Application of Artificial Intelligence Technology for Dam–Reservoir Operation in Long–Term Solution to Flood and Drought in Upper Mun River Basin

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Abstract

This study aims to establish the multi–reservoir operation system model in the Upper Mun River Basin which includes 5 main dams namely, Mun Bon (MB), Lamchae (LC), Lam Takhong (LTK), Lam Phraphoeng (LPP), and Lower Lam Chiengkrai (LLCK) Dams. The knowledge and AI technology were applied aiming to develop innovative prototype for SMART dam–reservoir operation in future. Two different sorts of reservoir operation system model namely, Fuzzy Logic (FL) and Constraint Programming (CP) as well as the development of rainfall and reservoir inflow prediction models using Machine Learning (ML) technique were made to help specify the right amount of daily reservoir releases for the Royal Irrigation Department (RID). The model could also provide the essential information particularly for the Office of National Water Resource of Thailand (ONWR) to determine the short–term and long–term water resource management plan and strengthen water security against flood and drought in this region. The simulated results of base case scenario for reservoir operation in the Upper Mun from 2008 to 2021 indicated that in the same circumstances, FL and CP models could specify the new release schemes to increase the reservoir water storages at the beginning of dry season of approximately 125.25 and 142.20 MCM per year. This means that supplying the agricultural water to farmers in dry season could be well managed. In other words, water scarcity problem could substantially be moderated at some extent in case of incapability to control the expansion of cultivated area size properly. Moreover, using AI technology to determine the new reservoir release schemes plays important role in reducing the actual volume of water shortfall in the basin although the drought situation at LTK and LLCK Dams were still existed in some periods of time. Meanwhile, considering the predicted inflow and hydrologic factors downstream of 5 main dams by FL model and minimizing the flood volume by CP model could ensure that flood risk was considerably minimized as a result of new release schemes.

KEYWORDS: Upper Mun River Basin, Fuzzy Logic Model, Constraint Programming Model, Artificial Intelligence, Machine Learning