CLIMATE CHANGE IMPACT ON RESERVOIR WATER AVAILABILITY IN THAILAND

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1. INTRODUCTION

Water is an increasingly limited and highly essential resource for many countries where agriculture is the main income of the economy corresponding with ensures the well-being of the people. The proper planning of water resource availability based on uncertainty climate change impact is very necessary. The large scale of multiple purposes reservoir is main sources to manage and address both flood and drought problems. Therefore, the forecasted hydrological inflow data is very important. It will help the operators to support their decision making to release the water subjected to the rules or constraint in advance and be consisted of the development plan in future. The objective of this study is to assess future water resources availability in term of inflow through large scale reservoirs in Thailand by using General Circulation Model (MRI-AGCM3.2S) [1] which is provided by Meteorological Research Institute of Japan (MRI). MRI-AGCM3.2S was chosen to investigate the effect of climate change on temperature, precipitation and evapotranspiration upstream of each dam.This study is to apply a distributed hydrological model (1K-FRM), which can reproduce the phenomena of inflow to reservoir, and to apply the model for the future climate change on large scale reservoirs in Thailand.

2. METHODOLOGY

The five large scale dam reservoirs located in the northern, central and western parts of Thailand which consist of the Ping River basin having Bhumibol Dam, the Nan River basin having the Sirikit Dam, the Pasak River basin having the Pasak Jolasid Dam and the Mae Klong River basin having the Srinagarind and Vajiralongkorn dams, were selected to study as dominant source for downstream water utilization. The observed temperature, precipitation data and inflow information were prepared from twenty-five meteorological stations and observed hydrological station of each dam site.
For the location of large scale reservoir and River Basin of each study area and characteristic features are shown in Fig.1 and Table 1. The MRI-AGCM3.2S simulation results were compared with observed data from meteorological stations from 1979-2003 and the projection of climate data was selected for 2075-2099 with worst scenario cases (RCP8.5).

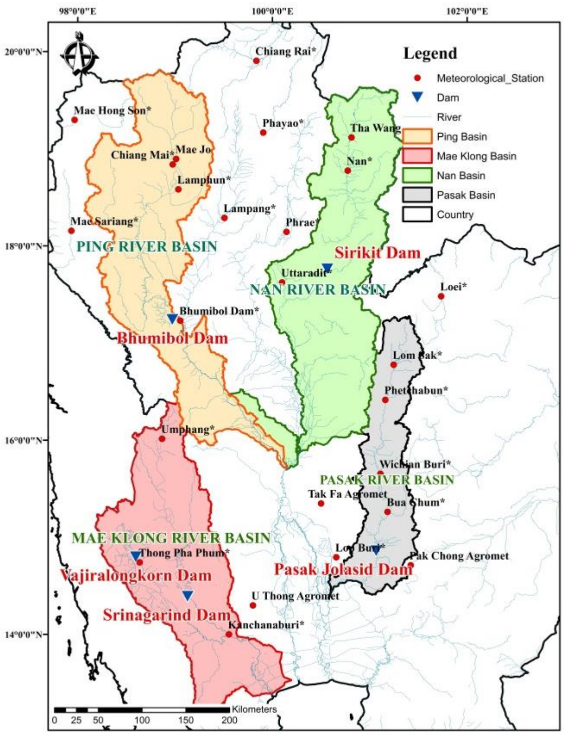

Fig1. Location map of large scale reservoirs and meteorological stations in Thailand.

Table 1 Characteristic features of selected reservoirs

Name	Bhumibol	Sirikit	Srinagarind	Vajira longkorn	Pasak Jolasid
Location	17°14′33″N 98°58′20″E	17°45′50″N 100°33′48″E	14°24′31″N 99°07′42″E	14°47′58″N 98°35′49″E	14°51′41″N 101°03′58″E
Catchment Area (km2)	26,386	13,130	10,880	3,720	12,292
Storage Capacity (MCM)	13,462	9,510	17,745	8,860	785
Opening Year	1964	1974	1980	1984	1999

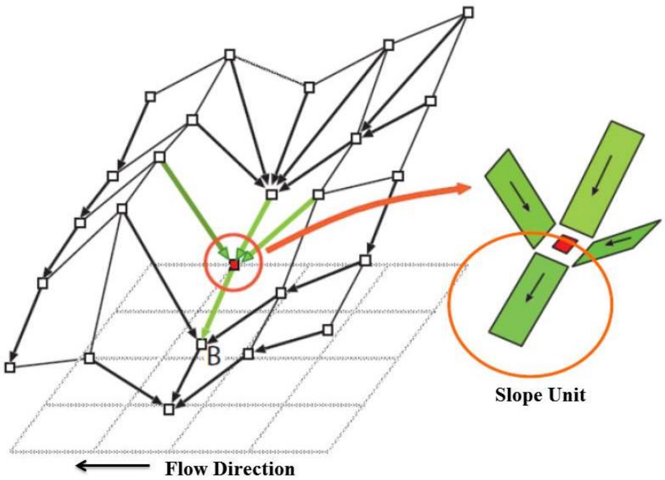

Fig2. Schematic drawing of a watershed model using the 8-direction method.

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The topography of the catchment is modeled using the 8-direction method which assumes the flow direction one-dimensionally to the steepest gradient direction. The schematic drawing of a watershed model is shown in Fig.2. The topographic information used for flow routing model 1K-FRM[2)] in this study is generated by processing 30 arc-second spatial resolution the USGS HydroSHEDS[3)] Digital Elevation Model (DEM) in the scale-free global stream-flow network dataset. 1K-FRM is a distributed flow routing model based on kinematic wave theory. The kinematic wave model is applied to all slope units and runoff is routed according to the flow direction information. The fundamental form is defined by the following equation:

$$\frac{\partial A}{\partial t}+\frac{\partial Q}{\partial x}=q_L(x,t) \tag{1}$$

$$Q=\alpha A^m, \alpha=\frac{\sqrt{i_o}}{n}\left(\frac{1}{B}\right)^{m-1}, m=\frac{5}{3} \tag{2}$$

Where, $A(x,t)$ is the flow cross-sectional area, $Q(x,t)$ is flow discharge, $q_L(x,t)$ is lateral inflow pre unit length , i_o is the overland flow slope, n is the Manning roughness coefficient, and B is the width of the sheet flow. The Eq. (1) is the continuity equation which is obtained from the principle of mass conservation within a control volume and Eq. (2) is also derived from Manning's equation which is related to flow resistance based upon experiments on open channel uniform flow. Hunukumbura and Tachikawa[4)] developed a distributed hydrological model, 1K-FRM, based on combination of the watershed model and the flow model. The spatial resolution 3 arc-second (about 100 m) of a digital elevation model (DEM) was used in the watershed model. Moreover, the kinematic wave model was also applied for the watershed model.

3. RESULTS

For the model calibrating and validation, rainfall discharge and inflow of all reservoirs were obtained with corresponding historical data (Opening year to 2013). Finally, the 1K-FRM hydrological model was used for daily dam inflow prediction. Results of this finding estimated the dam inflow based on lately MRI-AGCM scenario that can be used for optimized water resources management in the downstream areas and verified the effective reservoir operation for appropriate adaptability in the future.The further step is to simulate the future situation of appropriate release flow in the reservoir under the impact of climate change.

4. CONCLUSIONS

The expected output of the study will obtain the distributed hydrological model and the set of the model parameter, which are represented the characteristic of the hydrological process in the each River Basin. The developed distributed model will be applicable for simulating future inflow series that that supplies water to agriculture and other sectors. The further step of this research will developed methodology for searching the optimal reservoir operation rule curves in corresponding to water resource potentiality.

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