAE university, as one of the biggest public institute in Al Ain is assessed for the period 2016-2017. The study will fill a gap in literature about water consumption at public institutes in arid environment. It utilizes Geographic Information System (GIS) to answer where water is highly consumed within the university (hot spots), when (time), who consume it, why (causes), and how to minimize consumption. It assembles diverse data reside at various departments to gain a better knowledge about the broad patterns of water consumption in the university campus. The assumption made here is that water consumption is directly proportional to population density (students/faculty/staff) and less during winter. The highest water consumption is found at the College of Information Technology (CIT) and this is due to its size and heterogeneity of its activities (lectures, workshops, conferences, book distribution, restaurants). The relationship between water consumption and number of students is modeled using least square. The coefficient of determination (R^2) is found ranged between 0.13 and 0.47. These values indicate low correlation between water consumption and number of students. This may be due to the centralized usage of buildings and movement of students between buildings during lectures.

Temporal variation showed sharp decrease during July of 2016 and 2017 irrespective of the building type/size and this is associated with summer holidays. The hypothesis of activity-driven consumption showed that the highest water consumption (67.8%) is found at residential buildings (hostels). This is due to many reasons such as longer stay time at the hostels and use of water for showering, flushing, ablution, and washing machines. The library showed consistent low water consumption. It is very interesting to deduce the library usage while investigating water consumption, but it is a lesson that water consumption could be used as a proxy to reveal number of users at buildings. The water consumption at UAEU is benchmarked with the university of Bordeaux in France and other public institutes in Al Ain. On average the water costs the university annually around two million dirhams (AED 2,030,429 = EUR 474,399 = USD 553,250). The result from this study identified sites with the highest water consumption and this could be used to adapt water conservation techniques and campaigns at these sites.

Keywords: Water consumption, public institutes, UAE University, GIS, public awareness

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GUEST SPEAKER: C08

USE ARTIFICIAL INTELLIGENCE AND IOT TECHNOLOGIES TO BUILD SMART IRRIGATION SYSTEM.

Richard Huang*

Taoyuan Irrigation Association (TIA) is responsible for managing irrigation water resource in Taoyuan area, Taiwan. The major water source of Taoyuan canal is from Shi-Men reservoir. Taoyuan canal transports the water to 12 branch cannels and their subsidiary ponds. All the farmland in this area is watered through these ponds. A so-called traditional irrigation policy is to supply a fixed quantity of flow for irrigation during a whole crop season. Staffs of TIA calculate required daily quantity of flow based on the factors of field size, type of crop and the period of crop growth cycle. In a crop growth cycle, water is supplied 7days x 24hours from reservoir to canals, ponds and end up to farmland.
However, the traditional irrigation policy is inefficient. The water may be over supplied in raining days and may be under supplied in hot summer. To improve the efficiency of water management, we build a system to predict the quantity of flow variation in next 3 hours of Taoyuan Canal. Base on the prediction, staffs of TIA fine tune gate of ponds to reserve extra water in advance.
All the staffs of TIA review prediction results and gate tuning suggestions from web site and mobile application.

In this project, we employ artificial intelligence model, linear planning model and IoT technologies to provide high-quality decision-making support system mentioned previously. First, we apply NNR (neural network regression) to build a prediction model. We collect over ten thousand of precipitation and water level historical data pairs as training vectors. In each vector pairs, output vector is composed by water level data and an input vector is composed by precipitation data. CC (correlation coefficient) and MAE (mean absolute error) are chosen to be the performance indices of the trained model.
The average correlation coefficient of the trained model between the predication results and on-line monitoring data from sensors is over 92%. The average mean absolute error is less than 3 centimeters.
Second, we use linear-planning model to rank the ponds which need to irrigate. The factors of the model include current volume of pond, the economic factor of pond, the length of canal between pond and main canal and the irrigation area of the pond.
The data of current volume of pond are gotten from AnaSystem's IoT system, the Senslink and SensMini A4. The SensMini A4 is an innovative compact front-end remote data acquisition device, which provides complete functions that a front-end IoT device needs. Those functions include solar charging, data logging, IP68 protection, auto data addendum, LPWAN communication (4G, LoRaWAN and NB-IoT) and universal industrial I/O.
The Senslink provides hundreds of open API for users to develop their own user interface and applications. The Senslink kernel collects, dispatch and store massive data from IoT front-end device very efficiently. In this project, our system provides gate operation suggestions for each pond every 10 minutes base on the infrastructure of Senslink.

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WHAT INFORMATION ABOUT THAI LAKES DOES A WEB APPLICATION, CLIMATES OF LAKE BASINS CONTAINS?

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Lakes are very important for multi-sectors including water sector in Thai because of a long dry season from December to April. Thai researchers know lakes in Thailand very well but foreign researchers do not always so. It is interesting to know how much information we can obtain information about lakes in Thai on the Internet. This study investigates what information and how much about lakes in Thai are accessible for preliminary scientific investigations through the Internet.
A web application, Climates of Global Lake Basins (CGLB) have been developed for providing lake information from the view point of hydrological and water resources by the combination of existing data sets. The distinction of CGLB from other web applications is that CGLB has a drawing functions of climatological information on demand. CGLB also provides landscape photographs provided by Global Confluence Project as well as quasi-real time monitoring of lake water levels using satellite altimetry provided by U.S. Department of Agriculture. The first version of CGLB contained about 600 lakes or more in the world. Recently, CGLB has been upgraded by changing a lake information database from the World Lake Database (WLDB; http://wldb.ilec.or.jp/) to the HydroLAKES following a new development of the source code due to introduction of a free database module to treat more than more than 1 million of lakes.
Lake database targeting the entire world contains some lakes only due to the coverage of the whole globe. For example, WLDB contains only 5 lakes in Thai: Boraped Reservoir (Bung Boraphet), Lam Ta Khong Reservoir, Luang Sea, Lake Songkhla, and Ubolratana Reservoir. Nobody knows the rationale of these selections. On the other hand, CGLB based on HydroLAKES contains 2004 lakes in Thailand. As an example, we demonstrate what information and how much data of Lake Thale Sap Songkhla or Thale Luang are available from CGLB.

Keywords: lake, climate, global

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EVALUATION OF SATELLITE PRECIPITATION FROM GOOGLE EARTH ENGINE IN TONLE SAP BASIN, CAMBODIA

Phanit Mab , Steven Ly[2], Chuphan Chompuchan[1], Ekasit Kositsakulchai[1,3*]

Precipitation is important to life on Earth. It is a predominant process in the global hydrologic cycle and is an indispensable component of water balance analysis. However, in some area like the Tonle Sap basin in Cambodia, the information on precipitation is deficient and sometimes difficult to access. In this case, satellite remote sensing coupled with GIS techniques have been applied and considered as a powerful and effective tool in handing precipitation analysis tasks. Recently, the Google Earth Engine (GEE) platform provides satellite datasets and collection of the tool for analysis of data using JavaScript without downloading huge data from the Internet. In this study, we aimed to evaluate the application of GEE platform for retrieving and analyzing precipitation data of the Tropical Rainfall Measuring Mission (TRMM) in Tonle Sap basin (TLS). The methods included: (1) to collect the satellite precipitation data (3B43V7) by manual download and by retrieving them from GEE platform; (2) to analyze monthly precipitation over the study area by GIS analysis functions and by JavaScript on the GEE platform, data in 2010 was sampling as a case study; and (3) to compare results from both GIS and GEE with observation data from ground stations. The results showed the good correlations between the precipitations from manual download and those from a GEE platform, with R2 greater than 0.8. In short, the application of GEE platform is very effective; it provides a comprehensive tool for managing time-consuming tasks, like precipitation data collection and analysis, and results in reliable outputs.

Keywords: Satellite precipitation, Mekong river, Google Earth Engine

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PAPER ID: TC303-1

IMPACT OF WATER LOSSES ON PRESSURE AND ENERGY IN MWA TRUNK MAIN NETWORK, THAILAND

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The Metropolitan Waterworks Authority (MWA) is responsible for providing potable water for three provinces in Thailand: Bangkok, Nonthaburi and Samutprakarn. Its trunk mains networks composes of 1,700 km of 500-1800 mm trunk mains, 4 water treatment plants, 11 distribution pumping stations. In March 2013, the system input volume (SIV) was 5.18 MCM/day, the water losses (WL) was 1.34 MCM/day (%WL = 25.8%) with the average pressure of 8.66 m, and the electricity energy consumption for water distribution system (Einput) was 369 MWh/day. Using these data, the MWA trunk main network model was built and calibrated. The MWA has set the targets to reduce %WL to 19% and rise the pressure to 10.8 m in 2021. Since the MWA water losses are mainly leakage, directly depending on pressure, the achievement of both targets is rather difficult. The MWA throttled 130 valves on its trunk main network to reduce WL and control flow, however, causing an adverse effect on pressure and energy during peak demands. Our analysis found that if the input pressure at all sources remains the same but all throttling valves are open, %WL and the pressure may increase to 28.9% and 9.24 m, respectively. Then, if MWA can find and fix leaks and reduce %WL to 19% as its WL target, the pressure will rise to 10.7 m almost equal to its pressure target without increasing its pressure at the sources. The other benefits are that SIV will reduce 0.434 MCM/day, and Einput will reduce 31.0 MWh/day.

Keywords: Water-energy nexus, Water losses, Pressure

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RESILIENCE INDEX FOR CHLORINE ANALYSIS IN WATER DISTRIBUTION NETWORKS

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Chlorine is a chemical commonly used in the water treatment process. Metropolitan Waterworks Authority (MWA) has used chlorine in its water supply system. MWA is controlling the chlorine source to a high concentration level of approximately 1 mg per liter to keep the level of free residual chlorine as recommended by World Health Organization at 0.2 mg per liter. The major factors that cause the decay of chlorine are the reaction of chlorine in bulk water and the reaction at pipe walls. This study simulated chlorine distribution in a MWA district metering area (DMA) to the customer meter level by using EPANET 2.0. We evaluated the reliability of free residual chlorine in the DMA by using a resilience index (Ir). Higher Ir implies a more reliable system. The effect of water losses on chlorine distribution is considered. Comparing the cases with and without water losses, Ir surprisingly decreases from 0.56 to 0.51, respectively. It implies that without water losses, velocities in pipes decreases and causes an increase in water age in the network. Subsequently, customers receive lower free residual chlorine concentrations.

Keywords: Chlorine, Water Distribution, Water Quality

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LAGRANGIAN ANALYSIS OF THE CHAO PHRAYA RIVER ESTUARINE CIRCULATION

Siriwat Kongkulsiri and Sirod Sirisup*

Bangkok metropolis and its vicinity mainly rely on the Chao Phraya River in supplying the freshwater. Salinity in the freshwater is one of the critical water quality parameters. The saltwater intrusion intensifies in the dry season when the demand for fresh water is excessively high affecting various sectors including agriculture, industry and waterworks. The situation further deteriorates in the face of climate change and sea-level rise. The ocean tides and river discharge primarily control the salinity in the Chao Phraya River. Thus the interplay between these two factors is crucial in determining the availability of freshwater. As brackish water moves, each fluid particle carries tracers such as salt, nutrients as well as other particulate matters. The transport of brackish water and its tracer content, as well as the pathways and timescales for that transport, are main facets in how the ocean tides and river discharge play a role in estuarine ecology. To this end, perform the Lagrangian analysis to analyse the output of the validated estuarine circulation model, Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM). In this Lagrangian approach, large sets of virtual particles are integrated within the three-dimensional, time-evolving velocity fields. In the full paper, we will demonstrate and discuss the use of analysis of Lagrangian particle trajectories improve the understanding of the Chao Phraya River estuarine circulation and dynamics.

Keywords: Lagrangian analysis, Estuary, Tracers

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PAPER ID: TC311-2

QUANTIFICATION OF THE NEXUS IMPACT OF URBANIZATION ON FOOD-WATER-ENERGY ALLOCATION

Chun-Yueh Lin and Chihhao Fan*

Over the years, climate change results in extreme weather events of droughts, floods and heat stress, which significantly threaten the utilization food, water and energy (FWE) resources. Such a disturbed FEW nexus becomes even worse under the stress of urbanization. In addition, the consumptions of FWE resources in urban and rural areas may vary significantly, due to the apparent differences in lifestyles, industrial structures and consumers' behaviors. Therefore, this study aimed to construct a sustainable FWE index to quantify the nexus among FWE resources under the influence of urbanization. In the simultaneous equations model of FWE resources developed from the present study, the rural area demonstrates higher sustainability than the urban one. The negative correlation with the population density showed that the massive consumption of FWE resources can decrease the level of sustainability. For both the urban and rural areas, the sustainability exhibits a high dependency on the water resource, which has a great influence to agriculture and industry. Due to the frequent trading and transporting, the food resource demonstrated a limited impact on sustainability in the urban area of Taiwan, and the food supply remains stable even in urban areas with a weak agricultural productivity. Moreover, the required resources assurance and potential environmental impact reduction are the primary measures to achieve a sustainable FWE development. This research provides an overall quantification of FWE nexus and prioritizes the FWE conflicts to be solved under the stress of urbanization.

Keywords: FEW nexus, simultaneous equations model, urbanization

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PAPER ID: TC313-1

CLASSIFICATION OF THE RAINFED AREAS FOR THE WATER DEVELOPMENT PROJECTS IN THAILAND

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The water resources management in Thailand is currently managed by area-based consideration composed of irrigation, and rainfed areas. However, the water supplies in the rainfed areas are mainly related to rainfall, small-waterbodies, and ground water resources. Therefore, the rainfed agriculture is under the water deficit risk due to the climate variability, and uncertainty. For this reason, the main propose of this work is to analyze, and classify the potential of rainfed areas based on land-uses, household incomes, water resources risks, and household locations. The results are showed that the rainfed areas were classified into 7 types by prioritizing the water resources problem levels (severe, moderate-low, or normal levels), special economic zone, household income (higher or lower than poverty line), and revenue structure (agriculture sector or other sectors). Additionally, the rainfed classification results can be applied to support the decision maker for allocating the water resources development projects in the critical rainfed areas. For example, the Department of Water Resources, Thailand, was applied the rainfed classification results to implement the water distribution projects by using solar-powered irrigation systems in the high critical rainfed areas to provide environmentally sustainable, and reliable access to energy, and water resources, to create the agricultural innovation, and to alleviate small and medium farmer's income and livelihood.

Keywords: Rainfed areas, Water Management, Solar-Powered Irrigation System

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WATER AND FOOD RELATIONSHIP EVALUATION ON WEF NEXUS IN GREENHOUSE WITH WATER STRESS AND SOIL CONDITION

Pureun Yoon[*] · Jin-Yong Choi[**] · Kwi-Hoon Kim · Yoon-hee Lee

Due to the population growth, food production demands and water use increase, there is a wide variety of global discussions on resource management in terms of securing resources such as water and food considering sustainability. The concept of "Water-Food-Energy Nexus" has emerged to interpret the linkage of water, energy and food resources and to suggest an integrated management plan. There is a trade-off relationship among input resources such as energy, water and cost, for increasing food productivity, therefore, it is necessary to analyze the relationships comprehensively rather than single resource analysis. This study was conducted to evaluate the relationship between water and food among the water-food-energy nexus of upland crops in greenhouse. Because the growing the upland crops in greenhouse could control the environmental condition such as the temperature, humidity, and wind speed, the analysis based on the scenarios according to the environmental conditions could be conducted. Also, the upland crops are more vulnerable to water stress than paddy rice which cultivated by flooding method. And water stress has a significant influence on the upland crop growth and production. Thus, this study included simulating the response of the upland crops in greenhouse to water and to evaluate the relationship between water and food resources, using AquaCrop model which estimate water productivity of the upland crop. The AquaCrop model developed by FAO analyzes the effects of water environment, fertilizer and irrigation method on the production of various crops. Input data includes weather, crop, soil data and farm management data including irrigation and fertilizer. Then, the upland crop yield and water productivity based on the irrigation method, fertilizer, weather condition are simulated in terms of water stress. From the results, it was demonstrated that the water and food relationships for Nexus water-food bridge could be quantified using AquaCrop model.

Keywords: Water-Food-Energy Nexus, Upland crop, water stress, AquaCrop

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PAPER ID: TC317-1

OUTLIER DETECTION OF RESERVOIR WATER LEVEL DATA USING ARTIFICIAL NEURAL NETWORK MODEL

Maga Kim, Jin-Yong Choi†

The agricultural reservoirs determine the amount of water supply of irrigation according to water and environmental conditions of the reservoir. The reservoir water level data estimate the current water storage of the reservoir by capacity curve, to figure out the ability for irrigation and to manage agricultural water reasonably. In Korea, pieces of reservoir water level measuring equipment are installed for agricultural reservoirs having 100,000 tons storage capacity or more, and reservoir water levels are measured every 10 minutes. In spite of vast amount of available reservoir water level data, outlier detection systems for measured data is not properly equipped. The manual outlier detection and quality control requires time and labor consuming, and outliers and missing values create problematic causes in utilization of the reservoir water level data for irrigation planning appropriately. Therefore, it is necessary to detect outlier and improve the quality of reservoir water level data. This study was conducted to detect outliers of reservoir water level data using artificial neural network model. The artificial neural network model was trained with prepared training dataset as normal data (T) and outlier or missing data (F), and the artificial neural network model operated for identifying the outlier. The models are evaluated with reference reservoir water level data which were collected in daily by Korea Rural Community Corporation (KRC).

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EVALUATION OF THE RELATIONSHIP BETWEEN ELECTRIC CONDUCTIVITY AND SPECTRAL INDEX FOR SOIL SALINITY MAPPING OF RICE PADDY FIELD IN KHON KAEN PROVINCE

Masayasu Maki*, Supranee Sritumboon, Mallika Srisutham, Koshi Yoshida, Koki Homma

Geospatial information about salt injury is required for rice growth management in Khon Kaen. However, the soil salinity map which is effective for rice growth management in Khon Kaen does not exist. As the first step, evaluation of the relationship between electric conductivity (ECe) which is the indicators of salt injury before planting and leaf area index (LAI) during growth period was conducted in this study. Soil samplings for measuring ECe before planting were conducted in Khon Kaen on 6th and 7th April 2016. To generate geospatial map of rice growth condition during growth period, Spectral measurement using drone and field measurement of LAI were conducted in the same area on 7th September 2016. As the results, it was confirmed that LAI during growth period and ECe before planting had negative correlation. Secondly, evaluation of the relationship between ECe and spectral index was performed for mapping the spatial distributions of ECe in the study area. Soil samplings for measuring ECe in the study area were conducted on 22nd December 2016 and 11th May 2017. Spectral measurements using drone for calculating normalized difference salinity index (NDSI) were excuted on the same days. As the result, EC and NDSI obtained on 11th May 2017 had strong positive correlation compared to the one obtained on 22nd December 2016. These above mentioned results indicate that soil salinity map derived from NDSI image on the end of dry season has the potential to give the effective information for rice growth management.

Keywords: salt affected soil, soil salinity mapping, remote sensing

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PAPER ID: TC319-1

MONITORING LANDSCAPE CHANGES IN CATCHMENT USING REMOTE SENSING TECHNIQUES

Wen-Sheng Lin*, Chihhao Fan, Chih-Renn Chen***, Cheng-Jui Hsu***; Jia-Yu Lin*****

Due to the frequent occurred incidents in over-limit development and the illegal use of the catchment area, it is crucial to strengthen the management of land use, regularly check whether there is illegal use, and maintain the ecological conservation of the catchment area to prevent from the over-utilization and illegal development of the land. Traditional patrol personnel for the conventional routine inspections have been carried out on-site to use the digital cameras, GPS positioning and paper recording method. Such manual inspections and records have been time-consuming and labor-intensive resulting in low inspection frequency and standards varied due to different patrol members. This result could cause the subsequent data collection and analysis without the same standards. However, remote sensing image has a large monitoring area and can analyze by using algorithm to find the suspicious points. Remote sensing techniques has the characteristics of high instant, low cost and long-term observation and can be used for long-term, large-scale and near-instant monitoring in catchment area. The advantages for monitoring landscape changes in catchment area using remote sensing techniques can be quickly and synchronously monitoring the overall landscape changes trend in catchment for the management of the water source area. Therefore, this study establishes a monitoring process which construct the relationship between the vegetation and the satellite spectrum. Through the conversion relationship, the satellite spectral values are converted into monitoring data. According to the calculation of NDVI vegetation index, the location of vegetation can be screened out. This study finds the threshold of the NDVI index of 0.05 in the green cover and non-green cover. This value is further used to automatically convert into an image of the NDVI index greater or less than threshold. In this study, the green part image is vegetation area and the dark gray part image is landscape change area. After the image transformation, the algorithm can be used to automatically compare the pre- and post-images, and automatically select the landscape change area from the original green to the non-green area. Through the algorithm used in this study, it is feasible to see the effectiveness and advantages of using the NDVI vegetation index to judge the landscape change. Since the patrol personnel may not be able to judge the illegal use of the catchment area first. Therefore, if using hyperspectral remote sensing data to judge the illegal development area, it will be beneficial for the conservation management of the catchment area. The development of smart image interpretation technology, image data collection and interpretation of illegal development data can assist water resource conservation and land use management in catchment area.

Keywords: remote sensing data, NDVI, landscape changes

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DTM GENERATION WITH UAV BASED PHOTOGRAMMETRIC POINT CLOUD IN LAMPHACHI RIVER

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This research aims to evaluate the efficiency of terrain digital terrain model (DTM) with aerial photo and photogrammetric point cloud. The study area is 1.28 kilometers at Lamphachi river in Karnchanaburi province of Thailand. The PHANTOM 4 PRO flight was conducted with 559 aerial photographs at 120 m altitude. The ground control points were set at 8 points. Agisoft Photoscan software is used to create point cloud and CSF (Cloth Simulation Filtering) algorithms for point cloud modification.The parameters are CR (Cloth resolution), maximum iteration and Classification threshold that the values were 1.0, 500 and 1.0 respectively. The results of this study were as follows: Root Mean Square Error (RMSE) was compared with 407 checkpoints, including in channel sandbars and river banks is 135 points, 119 points and 153 points respectively. The result of study found that RMSE of the channel sand bars and river embankment is 1.24 meters, 2.18 meters and 1.56 meters respectively. Outcomes of the study show that it is possible to use the .UAV Photogrammetry data as map producing, surveying, and some other engineering applications with the advantages of low-cost, time conservation, and minimum field work.

Keywords: UAV, Point cloud, DTM

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PAPER ID: TC322-1

LAND USE CLASSIFICATION OF SMALL AGRICULTURAL PARCELS USING MID-RESOLUTION SAR AND OPTICAL IMAGES

Takanori Nagano[1], Abudukeremu Ainalibanua[1], Yoichi Fujihara[2], Natsuki Yoshikwa[3]

The agricultural land use order in Japan is now facing a big turning point. Aging of farmers and progress of depopulation in rural areas are causing severe shortage of workers. The profit margin of rice and other agricultural products is expected to decline in the future due to increase in import and decrease in consumption. It is thought that the abandoned parcels which amounts to 420,000 ha in 2015, would further increase in the coming years.Under such circumstances, it is increasingly important to monitor dynamics of agriculture, by identifying farmland use every year at broad scale. In a country like Japan however, it turns out to be very costly because agricultural parcels are small and high-resolution satellite imageries are necessary for accurate land use classification.

The unltimate goal of this research is to realize annual land use monitoring of all agricultural parcels in Japan. For this the following methodology is taken. We use open-access mid-resolution satellite imageries (such as Sentinel-1,2) as much as possible to cut cost, to achieve broadening and prolongation of analysis. In order to suppress the discrimination error in small agricultural parcels, we use GIS shape files of parcels provided by Midori-net (Land Improvement District Union) to accurately extract pixels of pure land use. We use high-resolution SAR image (Alos-2) to detect land use in small parcels.

We initiated this research in 2016 and study areas were set to farmlands in Sasayama city in Hyogo and Joetsu city in Niigata. Ground truth was carried out in 2016 and 2017 using drones and main land use in two areas were paddies, soybean fields and abondoned fields.

So far from data in 2016, using Sentinel-1 and Sentil-2 alone, paddies largers than 16.1a were detected with extraction accuracy of 98.0%. Soybeans field larger than 26.3a were detected with extraction accuracyt of 100%. With addition Alos-2, paddies with size of 5-10a are also expected to be accurately extracted. Now we are analyzing the landuse of 2017 with much increased sampling numbers.

Keywords: Remote sensing, SAR, Midori-net

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Session D
Disaster Management/Groundwater Management

GUEST SPEAKER: D01

SUSTAINABLE GROUNDWATER MANAGEMENT IN ANTHROPOCENE

Makoto Taniguchi*

Global sustainability during the Anthropocene depends on the groundwater governance in Asia, this is not only because of large water footprints through global trade of agricultural/industrial materials, but also due to carbon emissions through human activities using groundwater in Asia. Challenges for the future of groundwater hydrology towards global sustainability are discussed from the viewpoints of system knowledge, target knowledge, and transformation knowledge. Regarding system knowledge, interactions between groundwater-food-energy nexus and environmental/economical impacts, and groundwater footprints with sustainability indices are essential as the center of information among nature, society and humanity. Back cast scenarios and future designs are important for target knowledge. Transformation knowledges are related to human behavioral changes and technological innovations. Natural and social tipping points, regime shifts, and resilience are keys for the future of hydrogeology and a sustainable society. Sustainable groundwater governance has cultural dependency because of differences in hydroclimate, hydrogeology, water management, and water culture in each area. Therefore, an interaction between humanity and nature is important for finding solutions towards sustainability for the current complicated and wicked global environmental problems.

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GUEST SPEAKER: D02

DELIVERING BIG DATA AND THE CHANGING LANDSCAPE OF MOBILE AND WEB-BASED TECHNOLOGIES TO ADDRESSGROUNDWATER SECURITY CHALLENGES

Sachin Shah*

Water security challenges require an understanding of how the primary drivers of groundwater stress—overuse and drought—affect the management of groundwater issues. Major progress has been made in the use of traditional water management tools such as remote sensing and groundwater modeling. In developing and middle-income countries, augmenting traditional water management tools with web-based applications for disseminating large data sets (big data) vital to solving water security challenges is essential. Compiling and disseminating big data by using digital solutions such as mobile and web applications provides water-resource managers with the tools they need to act swiftly and confidently when making water management decisions. For example, unprecedented economic expansion, land development, and climate variability in regions such as Southeast Asia have increased the frequency and intensity of urban and rural groundwater usage. Leveraging new technological solutions has helped the U.S. Geological Survey (USGS) to work with collaborators and stakeholders to track changing groundwater levels and management scenarios over time. In addition to addressing groundwater-level changes and simulating aquifer conditions , emerging technology helps areas that have under gone rapid environmental changes to address other issues such as land-subsidence, and changes in water quality. Tran boundary aquifers are inevitably linked to water-related conflicts, creating the need for faster access to water data for water use and regional allocation decisions. To help alleviate conflict, water-data infrastructure and governance serves as the backbone for efficient data delivery. To enable and sustain a high level of efficiency, rigorous data management processes can facilitate communication among agencies and NGOs to foster collaboration—a key to effective trans boundary water data sharing and delivery. As applications are modernized and new data are included, the public's understanding of groundwater hydrology and how the data benefit their daily lives can also grow. Open access to transparent data on mobile and web-based applications can increase the public's confidence in water management institutions, and data-driven decisions can drive investment in groundwater-resource solutions to meet challenging and continually changing groundwater issues.

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GUEST SPEAKER: D03

THAMLUANG CAVE SYSTEMS IN THE VIEW OF HYDROGEOLOGY AND RELATED ISSUES

Chaiporn Siripornpibul*

ThamLuang Cave system in Chiang Rai Province, Thailand, is located in the very thick carbonate rocks, mainly consists of limestone and some parts of marble, which created unique aquifers and accommodating complex hydrogeological conditions in 3 different cave systems; dry caves, stream caves and phreatic caves in the same area. Besides, it is the 4th longest caves in Thailand with a total length of about 10.3 km. Rainfall pattern in this area is the main factor controlling changes of water levels in the main cave and causes flooding passages during the rainy season. Another factor is the complexity of the cave system, especially the variety of cave passages in term of dimensions and elevations. On June 23, 2018,the heavy rainfall caused flooding that trapped a soccer team of 12 boys and their coach inside the cave. To rescue the team, the author and staffs from the Department of Mineral Resources, together with the experts from the Royal Irrigation Department, Department of National Parks, Wildlife and Plant Conservation, Thai Royal Army and several hundreds of local people were collaborating to search for locations of stream sinks where water from streams flow into the upper part of the cave system. Also, they constructed small weirs to divert water from the northern and southern parts of the main cave. These actions ledsignificantwater-level decline, therefore the decision maker began the unbelievable rescue operation that successfully saved the football team out from the cave. ThamLuang cave area is the outstanding place and attractive for adventure tourism because of its astonishing karst features. In addition, there are pieces of hydrogeological evidence that we can investigate and further study such as Karst Biodiversity, Paleontology, Paleo-climate, Carbon sink and Neo-tectonic.

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GUEST SPEAKER: D04

GROUNDWATER PROTECTION IN LARGE CITIES

Vuong Bui Tran

Currently there are 795 cities in Việtnam, of which, 2 cities (Hanoi and Ho Chi Minh City) are the special cities; 3 cities (Hai Phong, Da Nang and Hue) are Class I cities directly under the central government;14 cities are Class I cities; 25 cities are Class II cities; 41 cities are Class III cities; 84 cities are class IV cities and 626 cities are Class V cities.

The volume of water used for the cities in Vietnam is from several hundred to thousand millions of m3 per year, of which, about 50% of water supply amount is from groundwater. The abstraction of groundwater has contributed significantly to the socio-economic development of the country, improving the quality of people life. However, groundwater abstraction and urbanization have created many adverse impacts to groundwater resources such as: depletion, increased pollution , salt water intrusion of groundwater resources and land surface subsidence.

Recognizing the importance of groundwater resources for socio-economic development in our country's cities now and for many years to come, the Prime Minister issued Decision No. 323 / QD-TTg dated 18/02/2013 approving the project "Groundwater protection in large cities". Following the decision of the Prime Minister, the Ministry of Natural Resources and Environment issued Decision No. 1557 / QD-BTNMT dated 30 August 2013 approving the content and budget for the groundwater protection project. Phase I will be implemented in 09 key cities: Ha Noi, Thai Nguyen, Hai Duong, Quy Nhon, Vung Tau, Buon Me Thuot, Ho Chi Minh City, Can Tho and My Tho.

The project was implemented by the National Center for Water Resources Planning and Investigation with the participation of the following organizations: Division of Water Resources Planning and Investigation for the North of Vietnam, Division of Water Resources Planning and Investigation for the Central of Vietnam; Divisiong of Water Resources Planning and Investigation for the South of Vietnam; Center for Quality and Protection of Water Resources; Water Resources Data Center; Center for Water Resources Technology and Department of Water Resources Management. The project was implemented from 2013 to 2017, basically completed in 2018.

The presentation will present the main results and several recommendation of and from the above-mentioned project.

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GUEST SPEAKER: D05

ADAP-T FOR WATER DISASTER RISK MANAGEMENT AND SUSTAINABLE DEVELOPMENT

Taikan Oki[1], Kiatiwat Thanya[2], Hiroaki Shirakawa[3], Weerakaset Suanpaga[2], Taichi Tebakari[4], Sompratana Ritphring[2], Masashi Kiguchi[1] and Kyoko Matsumoto[1]

The anthropogenic climate change is increasing water-related disaster risks such as flood and drought, in particular, because most of the adverse impacts of climate change is delivered to society through water. The global mean temperature has risen by more than 1.0 degree Celsius increase compared to pre-industrial era and it is predicted that it will likely reach 1.5 degree Celsius between 2030 and 2052 if it continues to increase at the current rate, according to the latest IPCC Special Report on the impacts of global warming of 1.5 degree Celsius. Mitigation efforts to reduce the greenhouse gas, e.g., CO2, emission and to reduce the speed of climate change is essentially important, and at the same time, adaptation measures to reduce the vulnerability and exposure of human lives and properties from risks exacerbated by climate change are also relevant.

After the Paris Agreement of UNFCCC in 2015, all the member states are encouraged to set their National Adaptation Plan, and a new research project entitled "Advancing co-design of integrated strategies with adaptation to climate change in Thailand (ADAP-T)" with international collaboration between Thailand and Japan was proposed, approved, and implemented since 2016, supported by JICA for Thai side and JST for Japanese side under the framework of SATREPS. ADAP-T has three piers of research, namely i) Knowledgebase of climate change, ii) Adaptation measures to climate change, and iii) Co-designing adaptation measures. Major sectors prone to climate change, such as riverine hydrology, forest hydrology, sediment erosion, coastal erosion, urban hydrology, and agricultural hydrology are considered in ADAP-T, and Kasetsart University, Thai Meteorological Department, Royal Irrigation Department, and ONEP (Office of Natural Resources and Environmental Policy and Planning) are managing the ADAP-T project in Thailand with close communication with The University of Tokyo and member researchers. Latest research achievements will be introduced in the THA2019.

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GUEST SPEAKER: D06

FLOOD COMPUTATIONS FOR CHANGING RIVER ENVIRONMENT IN KOREA

KYUNG SOO JUN*

The primary objective of the Four Major Rivers Restoration Project, the largest pan-national river project in Korean history in terms of its spatial coverage and budget, is to secure water in river channels. This is achieved by large-scale channel dredging and constructing a number of weirsin low flow channels. Among the four major rivers, the Nakdong River is the focus of the project. The weirs and estuary barrage in the Nakdong River are partially gated. The gates are to be opened when a flood occurs to prevent water level rise. On the other hand, the water level of the weirs and estuary barrage should not fall far below the normal pool level at the end of the flood because it is required to secure water in the low flow channel. Gate operation strategies for weirs and estuary barrage are needed to satisfy those two conflicting objectives, and appropriate simulation models are essential for developing them. A numerical model was developed that can simulate gate openings of estuary barrage and a series of weirs as well as the unsteady flow in the Nakdong River, Korea. The computational model can appropriately simulate composite flows at multi-functional weirs including weir overflow, orifice-type flow, and fluvial-type flow. Operation strategies for weirs were established such that gates are closed for water level below a certain reference level and gate openings increase as the water level rises. The prescribed operation conditions were well simulated by the model, and sensitivities to the parameters of the gate operation strategy were analyzed. The computational model developed herein has been utilized in establishing operational strategies during flood periods for a series of the weirs and the Nakdong Estuary Barrage.

Keywords: Flood computation, Gate operation, Unsteady river flow, Nakdong River

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GUEST SPEAKER: D07

FUTURE DROUGHT RISK ASSESSMENT IN CHANGING CLIMATE USING HYDRO-METEOROLOGICAL AND SOCIO-ECONOMIC INDICATORS

Joo-Heon Lee*, Hyun-Pyo Hong, Seo-Yeon Park, Chanyang Sur

Climate change is a major crisis facing the world and future generations, and the frequent occurrence of extreme weather phenomena can lead to changes in the stabilized hydrologic cycle. In addition, the extreme drought caused by climate change should be prepared not only for natural disasters but also for the level of catastrophic that have enormous socio-economic impacts. For sustainable management of water resources, it is very important to understand the frequency and severity of the extreme climate and the impacts and vulnerabilities of the climate damage to the economy.

In this study, 26 GCMs of CMIP5 based on the RCP scenario were evaluated for the extreme drought risk assessment considering future climate change (2011 ~ 2099). Through analyzing the annual average rainfall, the number of rainless days, the drought frequency, and the average drought severity, we selected the GCMs that predict the future drought most severely. In order to evaluate the historic drought using observed meteorological data, KMA(Korean Meteorological Administration) ASOS(automated synoptic observation system) data (1976 ~ 2005) were used to quantitatively assess past and future Korean drought to predict changes in drought risk.

In this study, Drought Hazard Index (DHI) was calculated for the future period (2012 ~ 2040, 2041 ~ 2070, 2071 ~ 2099) divided into three time windows based on RCP 4.5 and RCP 8.5 scenarios considering meteorological drought occurrence characteristics. For calculating the drought hazard index, the frequency of drought, average drought severity, and probable drought severity were used.

The Drought Vulnerability Index(DVI) was calculated using socioeconomic indicators including population, agricultural land area, and municipal, industrial, agricultural water use. The calculated indicators were transformed into dimensionless variables through the re-scaling method, which is a standardization method, and the DHI and the DVI were calculated by applying the weighting factors for each indicators with use of Analytic Hierarchy Process(AHP).

The Drought Risk Index(DRI) was calculated as the product of DHI and DVI. According to the results of this study, the risk of future extreme drought calculated through Hazard and Vulnerability changes in time and space in the future. Based on the results of this study, it will be possible to predict the future extreme drought risk and to develop customized drought countermeasures.

Keywords: drought risk, climate change, vulnerability, hazard

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RELATIONSHIP BETWEEN GROUNDWATER,HYDROLOGY AND WATER USE IN LOWER NORTH REGION OF THAILAND

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Groundwater is an alternative water resource in addition to the widely used surface water. If the groundwater is used excessively more than the groundwater safe yield, it will cause the groundwater to decline continuously and increase the cost of groundwater pumping. This study was carried out to investigate the status of groundwater in the lower north region of Thailand covering three provinces such as Sukhothai, Phitsanulok and Pichit, located in Yom and Nan river basins. The provinces are important agricultural areas of rice production and often pump the groundwater for conjunctive use along with the surface water. The study was done to determine the trend of groundwater and the relationships between the groundwater levels and the related factors such as the river water levels and the water uses in the areas. It is found that the trend of groundwater levels was to decline on the average of 0.69m./year in Sukhothai, 0.37m./year in Phitsanulok and 0.46m./year in Pichit, indicating the excessive groundwater uses. The groundwater levels were found to be closely related to the rainfall amounts and Yom and Nan river water levels, showing the role of recharging the groundwater. Also, the groundwater levels were related to the groundwater uses. The water demands, water uses and water resources within the three provinces were studied. The total average annual water demand was 3,765 million cum., dividing into Sukhothai as 30.9%, Phitsanulok as 43.1% and Pichit 26%. The water demand was classified according to the different uses such as the agriculture as 75.4%, the ecology as 17%, the consumption as 7% and the industry as 0.6%. The water resources to meet the water demands were obtained from the effective rainfall as 43.6%, the surface water resource as 42.7% and the groundwater resource as 13.7%.

Keywords: groundwater levels, Yom and Nan river water levels, groundwater uses

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EFFECTIVENESS OF THE LEVEE AGAINST FLOODING AT DIFFERENT RAINFALL RETURN PERIODS IN MANDULOG RIVER, ILIGAN CITY, PHILIPPINES

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Abstract: The Mandulog river levee located in Hinaplanon, Iligan City, Philippines is one of the engineering mitigating measures undertaken by the national government in order to prevent another devastating flood, like the one brought by TS Washi (locally known as Typhoon Sendong) that badly hit Iligan City and Cagayan de Oro City in December, 2011 resulting to thousands of death toll. The study determines the effectiveness of the levee against possible flood overtopping using a 50-year and 100-year rainfall return periods. Hydrologic simulation and 2D flood modelling were done using HEC-HMS 4.1 and HEC-RAS 5.0.3. The LiDAR dataset and bathymetric river survey in 2012 is used in river and floodplain geometric data generation. Results of the 2D flood model shows that the levee can prevent river flooding for the two rainfall scenarios. It also shows that the levee is effective against flood overtopping. However, it blocks the runoff from the land side outside the levee, thereby causing flooding in the nearby areas. The model and the river basin's calibrated hydrologic parameters are very useful in planning, constructing and maintaining a levee.

Keywords: levee, rainfall return period, flooding

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COMPARISON OF TWO LAND COVER SCENARIOS AND ITS EFFECT ON THE RUNOFF PROCESSES INSIDE THE MANDULOG RIVER BASIN, PHILIPPINES

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This study seeks to determine what happens to runoff volume, peak flow and the lag time between peak rainfall and peak river discharge or peak flow when no proper land use management is done inside the Mandulog River Basin, Iligan City. This is represented by the Projected Land Cover. Another is what happens to the runoff processes when sound land use management is adopted. The first land cover scenario was created using a Trend Analysis function from MS Excel derived from the 1973, 1989, 1998, 2008 and 2010 land cover images. The second scenario is the Desired Land Use wherein it makes use of slope as the basis in assigning the different land uses. The SCS Curve Number values were determined for the two land cover scenarios. Limitedly available LiDAR DEM strips were integrated into the IFSAR DEM to generate a detailed basin model and slope in GIS. The HEC-HMS was used for simulating runoff models. The study shows that the Projected Land Cover has a higher total runoff volume, peak flow and shorter Lag time as compared to the Desired Land Use in the four (4) Rainfall Return Period scenarios. It also shows that the Desired Land Use has twice as much forest vegetation that results to a reduced runoff volume, and thereby decreases the extent of the flooded area.

Keywords: runoff volume, peak flow, land cover

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PAPER ID: TD407-1

GROUNDWATER AND SURFACE WATER INTERACTION ESTIMATES VIA GROUNDWATER MODEL - CASE STUDY IN PLAICHUMPHOL IRRIGATION PROJECT, THAILAND-

Pwint Phyu Aye[*1,2] and Sucharit Koontanakulvong[1]

The Plaichumphol Irrigation Project, Thailand is the area which depends on both irrigation water and groundwater for long time. Farmers in that area have their cultivation almost whole year, therefore groundwater supply is a major alternative source of water for their cultivation especially in the dry peroids. The purpose of the study is to understand the groundwater and surface water interactions and patterns via development of local groundwater model with the grid size of 400 x 400 square meters. Boundary conditions were determined based on the geology, hydrogeology and piezometry of the aquifer of the calibrated regional groundwater model. River water level, pumping wells and recharge rates are also used from regional groundwater model with grid size of 2 x 2 sq.km. Field river seepage measurements were carried out to estimate hydraulic conductance of the river, to analysis interaction mechanism and to compare with the developed local groundwater model (flux) results. The calibrated local groundwater model can produce water flow budget of surface and groundwater interactions in the time series and in patterns (annual, seasonal). The understandings of groundwater and surface water interaction mechanism will bring better estimates of groundwater yield and better recommendations on groundwater management measures to counter with drought issue in the study area.

Keywords: sw-gw interaction, field measurement, seepage, flow budget, Plaichumphol Irrigation Project

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DETERMINATION OF DEEP PERCOLATION via FIELD SENSOR MEASUREMENTS IN SAIGON RIVER BASIN, VIETNAM

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As a critical factor of the groundwater balance, the groundwater recharge rate plays an essential role in determining sustainable yields for groundwater resources, especially in overexploited aquifers. Traditionally, due to the difficulty of measurement, groundwater recharge could be estimated based on lysimeter, unsaturated zone water balance, Darcy flux, water table fluctuation, tracer, and parameters optimization from groundwater modeling. However, soil profile somehow cannot be validated and lead land recharge incorrectly equated with the sustainable yield of an aquifer.

Hence, the paper will focus on describing field measurement setup with soil moisture approach and estimate deep percolation rate using Richard's function (Hydrus 1D). First, the field measurement system with daily sensor moisture measurements of 3 soil types were designed and conducted at Di An, Tan Uyen, and Cu Chi along Saigon river during Oct 2017 – Oct 2018. Second, according to the field data, deep percolation flow is analyzed more reliable on the soil characteristics using the Hydrus 1D model. The water retention parameters are calibrated and verified by field experimental data in the study area of Saigon River Basin, Vietnam. Third, relationship of effective rainfall and deep percolation are analyzed to detect the deep percolation function for 3 soil types in the Saigon River basin, South East of Vietnam. Finally, the water balance assessment of percolation flow provides a better understanding of the deep percolation system.

This investigation gives an insight on deeper percolation mechanism as well as potential land recharge from rainfall utilizing soil moisture approach for developing groundwater modeling. Henceforth, the deeper percolation procedure and results will be useful for further determining groundwater yields and disaster management as in the consecutive drought years.

Keywords: Deep percolation, soil moisture approach, field measurement, Hydrus 1D

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REVIEW AND FUTURE DIRECTION OF RESEARCH ON DELTA AT RISK AND RESILIENCE TO WATER-RELATED DISASTERS

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The number of population living in the delta cities are increasing year by year due to abundant natural resources and accessibility. However, this condition is not equivalent with the capabilities of the cities against natural disasters. The inclination toward global climate change will increase the risk of water-related disasters. Assessing the delta city resilience on infrastructure, social-ecology, and policy is necessary to reduce damage and loss. This paper aims to review the current research trend on the vulnerability of delta cities toward the water-related disasters. These disasters define as a natural event such as flood, tsunami, storm, climate change effects that causes great damage and loss in delta region. Reviewing current achievement and methodology, finding the missing gaps from previous literature, and providing the future recommendation for researcher are important for future outlook in this subject. Using Scopus database and some private institutions as a complement to sort particular papers in this topic, the results show that many studies are still centralized in Asian and European countries. Mostly, the articles focus on climate change effect and the lack of policy on disaster resilience. Adding new scenario framework, integrating with policy sector, and shifting study location to Africa or Oceania to evaluate the resilience status in delta cities against water-related disasters can be a breakthrough in this field.

Keywords: water-related disasters; delta city resilience; climate change

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ASSESSMENTS OF GROUNDWATER–SURFACE WATER CONNECTIVITY FOR THE LOWER YOM AND NAN RIVERS.

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This study outlined the first-time assessments of groundwater–surface water connectivity for the Lower Yom and Nan Rivers. The direct measurements of exchange fluxes using seepage meters were carried out. The diurnal flow directions between groundwater and surface water were then investigated based on thermal conditions in streambeds (8-m depth within the sediment). The study's findings exhibited seasonal influxes and effluxes (-4.32–163 cm/day for the Lower Nan and -1.90–198 cm/day for the Lower Yom) of surface water associated with groundwater. In addition, the rapid thermal responses (~1.5 ^{o}C) in the streambed due to high rates of infiltration were diurnally evident. The groundwater–surface water interactions are essential for laying the foundations of conjunctive water management approach. Better understandings of the groundwater–surface water connectivity would help enhancing integrated water resource planning and management at the river basin level in order to achieve the efficiency of agricultural production, economic equality, and environmental sustainability.

Keywords: Groundwater connectivity, Exchange fluxes, Seepage meters, Infiltration, Conjunctive water management.

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GRID-BASED SOCIOECONOMIC DATABASE FOR EXPOSURE ESTIMATION IN FLOODING RISK ANALYSIS

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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, but its values and usefulness will be slashed without further risk analysis. Socioeconomic data with its regional distribution are vital for risk analysis in natural disaster mitigation.

This paper will present a grid-based spatial database to capture the regional variations in socioeconomic data for better loss and risk assessments in risk analysis for flooding disaster mitigation. A 40m by 40m digital terrain model(DTM) available in Taiwan was commonly used in flood simulation. Although a new version DTM with 5m by 5m resolution has been established for better capture of terrain variations, a grid framework with 40m resolution will be used for this database construction considering the necessity for spatial variation representation in socioeconomic data.

Multiple sources were used for this database establishment including: Population Census, Agriculture Census, Commercial & Industrial Census, Building Administrations, Land use survey, Address Coordinate database, Manufactory and Business Registration, etc. Data from the above sources were spatially disaggregated from their original spatial units into the grid framework with 40m resolution.

Some problems in disaggregation from larger spatial units to smaller ones will be discussed. A demonstration using this socioeconomic database with the flooding simulation for regional flooding loss assessment will also be presented.

Keywords: Flood risk, Socioeconomic, Exposure, Flood loss assessment, Census

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THE CHARACTERISTICS OF SEDIMENT TRANSPORT IN THE UPPER AND MIDDLE YOM RIVER, THAILAND

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Seree Chanyotha[1], Butsawan Bidorn[1*]

The Yom River is one of the major sediment supply source to the Chao Phraya River, the largest river in Thailand. The upper and the middle portions of Yom River basin are a mountainous feature. Without the existence of a large storage reservoir in this area, it is important to evaluate the sediment discharge for the water development projects in the future. The objective of this study is to study sediment transport characteristics in the upper and middle reaches of the river. River data including river cross-section, flow velocity, suspended sediment concentration, bed load, and bed material were observed in 2011, 2012, 2013, and 2018 for studying sediment characteristics of the Yom River. Historical data on river discharges and suspended sediment loads collected during the period 1978-2014 at four RID (Royal Irrigation Department) hydrological stations were used to investigate the variation of the long-term sediment discharge along the river. Results of this study revealed that the Yom River was characterized by coarse sand and very coarse sand with d_{50} ranged between 0.70 mm and 1.75 mm, and the bed-to suspended loads ratio along the river varied from 0 to 1:100. In addition, the daily suspended load in the upper and middle rivers showed a good correlation with the daily river discharge (R^2>0.8).

Keywords: bed load, suspended sediment load, mountainous river basin

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HISTORICAL SHORELINE CHANGE OF THAP SAKAE COAST, PRACHUAP KHIRI KAN, THAILAND

Nathamon Phanomphongphaisarn[1], Butsawan Bidorn[1*], Anurak Sriariyawat[1]

Coastal erosion is a critical problem in Thailand significantly affecting the coastal development and economy of the country. This paper presents the situation of shoreline change along the Thap Sakae Coast, which is one of the highest potential areas for coastal development of the country. To evaluate the coastal erosion situation of the study area, eight shoreline positions were extracted from the aerial photographs and satellite images taken between 1966 and 2017 using the Geographic Information System (ArcGIS). The rates of shoreline change were analyzed by the Digital Shoreline Analysis System (DSAS). Additionally, field surveys was carried out in 2018 to observe the current coastal environment. Based on the results from shoreline analyses, the long-term (1966-2003) and short-term (2003-2017) rates of shoreline change along the Thap Sakae coast were -0.1 and 0.33 m/y, respectively. As the average rate of shoreline change was less than ±1 m/y, the Thap Sakae coast seemed to be a stable coastal area. However, local coastal erosion was found during the past 15 years due to the land development mainly for tourism purpose. Coastal protection structures were found in many locations along the study area. Those coastal development and coastal protection measures has likely been driving the negative effects to their adjacent areas. As the Thap Sakae coast has a high economic values, an erosion rate with a small degree can cause a significant damage to the local and regional economy.

Keywords: coastal erosion, sandy beach, high water line

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DELINEATION OF UNCONVENTIONAL GROUNDWATER: II. SALINE GEOTHERMAL GROUNDWATER IN KRABI, THAILAND

Wipada Ngansom and Helmut Duerrast*

Common groundwater is usually of meteoric origin; rain seeps into the ground and thus forms aquifers at depth, which then can be utilized via wells for human consumption and industrial use. The quality and the amount of groundwater in such an aquifer depend on water-rock interactions and the physical properties of the sediments and rocks forming the aquifer. Groundwater aquifers are exposed to dangers of contamination and pollution from external sources as for human consumption requires a certain quality. Hence, the protection of groundwater sources is of uttermost importance. However, naturally occurring un-conventional groundwater also can be found in the subsurface, mainly originating at deeper depth from geological fluids, which often are not feasible for human consumption. Therefore, a clear delineation of the boundaries between both types of groundwater is required. The saline geothermal groundwater in Khlong Thom District of Krabi Province in Southern Thailand is one example. Here, a range of geological, geophysical, and geochemical methods and investigations have been applied in order to fully characterize the geothermal system, thus determining its boundaries from the conventional groundwater system. Parallel, this also allows a better utilization and management of the hot water itself as it can be used for human health purposes as well as for renewable energy production, either as direct use for drying food, for example, or for electricity production via geothermal power plants. A continuous monitoring of the overall system will ensure a sustainable use of the saline hot water as well as the surrounding common groundwater.

Keywords: Unconventional groundwater, saline hot spring, Krabi

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DELINEATION OF UNCONVENTIONAL GROUNDWATER: I. SODA GROUNDWATER IN SONGKHLA, THAILAND

Poonnapa Klamthim and Helmut Duerrast*

Common groundwater is usually of meteoric origin; rain seeps into the ground and thus forms aquifers at depth, which then can be utilized via wells for human consumption, agriculture, and industrial use. The quality and the amount of groundwater in such an aquifer depend on water-rock interactions and the physical properties of the sediments and rocks forming the aquifer. Groundwater aquifers are exposed to dangers of contamination and pollution from external sources as for human consumption requires a certain quality. Hence, the protection of groundwater sources is of uttermost importance. However, naturally occurring un-conventional groundwater also can be found in the subsurface, mainly originating at deeper depth from geological fluids, which often are not feasible for human consumption. The soda groundwater in Khlong Hoi Khong District of Songkla Province in Southern Thailand is one example. Therefore, a clear delineation of the boundaries between both types of groundwater is required. In this study a range of geological, geophysical, geochemical, geostatistical methods have been applied as well as modeling approaches in order to fully characterize the soda groundwater system, thus determining its boundaries from the conventional groundwater system. Furthermore, the natural soda groundwater in Khlong Hoi Khong is not only of exceptional occurrence in Thailand, but it also has the potential for human consumption comparable to industrial made soda water; therefore this study also investigated the chemical composition of the natural soda water in order to evaluate its potential for a sustainable utilization of all available groundwater resources in the area.

Keywords: Unconventional groundwater, soda groundwater, Songkhla

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POTENTIAL IMPACT OF SEVERE WEATHER ON HYDRAULIC PERFORMANCE OF A FIELD-SCALE WASTEWATER TREATMENT PLANT: A CASE STUDY FOR HYDRODYNAMIC RECONFIGURATION WITH BAFFLES-BASED POND

Saifhon Tomkratoke*, Teppatat Pantuphag and Sirod Sirisup

Water pollution is a relevance problem to Thailand's water resources management. Overall, the current status of the surface water of Thailand is moderate to good quality except that of the central Chao Phraya watershed which deteriorates. This fact indicates that the environmental management policy and wastewater treatment infrastructure of the country may need to be improved for enhancing efficiency in wastewater. Focusing on the latter issue, despite significant wastewater contributions from domestic and industrial sectors, establishing and maintaining their own wastewater treatment plants need utmost responsibilities and must be ready for challenges from climate variation influences. However, the excessive cost is still a vital issue in developing wastewater treatment infrastructure, therefore, improving and modernizing the existing structures can be more beneficial alternatives. On a field scale, waste stabilization ponds with baffles (WSPBs) configuration can be one of the possible solutions to the mentioned issue. However, generalizing the structure to fit various sites and finding the optimal design remain a challenge. In developing know-how for a country with different climatic regions like Thailand, the impacts of environmental factors like severe weather, unusually heavy rainfall on hydraulic performance and caring capacity of the pond should also be included. In this study, we conduct a numerical experiment of hydraulic flow of WSPBs via a sophisticated Navier-Stoke model. Several stormwater flow scenarios associated with severe weather conditions have been used to drive the model. Finally, the optimal design of WSPBs will be evaluated. This research could help benefit the communities related to water pollution management and provide an understanding of wastewater infrastructure design.

Keywords: Wastewater treatment, hydraulic performance, baffles

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GEOGRAPHICALLY WEIGHTED REGRESSION ANALYSIS APPLIED TO THE ESTABLISHMENT OF PADDY FIELD FLOODING LOSS FUNCTIONS

LingFang Chang[1], Wen-Tsun Fang[2], MingDaw Su[3]

Abstract Disasters due to typhoons and heavy rainfall occur frequently in Taiwan. With the increase of social and economic development density, flood damages are becoming more and more serious. Flood risk management has thus turned into a very important task. Flood damage assessment is the basis of flood risk management. The disaster damage estimation model is often divided into residential areas, industrial and commercial areas, agricultural areas and public facilities. Previous studies have mostly focused on residential, industrial and commercial areas. Agricultural losses are due to a large number of impact factors, and the relevant literature is insufficient.

The most common methods are the loss curves for unit area and the flood depth loss curves method. Although the loss curves for unit area method is relatively simple, the differences in loss caused by various flooding depths are not considered. The flooding depth loss curve method often needs to be established through questionnaires. However, questionnaire surveys have to consume lots of manpower and material resources. Both the two methods above do not take the growth period of crops into consideration.

When disasters occur in different growth periods of crops, the losses caused by the same flooding depth are different due to the various flooding tolerances of crops in each growth period. Due to the hydrological and geographical factors, such as climate, the growth period of rice transplanting is different due to dissimilar climatic conditions. The complexity of establishing a flooding loss curve for paddy field is thus obvious.

In addition, in case the analysis of the flooding loss data is based on the traditional global regression analysis approach, there usually exists a spatial autocorrelation of the residual term with no consideration of spatial variation. This result violates the assumption of linear regression. In view of this, this study is expected to use paddy field as the research object.

At first, paddy field loss factors considered in each literature are reviewed and studied. Relevant domestic factors are also collected and it then to establish a paddy field flooding loss estimation model, and then use the geographically weighted regression model for spatial analysis and spatial grouping comparison. The selection of the research site is to consider large-scale historical disaster events. The event is selected for analysis and assessment of the disaster area o of Typhoon Morakot in Kaohsiung City in 2008..

The selected prediction variable is the amount of flooding loss, the independent variable is the flooding area and the flooding depth. The global regression analysis shows that the flooded area is a significant influential factor, and the influence of flooding depth on flooding loss is not significant. The model explanatory power was raised up by a significant amount through geographically weighted regression analysis, which also improves the capability of problem solving the spatial residuals autocorrelation in the global regression.

Keywords: Paddy field flooding loss function, Paddy field flooding loss curves for growth period, Geographically weighted regression analysis

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PAPER ID: TD428-2

ANALYSIS OF EROSION HAZARD IN SUB-WATERSHED OF CILIWUNG HULU BOGOR, WEST JAVA, INDONESIA

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Erosion is the loss of a soil or parts of soil from a place that is transported by water or wind to another place. The growing quantity of human activity makes buildings around the sub-watershed of Ciliwung Upstream Bogor, West Java, Indonesia increase as well. The current condition of natural and environmental resources in the upstream Ciliwung watershed is quite apprehensive where environmental damage is already severe due to inappropriate use and use of land and urgent life needs. Therefore, mapping the spatial distribution of erosion hazards in the relevant research area needs to be done. The method that researcher use to predict erosion is the Universal Soil Loss Equation (USLE) equation. This equation is an erosion estimation model used to calculate the amount of erosion that occurs in the long term in an area. This equation can predict the average erosion rate in a plot of land at various slope steepness with a certain rain pattern for each existing cropping effort and soil management action. Variables used in this method are Rainfall Erosion, Soil Erodibility, Slope Length, Slope Slope, Ground Cover Vegetation and Soil Conservation Action Factors. The final output of this study is the spatial hazard distribution of erosion of the sub-watershed of Ciliwung Upstream Bogor.

Keywords: Analysis, Erosion, USLE.

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VERIFICATION OF ARC GIS FOR FLOOD HAZARD MAPPING: A CASE STUDY OF CHOLBURI PROVINCE, THAILAND

Supatchaya Chuanpongpanich[1], Tawatchai Tingsanchali[2,*], Sompop Kaewsawee[1]

Flood hazard potential maps over an area can be constructed by using Arc.GIS. The objective of this study is to verify the Arc GIS for flood hazard mapping given the following input data: rainfall, ground slope, ground terrain elevation, land use and soil types. To verify the Arc GIS, the weighting factor of each input data is assumed and adjusted to determine the sensitivity of each factor on the hazard maps. Then the weighting factors for all input components are assumed and adjusted by trial and error starting from the most sensitive factor and followed by the less sensitive parameters. The values of these weighting factors are finally determined when good agreement between the computed flood hazard maps and the observed flood conditions is obtained.

A case study was carried out for flood hazard mapping in Cholburi province, Thailand. The input data to Arc GIS are specified as mentioned above. Values of weighting factors for the input data are assumed and adjusted by trial and error according to the above-mentioned procedure. The weighting factors that yield acceptable agreement between the estimated flood hazard maps and actual flood conditions were obtained. Flood inundation maps in the past ten years from 2008-2017 were considered and used as the basis for comparison between the estimated flood hazard maps and the observed flood conditions. The results show that with the adjusted weighting factors, the Arc GIS gives flood hazard maps satisfactory well in comparison with the actual flood conditions.

Keywords: Flood hazard maps, Arc GIS, Cholburi Province

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Deep Percolation Characteristics via Field Moisture Sensor Measurements in the Lower Yom and Nan Basin, Thailand.

Nittaya Kangboonma[1, a] *, Sucharit Koontanakulvong[1,b]

Abstract

Groundwater recharge facility is an alternative to be used in the area where surface water is insufficient, or groundwater is over pumping. In the past, there were many experiments or projects to recharge water into groundwater. However, there is a need to understand more on percolation characteristics in order to design recharge facility more efficiently.

The research aims to understand percolation characteristics and their relationships to rainfall amount and the infiltration rate in each type of soil. The study area is located in the lower Yom and Nan basin where rice, economical crop, is cultivated. The soil moisture sensor systems were designed and installed in four area with different soil types at 4 meters deep (above shallow groundwater level). The soil moisture measurements were measured daily with other hydrological data from August to November 2017. The percolation characteristics were then analyzed by HYDRUS-1D based on Richard's Equation and compared with field infiltration measurements for each type of soil in the study area.

The model can simulate the movement of water (wetting and drying) in the soil and estimate deep percolation rate. The deep percolation characteristics and the relationship of deep percolation and infiltration rates of each soil type will be explored to be used for future groundwater recharge facility design to mitigate drought disaster in the study area.

Keywords: Deep percolation, characteristics, infiltration, field moisture sensor measurements, HYDRUS-1D.

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WATER QUALITY CHARACTERISTICS OF IONS ORIGINATING FROM SEAWATER AND MAN-MADE IN THE LOWER CHAO PHRAYA RIVER, THAILAND

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The purpose of this study is to clarify seasonal and longitudinal change of electric conductivity, ions originating from seawater (Na^+ , K^+ , Mg^{2+} , Cl^- , Ca^{2+} , SO_4^{2-} and HCO_3^-) and man-made (NO_3^-) at the surface and the riverbed water in the lower Chao Phraya River, Thailand.
The environmental water quality standard is still low and does not satisfied in Thailand. Regularly and/or continuous measurement and analysis of water quality will be important background information/data if water quality trouble will occur in the future.
We have observed and analyzed water quality at the surface and the riverbed in the lower Chao Phraya River for more than two years since August 2016. Moreover, we have analyzed automatic water quality data observed by Metropolitan Waterworks Authority (MWA).
As a result, the electric conductivity had seasonal characteristics caused by the dam operation throughout a year. It is clarified that the seawater intruded upstream as well-mixed type because the ions originating from seawater at the surface and the bottom were almost same values. The ions originating from man-made did not have any seasonal characteristic. However, NO_3^- which was ions originating from man-made at the surface and the bottom were shown different values at C02_T01(a distance of 26.6 km from the river mouth) and C06_S04(a distance of 90.1 km from the river mouth).
Above-mentioned results had clear seasonal change caused by release water from the Chao Phraya Dam.

Keywords: electric conductivity, seawater origin, man-made origin

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NUMERICAL EXPERIMENT OF CHANGE IN FLOODED AREA USING GRIDDED RAINFALL DATA DURING 1981-2017 IN THE MUN AND THE CHI RIVERS BASIN, THAILAND

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Kazuya Urayama, Taichi Tebakari**, Boonlert Archevarahuprok*****

Thailand is concerning that the effects of climate change such as strong drought during the dry season and massive flood during the rainy season and unseasonable weather may increase. Especially, there is a possibility that the occurrence frequency and scale of flood damage will be increasing.

Heavy flooding caused serious damage in the eastern region in 2011 and 2017. In the large flood of 2011, extensive flooding occurred in Yasothon, Sisaket and Ubon Ratchathani Provinces, where the Mun and Chi Rivers joined. Furthermore, the river slope was very gentle and the discharge capacity was small, which was considered to have caused extensive flooding. The impact of the flood has been causing serious damage to Thailand's major industries, manufacturing, agriculture and tourism. That is an urgent task to suppress such chronic flood damage.

The purpose of this study is to clarify the historical change in flooded area in the Mun and Chi Rivers basin using numerical simulation during 1981-2017. This study used the rainfall gridded data obtained by interpolating the point rainfall data observed by the Thai Meteorological Department (TMD) during 1981-2017 into 0.5 degree grid using the Kriging method. RRI (Rainfall Runoff Inundation) model, which is a rain runoff model capable of integrating analysis of river basin and river flow from rain runoff to flood, was selected for this study. Model parameters had been tuned by the rainfall event in 2011. Using these parameters, the maximum-flooded area of each year for 37 years was calculated and trend analysis was conducted.

Keywords: Numerical simulation, Flood, Thailand

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PAPER ID: TD436-2

A STUDY OF THE IMPACTS OF CROSS-BASIN FLOW INTERCHANGE ON RIVER MANAGEMENT

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Taiwan is located in the zone where active tropical cyclone frequently forms in the western Pacific Ocean, so rainfall intensity is typically high yet with very short concentration time of flow. The heavy rainfall of Typhoons usually causes nationwide floods, in turn, yielding huge loss of human lives and economics. The spatial and temporal redistribution of surface runoff produces greater levels and less peak time in urbanized areas. The rise in the potential risk of flooding associated with this change indicates the need to reassess the design criteria for existing flood control measures in flood areas. Research in general planning is currently focused on drainage basins as the research target. A drainage basin or catchment area is defined as any area of land where precipitation collects and drains off into a common outlet, such as a river, bay, or other body of water. The water surface exchange between the basin has an impact on river management and is an important concern in this study. This study uses the PHD model (Physiographic Drainage-Inundation Model) to simulate the Inundation due to flood in different return period events and to find cross-basin flow interchange that has an impact on river management.

Keywords: physiographic drainage-inundation (PHD) model, cross-basin, basin management

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FLOODING IN ODA RIVER BASIN DURING TORRENTIAL RAINFALL EVENT IN JULY 2018

Shakti P. C.* and Hideyuki Kamimera

Extreme rainfall events cause severe flooding and/or landslides almost every summer in Japan. It seems that the frequency of such events and induced human/economic losses has increased in recent years. Torrential rainfall in early July 2018 also triggered flooding and landslides, and induced extensive damage and losses over many prefectures in the western Japan. This study investigated severe flooding in the basin (about 480 km^2) of the Oda River flowing in Hiroshima and Okayama Prefectures during the torrential rainfall event.

According to two data sets of radar-based rainfall, basin-mean total rainfall was about 320 mm $(3\ d)^{-1}$ over the basin during July 5–7 2018. In the period, river water level rapidly increased twice, 3–4 m in six hours nighttime at a gauging station in the lower basin. After second peak of the water level rising, Yakage and Mabi areas of the basin were inundated. Inundation area and water volume in Mabi area were estimated as 8.28 km^2 and 15.3×10^6 m^3 respectively using a digital terrain model and aerial photographs. The water volume can be converted into basin-mean water depth as 31.7 mm; it is equivalent to about 10 % of the total rainfall.

To investigate the situation further and to reveal the ability to predict such a chain of phenomena from rainfall to inundation, this study applies Rainfall–Runoff–Inundation (RRI) model in the basin. Results of the modeling will be shown and discussed in the conference.

Keywords: Oda River, flooding, RRI model

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ASSESSMENT OF SATELLITE-BASED RAINFALL ESTIMATES OVER JAPAN

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Satellite-based rainfall estimates are valuable for water-related applications in ungauged regions, where ground-based observations (or estimates) do not exist (or are not available). This study compared the Global Satellite Mapping of Precipitation (GSMaP) gridded rainfall estimates from passive microwave radiometers (PMWRs, on board constellation satellites) and well-quality-checked reference rainfall estimates from ground-based weather radars in Japan for the period from 7 to 11 in September 2015.

Larger variance in the relation between GSMaP and radar rainfall estimates was recognized over land than over sea. Performance of GSMaP rainfall only over land was investigated further, because performance of radar rainfall is unknown over sea where no rain gauges exist. Satellite PMWRs tended to estimate lower rainfall, when the mean or standard deviation of radar rainfall in a GSMaP grid box was larger. Underestimation of GSMaP rainfall was smaller, when the shape of probability density function (PDF) of radar rainfall in a GSMaP grid box was more pointed (when geographical pattern of radar rainfall was more homogeneous). This result suggests that subgrid-scale PDF (or geographical pattern) of rainfall is a key index to correct rainfall estimates from satellite PMWRs.

Keywords: rainfall, satellite, GSMaP

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CROSS-VALIDATION OF SPATIAL INTERPOLATED RAIN GAUGE AND SATELLITE-BASED RAINFALL OVER THAILAND

Nelson Stephen L. Ventura and Piyatida Ruangrassamee*

Before satellite precipitation data can be corrected, the local rain gage data should be able to accurately represent its surrounding area. Using spatial interpolation techniques on these point data would predict and estimate the values where there gaps are found. The study analyzes the results of different spatial interpolation methods namely Inverse Distance Weighing (IDW) with and without exponential weights, Kriging with a Spherical Semivariogram, Kriging with an Exponential Semivariogram, and Kriging with a Gaussian Semivariogram in Thailand with daily rain gage data from 2008 to 2014 from Thai Meteorological Department (TMD) and Royal Irrigation Department (RID). Subsequently, the correlation of each interpolated dataset to the satellite precipitation estimate of Precipitation Estimation from Remotely Sensed Information using Artificial Neural Network - Cloud Classification System (PERSIANN-CCS) would be determined. The cross-validation results show that Kriging has a lower root-mean-square-error (RSME) than IDW interpolation. As for the case in Thailand, Kriging with Gaussian Semivariogram has the lowest RSME compared to the daily rain gage data which represents the precipitation dataset better than other techniques used. Among the techniques used, the Kriging with Gaussian Semivariogram has the highest correlation coefficient when compared to the PERSIANN-CCS dataset. Overall, the Kriging method provides a better representative to the rain gage data due to its stochastic characteristic which allows probability and uncertainty in the computation. Applying this technique in adjusting satellite data could improve the correction results.

Keywords: precipitation data estimation; spatial interpolation; kriging; satellite –based precipitation

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METHOD TO ACCESS WATER SCARCITY FOOTPRINT OF PRODUCT BASED ON ISO 14046 FOR THAILAND : A CASE STUDY OF 44 PRODUCTS IN THAILAND

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The Federation of Thai Industries (F.T.I.) cooperated with Groundwater Development Fund of Department of Groundwater Resources (DGR) conduct the project to assess groundwater use throughout the product life cycle or water footprint of product. The objective is to promote the water footprint in accordance with ISO 14046 and Life Cycle Assessment (LCA) for industrial sector and develop Thai experts of water footprint. As well as developing the appropriate certification system of water footprint for Thailand.

There are 15 pilot industries (companies) participating in this project and the experts join the consultation with the pilot industries to evaluate the water footprint of products and also to study the ways to reduce groundwater use (including surface water) from the manufacturing process. In addition, the technical committee has been appointed to develop the appropriate water footprint assessment and verification guideline for Thailand (in accordance with ISO 14046) and also appointed the water footprint certification committee to certify water footprint of product.

Outcomes of the project, we can develop a appropriate guideline of water footprint assessment and verification, water footprint certification system that suitable for Thailand and there are 44 products (15 products from 15 companies under the project and 29 products from 13 companies outside the project) from 12 product groups (corrugating medium, drinking water, soft drink, alcoholic beverages, portland cement, rubber, sugar, fresh chicken and products processed from chicken meat, polymer car accessories, electricity and steam, industrial water, aromatics) that have been certified for Water Scarcity Footprint (WSF).

Keywords: ISO 14046, Water Scarcity Footprint (WSF)

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MICRO-SCALE FLOOD HAZARD ASSESSMENT IN PHNOM PENH CITY, CAMBODIA

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Water-related disasters in urban area, especially urban floods have become more frequent and severe. This leads to loss of life, infrastructure damage, business interruption as well as time delay for traveling to any destinations. Phnom Penh, the capital city of Cambodia, has frequently experienced significant rainfall-flood events during rainy season. Without proper mitigation and management of urban drainage system, Phnom Penh is expected to face with the current and future challenge of water-related disaster. To address this urban flood inundation, flood modeling can make a visual representation of the urban flood hazard as basic information for land-use planning and limit development in flood-prone areas. This study therefore aims to simulate inundation situation in a downtown area with the complex storm drainage system in Phnom Penh using FLO-2D model. An independent catchment covering an area of 12.5 km^2 is chosen as study area since it is strategically important and frequently affected by rainfall-flood events. The main objective of this study is to assess the applicability of urban inundation model FLO-2D to the improved drainage system in Phnom Penh. The model performance is evaluated by comparing simulated flood depth and observed flood depth data collected recently. The simulated result is delineated into flood hazard map defined by three categories, ranging from low to high, based on flood depth and flood duration.

Keywords: Urban flood, flood hazard, FLO-2D, Phnom Penh.

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ESTIMATION OF GROUNDWATER USE PATTERN AND DISTRIBUTION IN THE COASTAL MEKONG DELTA, VIETNAM VIA SOCIO-ECONOMICAL SURVEY AND GROUNDWATER MODELING.

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Surface water resources in the Mekong Delta are under increasing strain due to unplanned extraction, pollution, salinization and climate change effects. In many provinces of Mekong delta, excessive groundwater extraction has resulted in many serious groundwater-related problems such as saline intrusion, arsenic contamination and land subsidence. The increase in demands and the afore mentioned negative effects of groundwater depletion raise the urgent question: at what time in future are the limits to local groundwater use reached? Hence, there is a need to know groundwater use pattern and distribution in the study area for future groundwater management.

In this study, firstly, the study used socio-economic data of Travinh Province, which is one of poorest area in Mekong delta Vietnam, to classify group of revenue, potential of water resources and population distributed in each districts during the period from 2007 to 2016. Secondly, nine communes were selected by the classification of commune revenue and water resources potential to conduct the field survey in the dry season of 2018. The data set of 419 survey questionnaires will be analyzed to estimate groundwater use pattern of each user type and then define distribution by number and location of abstraction wells. The survey results can be extended to propose the total groundwater use pattern and distribution during 2007-2016 by using socio economical data of the province. Finally, the groundwater flow model of the study area will be developed to verify amount of groundwater pumping (pattern and distribution proposed) from 2007 to 2016 using boundary conditions from the regional groundwater model, which covered whole of Mekong Delta area.

From the study, groundwater abstraction unit and total groundwater use will be presented details by crops, location and seasonal in period from 2007 to 2016 in Travinh Province. In future, the result can be used to assess damage of saltwater intrusion into aquifer via groundwater model based on future socio-economic development scenarios and under climate change impact.

Keywords: groundwater use, pattern, distribution, groundwater modeling, field survey

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A STUDY ON LOCAL KNOWLEDGE IN ADAPTATION TO LANDSLIDE DISASTERS IN SRI LANKA

Uditha Dasanayaka*[1]& Yoko Matsuda[2]

Natural disasters are unforeseen events which occur at hydrologic, geologic, and atmospheric origins. Landslides are the one common disaster in hilly terrains and which cause to loss of lives and property damages especially in Asia region. During last two decades, the occurrence and the severity of landslides significantly increase in the highland regions in Sri Lanka due to combination of heavy rains, geological changes and manmade activities. The Policy-makers still rely on mitigation strategies based on scientific approaches. But some isolated mountain villagers still survived without any landslide damages with their local knowledge based adaptations. Although there are much details about local knowledge mitigations, the wealth of this knowledge has not been well-recognized in the process of disaster risk reduction.

The primary objective of this study is to investigate the local knowledge in adaptation to mitigate the landslides disaster situations. Consequently the present study examines the local practices underlying in indigenous settlements in Sri Lanka through field survey supported by questionnaire surveys and semi structured interviews. So this study reveals that the sustainable solutions should be generated holistically using both the Local knowledge and the scientific approaches especially for the developing countries like Sri Lanka.

Key words: Landslides, local knowledge, semi structured interviews

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POLICY GUIDELINES ON DISASTER RISK REDUCTION FOR FLOOD PREVENTION AT KLONG YAN SUB-WATERSHED, SURATTHANI PROVINCE, THIALAND

Siwaporn Promdaen[1], Sangchan Limjirakan[2]

Based on the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5) in 2013, observed and statistical data in long-term trends since the 20th century showed the average globally surface warming due to an increasing of greenhouse gas emissions into the atmosphere. The IPCC AR5 also reported that water is a vulnerable resource to the impacts of climate change. Thailand is one of the South-East Asia Countries that having suffered from several extreme events resulting from climate change (UNESCAP, 2012). One consequence of changes is the severity and frequency of extreme events leading to flooding in all regions of Thailand. This research aimed to study policy guidelines on disaster risk reduction for flood prevention at Klong Yan Sub-Watershed, Suratthani province of Thailand. The purposive sampling method was used to select stakeholder's involvement, which included local governmental officers, local community leaders, local wisdom scholars, non-profit organization and the network of watershed group. These groups were in-depth interviewed using questionnaires and data were analyzed using qualitative method. The research results found that around 69 % of respondents did not familiar to the policy guidelines on disaster risk reduction. They viewed that policy guidelines such as the master plan of disaster prevention and mitigation is important to reduce losses and damages, while the measures for reducing risks should be focused on education and training, supportive infrastructures, financial supports, and cooperation among relevant stakeholders. According to respondents' experiences, effective policy implemented requires collaboration, knowledge training and awareness raising.

Keywords: Policy guidelines, Disaster risk reduction, Flood prevention, Klong Yan Sub-Watershed

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ESTIMATION OF GROUNDWATER RECHARGE FROM GRACE SATELLITE AND LAND SURFACE MODEL

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The recent growths of global population and the world economy are dramatic, and these increase water use. Groundwater availability is decreasing in some areas by too much groundwater abstraction. To prevent groundwater depletion, we should develop a tool to estimate the groundwater use is sustainable or not. This study aims to improve a global water cycle model in-land developed by a previous study (Kotsuki et al., 2012) to simulate groundwater resources sustainability. The amount of groundwater recharge is experimentally estimated in the simulation with the land surface model SiBUC. It is assumed as the proportion of base flow (q3). To define appropriate amount of groundwater recharge, we compare the variations of terrestrial water storage (TWS) observed by GRACE satellite. There is a strong correlation between time series of simulated and observed TWS in many areas even if we do not include groundwater into TWS. By considering groundwater, correlation coefficient should be better and appropriate groundwater recharge can be defined when correlation coefficient is highest value. To confirm the accuracy of groundwater recharge, field observation data of groundwater level is useful. We are conducting a field observation in Phisatsanuloke, Thailand and we will utilize the data for the validation.

Keywords: Land surface model, GRACE, Groundwater

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PERCEPTION OF CLIMATE CHANGE AND ADAPTATION IN RURAL THAILAND

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This research was conducted to figure out perception of climate change and adaptation in rural Thailand. Data were collected using semi-structured interview and questionnaire survey from a total sample of 297 households. It was found that 81.4% of respondents of questionnaire survey answered that "Change of temperature is serious at the present time". Next to "change of temperature", the percentage of respondents are high in the order of "seasonal change" (60.0%), "change of precipitation" (59.6%), "big wave" (42.5%), "coastal erosion" (41.1%), "storm" (28.1%). On the other hand, 65.2% of respondents answered that "Change of temperature will become more serious in future" from a long-term perspective. Next to "change of temperature", the percentage of respondents are high in the order of "change of precipitation" (50.0%), "seasonal change" (49.0%), "big wave" (40.3%), "coastal erosion" (34.5%) and "storm" (28.3%). Nevertheless, 46.4% of respondents answered that "I do not have willingness to adapt to climate change" and 41.3% of respondents answered "I can not decide whether I will take adaptation measures or not" from a long-term perspective. Moreover, we found that 99.3% of respondents got climate information from TV. Next to TV, the percentage of respondents are high in the order of neighborhood (46.2%), SNS (Social Network Services) (33.9%), local wisdom namely their experiences such as observation changes of cloud, moon, sky and ocean (33.6%). However, 59.2% of respondents answered that "Very reliable" about reliability of information from Local wisdom. The reliability of information from SNS is lower than TV, Neighborhood and local wisdom. (250 words)

Keywords: Perception of climate change, adaptation to climate change, sharing climate information

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MODIFIED CRITICAL ANTECEDENT PRECIPITATION INDEX (CAPI) FOR FLOOD WARNINGS IN UPPER NAN WATERSHED, NAN PROVINCE, THAILAND

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Since 2003, critical API for flood warning in upper Nan watershed were investigated and used for flood warning in upper Nan watershed until nowadays. In 2003, Soil surveys were conducted and soil samples were collected from 31 Sites (62 samples) all over Nan. Critical API of all soil sample sites were analyzed in Laboratory. Knowledge of flood warning and prevention using API was setup and transferred to local people. Existing critical API values in Upper Nan watershed range from 142.19 To 323.184 mm. However, number of soil samples used in analysis of API was few because of time and budget limits.

ADAP-T project has been started in Thailand since 2016. Recently, a research group named "ST2 Forest" conducted soil surveys in Nan watershed. Soil samples were collected at 28 Sites (69 samples). Some soil properties including critical API were analyzed precisely. The new critical API values called "modified critical API" are expected to be the output this study and can be used effectively for flood warning and prevention in upper Nan watershed. The modified CAPI was calculated and mapped using GIS program. CAPI and modified CAPI were compared with extreme rainfall and flood event in 2017–2018. The results was noticed that the modified critical API in Upper Nan watershed were changed range from 206.355 to 415.609 mm. Modified CAPI showed highest changing (increase) in forest area around Phua district. It can be imply that the potential of Upper Nan watershed was increased when have passed more than 10 years.

Keywords: API, Antecedent Participation Index, Flood warnings, Upper Nan watershed

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PAPER ID: TD463-1

ANASLYSIS OF LOCAL COMMUNITY AWARENESS ON CLIMATE HAZARDS IN PURSAT PROVINCE, CAMBODIA

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Climate hazards such as flood and drought frequently occurs almost every part in Cambodia. In term of basin scale in rural area, the level of vulnerability of elements at risk in the disaster prone area can be different based on the coping capacity of the local people. Moreover, to propose proper mitigation measure for such natural disaster, understanding on climate hazard characteristics and local community awareness on those hazards is considered as one of the essential steps to implement. This study is aimed to identify ways and means for rural and indigenous communities, as well as to local institutions, to prepare and to mitigate and respond to natural disasters. Questionnaire survey on 750 peoples was conducted in 46 villages of Bakan and Phnom Kravanh districts in Pursat province. Major findings of the survey are: (1) the area, mainly relying on agriculture, is high vulnerable to climate hazard especially drought and flood; (2) drought is the major climate hazard confronting by communities whose main assets confronting to drought are agricultural land, water supply, livelihood, livestock and natural resources; (3) flood occurred was flashflood that take shorter time to finish. Flood hazard is not really a major problem at the present but in the future it would be; (4) the capacity response to drought and flood is low and also limit to response climate hazards in the future. The results provide important information for further studies in order to propose a sustainable disaster management strategy.

Keywords: Climate hazards; drought; flood; local community awareness; Pursat province

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FORMULATION OF ADAPTATION MEASURES FOR FLOOD MANAGEMENT UNDER THE UNCERTAINTY OF FUTURE PROJECTION (ABSTRACT)

Hisaya Sawano*[1] and Toshio Koike[2]

Climate change is anticipated to affect the conditions of precipitation, which may, in turn, increase flood and drought risks in the future. Therefore, the necessity of adaptation measures is widely recognized and advocated. However, the evaluation of climate change impact is still in the realm of uncertainty because various future scenarios and General Circulation Models provide different future projections. Thus, the formulation of adaptation measures requires first quantifying uncertainty in order to identify the range of probable precipitation and assessing potential disaster risk in the future with socioeconomic changes. Then measures to reduce disaster risks should be determined by combining structural measures to mitigate the impact of hazards and non-structural measures to cope with the remaining risk after the completion of structural measures. Essential elements in this process are past and present data of hazards, damage, and socioeconomic factors and science and technology to assess current and future risks and evaluate the effectiveness of selected adaptation measures. Close cooperation among decision makers and practitioners is crucial in this process to share information and resources to formulate effective measures. To facilitate dialogue and consensus among decision makers in a country for actions to achieve disaster risk reduction, the platform on water resilience and disasters has been in place in several Asian countries and expected to be the basis for the formulation of adaptation measures. Focusing the platform, this paper explains an effective mechanism and requirements for formulating adaptation measures for the future impact of climate change.

Keywords: adaptation measures, disaster risk reduction, platform

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FLOOD HAZARD ASSESSMENT USING HYDRO-GEOSPATIAL TECHNIQUE: A CASE STUDY OF RIVER CHENAB FROM QADIRABAD TO TRIMMU IN PAKISTAN

Mr. Muhammad Asim

Flood is damaging phenomenon that occurs repeatedly. It is thus essential to address this natural disaster for future safety and to decrease its effects on people. In this study Chenab River reach in Pakistan from Qadirabad to Trimmu a reach length of 210 km was selected for flood modeling, mapping and hazard assessment for various return period floods. Hydraulic modeling (using HEC-RAS) and flood inundation mapping (using HEC-GeoRAS an extension of ArcGIS) were integrated to perform flood routing for the computation of peak flow attenuation and mapping for the estimation of flooded area extents and inundation depths in the floodplain. Input river cross-sections to HEC-RAS model were collected from physical survey and extracted from DEM SRTM 30 m resolution using HEC-GeoRAS. A very high flood of 2006 and an exceptionally high flood of 2014 were considered in flood hydraulic modeling and floodplain mapping. The results of model calibration and validation of HEC-RAS against observed data show high correlation coefficients thus assuring high model accuracy. Results of HEC-RAS model were exported into ArcGIS to perform flood inundation mapping and consequently flood hazard assessment of the study area. Flood extent and depth maps were constructed for floods of various return periods. Hydro-geospatial technique which was utilized performed very well in evaluating flood hazard and effectiveness of flood control infrastructures in terms of inundation depths and flooded areas.

Keywords: Flood hazard mapping, Arc GIS, Hydro-goespatial technique, River Chenab, Pakistan

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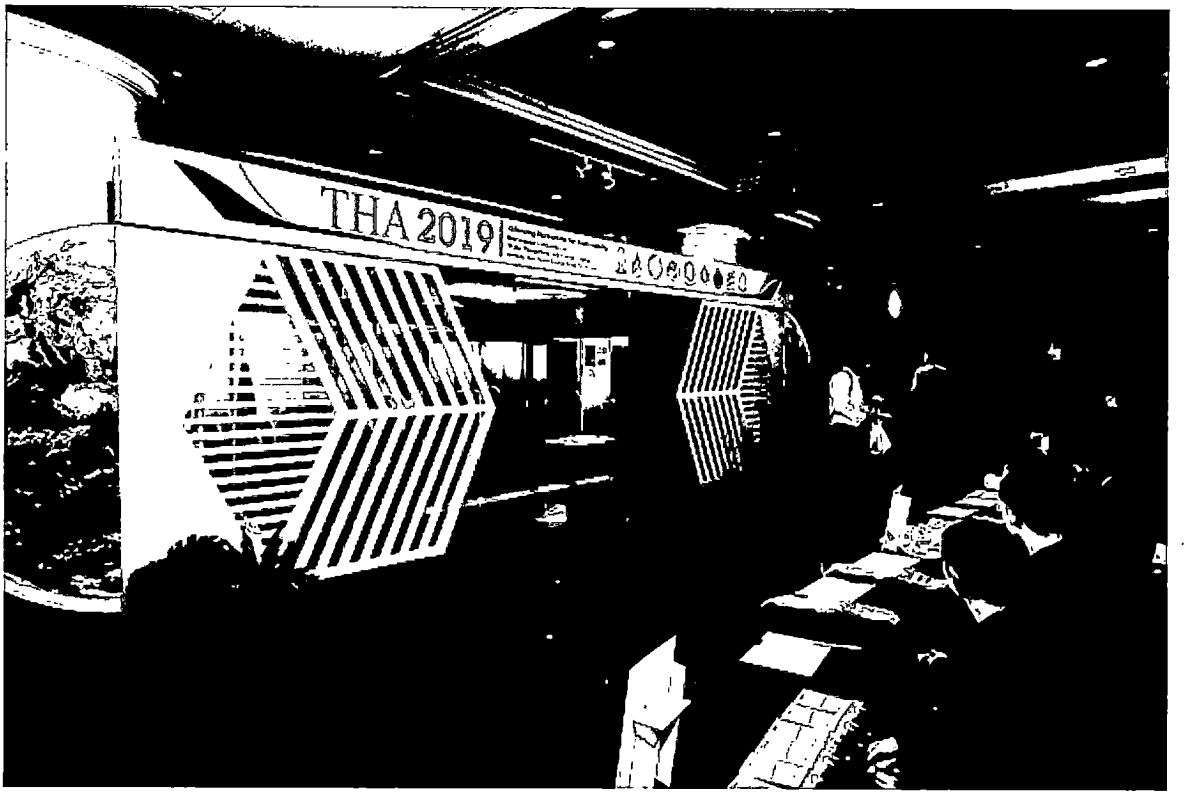
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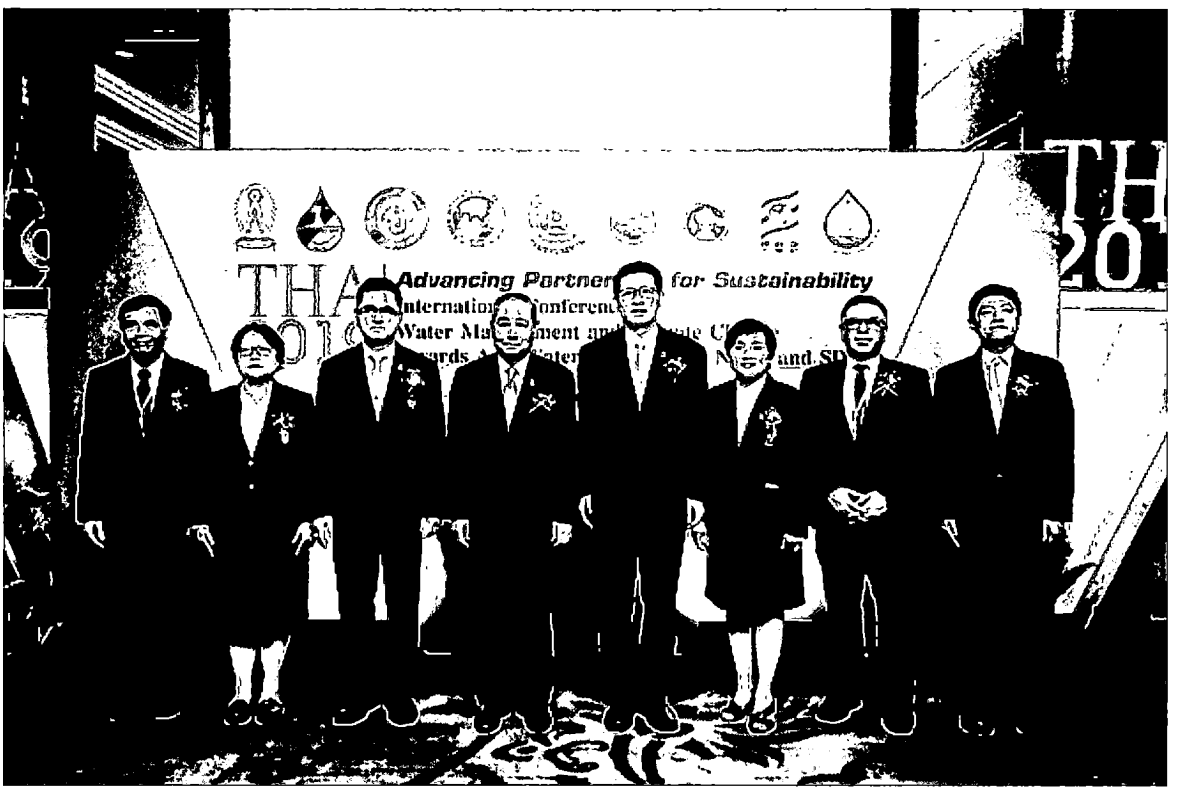
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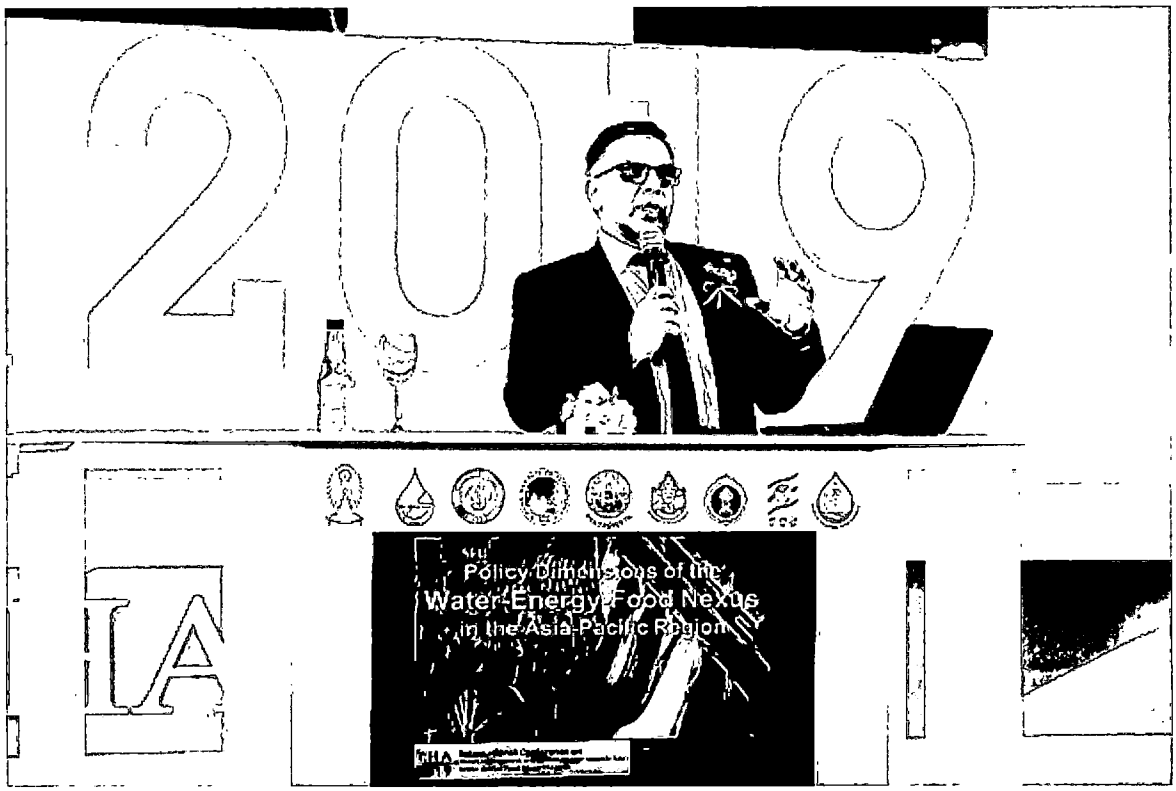
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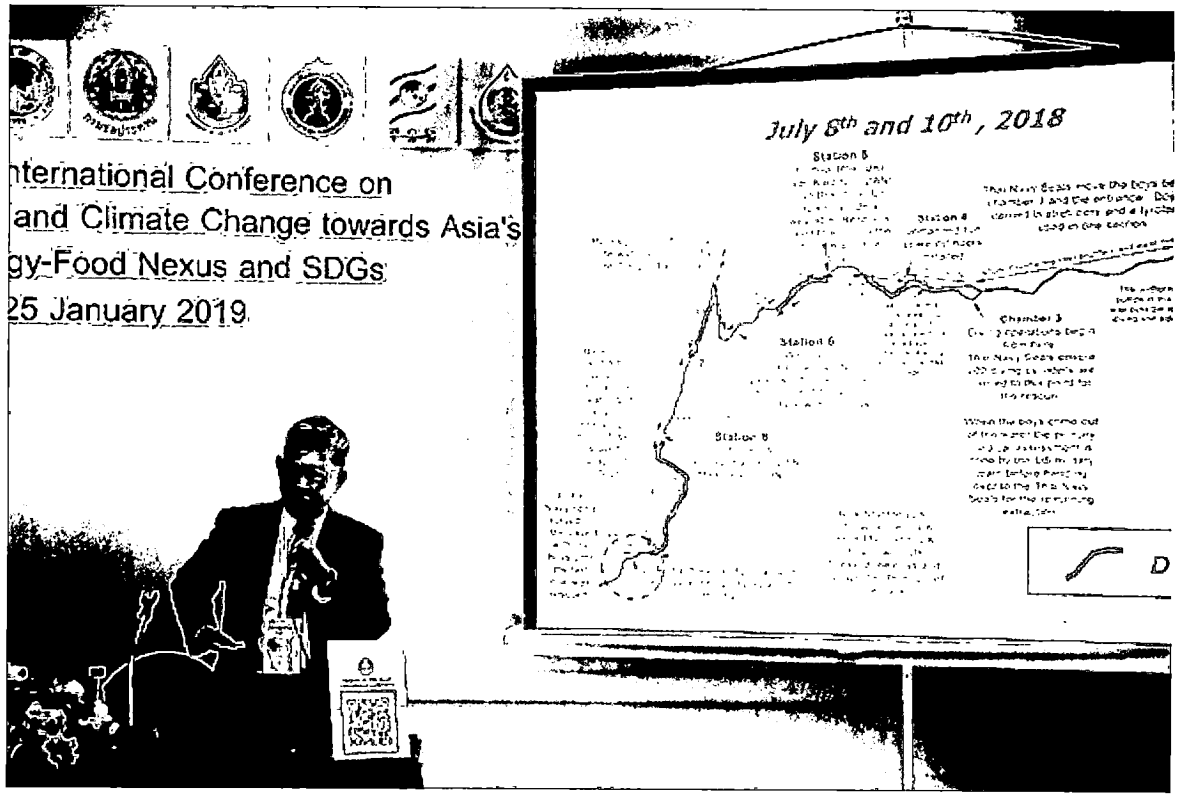
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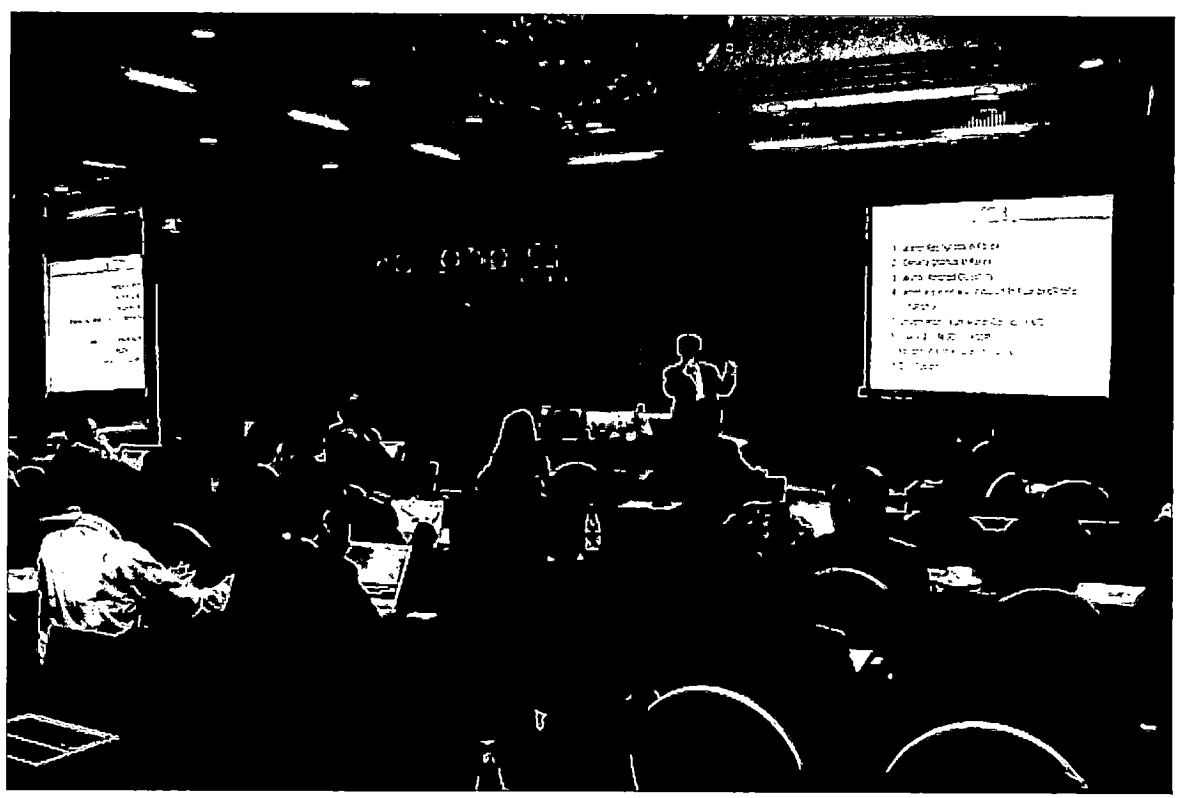

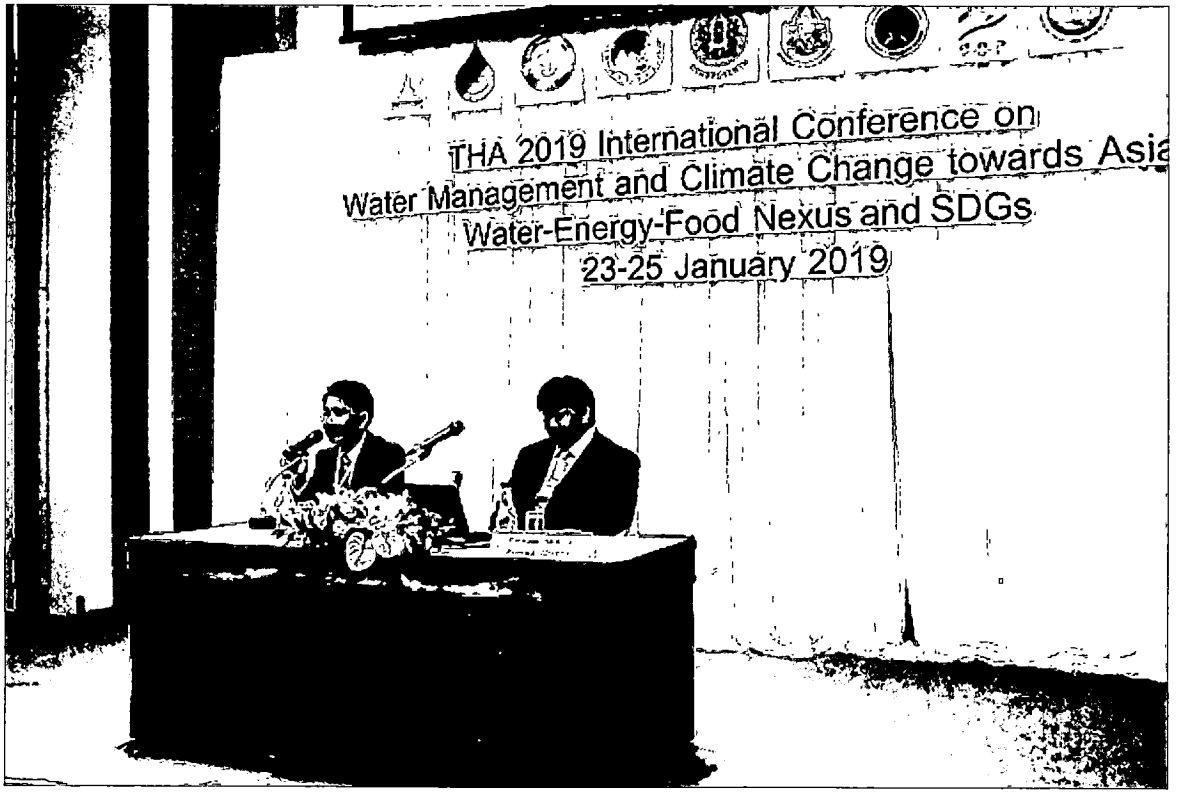
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