Development of future climate scenario based on multi GCMs of CMIP5 and rain gridded data observed by multi-agencies in Thailand

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Abstract— *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 the 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 underestimating when we use only TMD and RID dataset as usual. Our results will highlight the importance of appropriate evaluation for the performance of GCMs, and the impact assessment on climate change.*

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

I. INTRODUCTION

Climate change is one of the global issues, and might be one of elements what affects global water circulation including monsoon circulation. The DGDWGW (dry gets drier, wet gets wetter" is well known in global moisture change as one of effects of climate change. IPCC (2013) [1] shown that there is slightly increase trend in Thailand in future. Spatial resolution is, however, not fine, so that there is few research related to risk assessment and adaptation to climate change in Thailand. Finer information of rainfall as one of main factors of water related issues is necessary.

In Thailand, Asian monsoon strongly affects rainfall phenomena which is important for agriculture especially. More than 60 % of annual rainfall in Thailand is delivered by monsoon rainfall (e.g., Zhang et al., 2002 [2]). Kiguchi et al. 2015 [3] estimated high water stressed population in global, and indicated that some area newly face to water scarcity in future. Also seasonal march might affect crop calendar in agriculture. In central part of Thailand, there is pre-monsoon rainfall usually (e.g., Matsumoto, 1997 [4]). This kind of earlier rainfall prior to monsoon is important for decision making of crop calendar. Understanding of changes of rainfall in future is necessary for impact/risk assessment of climate change on water related sectors.

As above, rainfall and other elements in finer resolution is necessary but limited now. Watanabe et al. (2014) [5] developed a bias-corrected future climate dataset for projection of future river discharge in the Chao Phraya River basin, located in the center of Thailand. This research shown the importance of appropriate evaluation for the performance of

GCMs. Due to only the development of dataset in the Chao Phraya River Basin region, there is no suitable dataset for impact/risk assessment in whole Thailand. Because the northeastern part of Thailand is famous region for drought and flood, the impact/risk assessments on climate change are required by society.

Now, we are conducting the 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 (Japan International Cooperation Agency) for Thai side and JST (Japan Science and Technology Agency) for Japanese side under the framework of SATREPS (Science and Technology Research Partnership for Sustainable Development). 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. Because adaptation measures should be considered in context in local, it is necessary to impact/risk assessment in regional scale for estimation of adaptation measures. Purpose of this study is to develop data set for impact/risk assessments in whole Thailand. Under ADAP-T, we are firstly correcting the historical rainfall data in whole Thailand and are preparing the GCMs (Global Circulation Models) data set. Here, this activities are introduced.

II. DATA AND METHOD

A. Data

First, we collect observational rainfall data set of Thai Meteorological Department (TMD)'s synoptic stations, which number is more than 120 during 1981-2017.

Second, we collect observational rainfall data set of TMD's district level stations. Number of stations is increasing, so number during this period is difference in each year. Before using these data, it is necessary to do quality control. Now we are doing this process.

In parallel, we collect observational rainfall data set of Royal Irrigation Department (RID) during 1981-2017. Also, we are trying to correct observational rainfall data set of Department of National Park, Wildlife and Plant Conservation (DNP). Reason we collect the observational rainfall data of multi-agencies is that most of rainfall observatory of TMD are located near city, town, and so on. According to Kuraji et al. (2009) [6], there is altitudinal increase in rainfall over small river basin, northern Thailand. When we use only TMD data set, the results of estimation of runoff and river discharge might be underestimated. Kotsuki et al. (2014) [7] and Watanabe et al. (2014) [5] discussed about the underestimation of runoff and river discharge in Chao Phraya River basin.

On the other hand, 10 GCMs of CMIP5 (Coupled Model Intercomparison Project Phase 5; Taylor et al., 2012 [8]) are utilized. Also, the d4PDF (Database for Policy Decision-Making for Future Climate Change; Mizuta et al., 2017 [9]) data set are also utilized. This data set consists of outputs from global warming simulations by a global atmospheric model, and is intended to be utilized for impact assessment studies and adaptation planning for global warming.

B. Method

A hydrological simulation will be conducted using H08 model (Hanasaki et al., 2008 [10]). This model consists of six modules, and we use only the land surface hydrology and river routing modules for projection. Bias correction of GCM output is necessary for development of forcing data sets from GCM output because correction method applied has a large impact on the results (Watanabe et al., 2012 [11]). We used the bias correction method developed by Watanabe et al., 2014 [5].

III. EXPECTED RESULTS

We expect the developed data set for impact/risk assessments of global warming in future. In this study, we try to develop the rainfall grid data using not only TMD but also RID and DNP. Watanabe et al. (2014) [5] used rainfall data observed by TMD only for bias correction. We expect that underestimate of results of hydrological simulation will be avoided.

In this study, we use CMIP5 and d4PDF data sets for future projection. d4PDF is a 4K warmer simulation, and has 100 ensemble. This data set is intended to be utilized for impact assessment studies and adaptation planning for global warming. We expect this data set will contribute higher reliability results for helping policy decision making.

IV. CLOSING REMARKS

One of ADAP-T's target is to estimate cost and benefit of adaptation measures in six sectors; 1) freshwater, 2) sediment, 3) coast, 4) forest, 5) rural planning, and 6) urban. These information is useful for evaluation of adaptation measures to contribute policy decision making about climate change measures and establishment national plan related to climate change. This study is to develop data sets as knowledge basement of climate change in Thailand and to contribute to planning of climate change counter measures by central and local governments.

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