Neural Network Application for Predicting The Efficiency of Circulating Irrigation Pump System -Case Study in Inbanuma, Chiba, Japan-

循環灌漑の効率的な運用に向けたニューラルネットワークの適用
－千葉県印旛沼の事例－

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1. Introduction

About 330 million hectares of land is irrigated with 70% of total water withdrawals according to FAO 2017. In the agriculture sector, rice cultivation is one of the largest water users (Maruyama et al., 2008). The efficient use of irrigation water and increased water productivity are crucial for sustainable water management and adaptation to climate change. Over the decades, many methods have been developed to increase the efficiency of irrigation and drainage pump system. In Japan, one of the developed methods is the circulating irrigation and drainage pump system using pipeline irrigation and drainage pump.

Circulating irrigation pump system is implemented on Shiroyama-Jinbei paddy field district in Inbanuma Lake area. This system equalizes the water distribution and labor saving with stable water management, but relies on pump operation, which is an important issue for energy saving. Pump operation in Shiroyama-Jinbei depends on the precipitation and water supply. According to IPCC 2021, precipitation pattern and frequency of occurrence in Japan is increasing significantly because of the global warming and it is predicted to increase significantly on national average.

Therefore, it is important to analyze future pump operation based on any global warming scenarios with the characteristics of the irrigation pump that currently in operation in Shiroyama-Jinbei by simulating the pump operation using neural network.

2. Study Area and Methods

Shiroyama-Jinbei Pump Station and paddy field district is located on the northern part of Inbanuma lake in Chiba Prefecture. Japan. The paddy field district area is 982.9 hectares. The pipeline system flows from water tank to paddy fields through underground and drainage system flows through open canals.

Future pump operation prediction analysis conducted using shallow neural network in MATLAB software. The prediction is using the Neural Time

Fig 1. Shiroyama-Jinbei pump station

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Series Nonlinear Input-Output with function $y(t) = f(x(t-1),\ldots,x(t-d))$. The input data consist of 2019/2020 precipitation and daily average temperature from AMEDAS Sakura Data, water management schedule data from Shiroyama-Jinbei pump station, and Shiroyama-Jinbei pump operation data from Inbanuma Development Office. RCP 8.5; RCP 6; RCP 4.5; and RCP 2.6 will be used for meteorological forecast data with historical data from 1986-2005. The MRI GCM output will be downscaled statistically according to probability density distribution.

3. Ongoing Result and Discussion

Shiroyama-Jinbei pump operates from April-August during rice cultivation every year. The water usage from the station is higher during puddling and rice planting time and lower during intermittent irrigation. During the rainy season, the operation stops but depends on the water availability throughout the field. The pump operation forecast for year 2019, 2050, and 2090 had been done for this study using the RCP 8.5 scenario. The result shown in Fig.2 for comparison of the pump operation.

Fig.2 shows that the overall load of pump operation for both year 2050 and 2090 increased. This means higher workload of the pump will increase the pump operation maintenance costs. Even though rainfall intensity increased in the future with RCP 8.5 scenario, the pump operation keeps on increasing. This ongoing result will be improved by learning the actual measurement data for multiple years and using the 2020 pump management data for comparison. The next simulation will be done with forecast data created from multiple GCM data and scenarios comparison.

Further considering pump operation, withdrawal amount would be increasing in RCP scenario. It means that pump operation time would be longer, or as currently withdrawal water is storage in distribution tank next to pump station, the tank storage would be larger in future scenario. These operations could be enhanced pump work load. These analysis will be required.

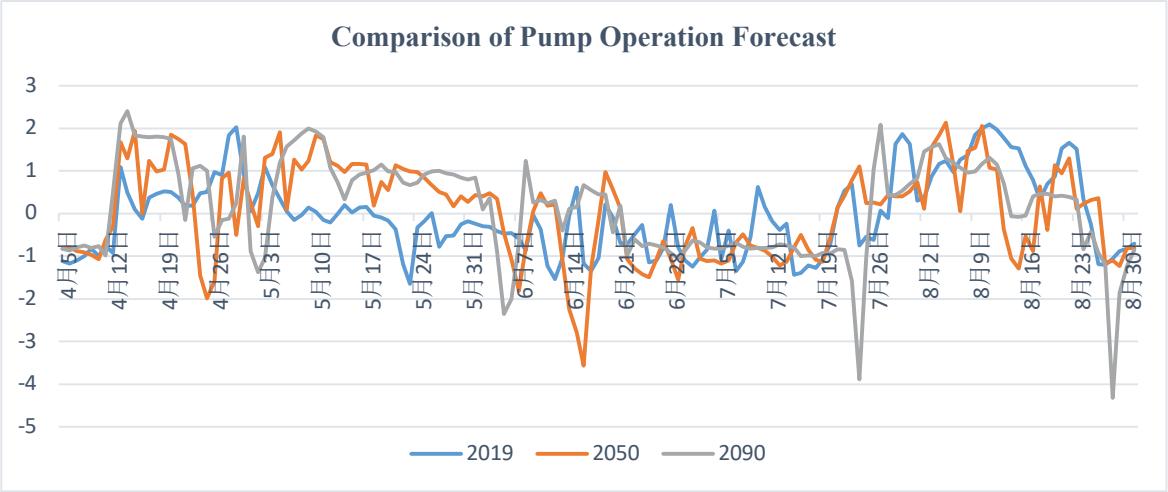

Fig 2. Comparison of pump operation forecast year 2019, 2050, and 2090 using RCP 8.5