Impacts of Future Climate Change in Water Resources Management at the Chao Phraya River Basin, Thailand(Digest_要約)

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論文題目	Impacts of Future Climate Change in Water Resources Management at the Chao Phraya River Basin, Thailand （タイ国チャオプラヤ川流域の水資源管理に及ぼす気候変動の影響）		

（論文内容の要旨）

In the heart of Thailand, food and water resources always rely on the Chao Phraya River Basin (CPRB) due to the characteristics of the basin and appropriate annual rainfalls of above 1,200 mm. However, those strengths can sometimes turn into risks caused by the impacts of climate change. Frequency of floods and droughts in the basin has risen year after year starting in 2005. Particularly, massive floods hit the basin for over three months in 2011. In reference to climate change, the Master Plan and the Free Pond Construction Project for non-irrigated areas were provided by the Thai government to mitigate floods and droughts. However, those plans do not consider how the changes in water resources management and future climate will influence the flow regime. This research aims to investigate the impacts of future climate change and adaptive water resources management on the flow regime, which is written in Chapter 1.

Chapter 2 provides knowledge and peer-review information from existing literature as well as opens necessary discussion for research methodology. Pros and cons in order to select hydrological model, climate change approaches, pond management model, and reservoir operation model have been reviewed.

In Chapter 3, the author has applied the Hydrological Simulation Program-Fortran (HSPF) model based on the characteristics of the CPRB. The author also evaluated the effectiveness in preventing the 2011 floods by two possible adjustments (*i.e.,* daily release storage ratios (r) and the timing of water release) for two large-scale dams. This chapter also dealt with the scenarios of detention ponds, including the proposed retarding basins by the Thai Master Plan and the suggested new detention ponds. The results have highlighted that the appropriate ratios (r) for dam operation were in the range of 0.007-0.008 during the mid-rainy season (July-August) and 0.001-0.002 during the end of the rainy season (September-October). Ninety-four percent of overflow volume, consequently, can be attenuated *via* the integrated watershed management, combining both advisable scenarios of dam operations and detention ponds.

Chapter 4 was aimed to build up approaches for the post-processing climate change data (interpolation and bias corrections) using the database for Policy Decision Making for Future Climate Change (d4PDF). In order to predict extreme rainfall, the gamma distribution combined with a Generalized Pareto Distribution (Gamma & GPD) and the gamma distribution methods were applied to the rainy and dry seasonal datasets, respectively, in the bias correction approaches. This chapter also included trends of the post-processing d4PDF outputs with three ensembles (MI, MP and MR) of two periods (2051-2070 and 2091-2110). The reduction of the annual rainfall was indicated at downstream of the Ping River Basin in the Upper CPRB. For the extreme rainfall, the

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maximum annual rainfall above 3,000 mm/year was projected by three ensembles.

Since so far the specific pond capacity for the Free Pond Construction Project for non-irrigated areas was planned and started without considering the local conditions, water requirement, or prevention of floods and droughts, Chapter 5 has achieved to construct a pond management model driven by the water requirement model, the water budget model and the economic model. With a view to estimate pond capacity considering long-term impacts, the future climate data were also included. At greater than 80% of pond reliability, the minimum capacity of future ponds was suggested to be in the range of 1,000-3,000 m^3 with a depth range of 2-4 m. The maximum pond capacity should be over 5,000 m^3 with a depth of more than 4 m to protect future overflows.

Since the reservoir operation of the two large-scale dams played a significant role in the flow regime, Chapter 6 has constructed a reservoir operation model using the Adaptive Neuro-Fuzzy Inference System (ANFIS). In order to achieve an effective reservoir operation for flood prevention, the simulated reservoir water releases by adding the daily release storage ratio (r) of 0.006 during the mid-rainy season and applying the ratio (r) of 0.001 during the end of the rainy season were designed for the additional reservoir operation. This chapter also included the future d4PDF climate data. The future reservoir discharges at the mid of the rainy seasons were about 500-2,000 million cubic meters (MCM) per month and less than 400 MCM per month at the end of it. During the rainy seasons, about 6,000-8,000 MCM would be stored at both dams to support water for the next dry season.

In Chapter 7, the author investigated the impacts of the future climate change, reservoir operations, and the pond management on the flow regime. The annual maximum daily flow relevant to non-exceedance probability was used and analyzed the flood frequency. Because of impacts from climate change and reservoir discharge, the extreme daily flow could be in the range of 5,500-6,800 m^3/s at the CPR origin. Related to the annual rainfall reduction in the downstream of Ping River, the period up to 80 days might have no flow as well as a water shortage at mid-stream of CPR. One of the most benefits within future impacts of pond management was the reduction of extreme peak flows at the end of rainy seasons. Also, the mitigation of water shortage was projected during the low flow.

The final chapter summarized the important research findings as mentioned above. Since the timing change and the quantity increase of the annual maximum daily flow at the Upper CPRB were the undesirable impacts of pond management, the timing of pond water release should be considered more detail in further research. For future Thai government plans, the author has also suggested to increase the river capacities considering the results of annual maximum daily flow.