1970 年代の営農の変化が大規模水田灌漑地区の配水に及ぼした影響
Effect of agricultural change in 1970s on water allocation in Large Paddy irrigation scheme in Japan

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1. Introduction

Japan's large paddy irrigation scheme has been recognized as a successful example of Participatory Irrigation Management (PIM), Satoh, 2021. This success is due to effective and equitable water by the Land Improvement District (LID) and Villages (Mura).

However, water management can be affected by the social agricultural change of farmers and Mura. Regarding the agricultural change in the 1970s and 1980s, the effects on water management are not yet clarified.

This research aims to clarify the effects of agricultural change in the 1970s on water allocation in the Large Paddy irrigation scheme in Japan.

2.Methods and Materials

2.1 Settings

Okazeki irrigation scheme located in Toride City, was selected as a case study site. Covering around 1600 hectares of paddy field, it has been divided into 53 irrigation blocks. Water boundary and village boundary are different and there are 45 villages. With an average water right of 4.6 m3/s, the Okazeki irrigation scheme has suffered from water shortage.

Since the 1970s pump stations have been installed to reuse drainage water as a countermeasure against water scarcity. Out of 53 irrigation blocks, 30 blocks have installed pump stations. All the costs for setting and operating the pumps are covered by LID.

2.2 How to clarify the effects of agricultural change on water allocation

Pump installations is supposed to show the to

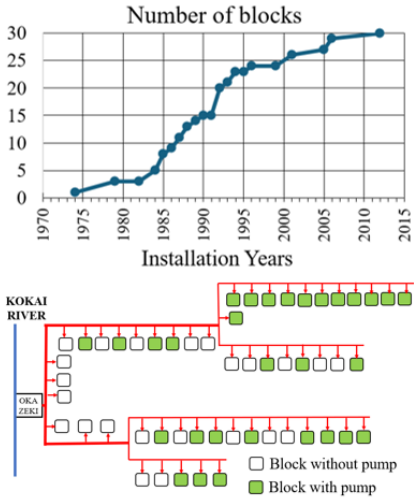

Fig.1 Outline of pumps installation

show the increment of water requirement for each block. So, pump installation was set as an index resulting from the effect of social condition change on water allocation. Considering 1970s as the period of decision-making for pump installation, water scarcity and social conditions of blocks with and without pumps were compared. As an index affecting social conditions, X1 for area per farmer, X2 for part-time farmers ratio, and X3 for areas irrigated were considered. For water scarcity index X4, water needed at the headwork for supplying the blocks was considered. From the main to secondary canals water was allocated based on the acreage and from the secondary canals to each block, upstream first and downstream after.

Using the chi-square test and Principal Component Analysis (PCA), the relation between factor and pump installation was evaluated.

2.3 Materials

As materials, blocks irrigation plan map (1985)

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and block network map (Ekpelikpeze, 2022) was used to clarify water boundaries and networks among blocks. MAFF Shuraku data 2015 was used to clarify village boundaries and areas. Based on Census data in 1970, the index of social conditions was considered.

3. Results

3.1 Change of social conditions in Okazeki

The social conditions of Okazeki in 1970s are characterized by an increase in the number of part-time farmers and a decrease in the total number of farmers. On average, around 60% of farmers have diversified their income in relation to the rapid economic growth. Consequently, farming size per farmer has been reduced. According to Fukutake (1964), the structure of rural households in 1950s was composed of full-time farmers. It can be considered that the social conditions were the same in Okazeki before 1970s. With such significant change, water distribution management activities become difficult. Then WUAs installed a pump station to increase the available water.

3.2 Factors for installing pumps downstream

The chi-square test results indicated a relation at a risk of 1 % between the installation of pumps and the factors part-time per total farmers, areas, and water scarcity, but no relation with areas/farmers as shown in Table 1.

Also, the PCA test result in Figure 3 shows all the factor vectors converge toward where the blocks with the pump are grouped. High water scarcity risk leads to pump installation mostly in downstream areas. Even in case of low water scarcity risk, weak social conditions such as a high ratio of part-time farmers affect installing pumps.

Table 1 Relation between factors and pumps installation

	Factors of social conditions	χ^2 test
X 1	Areas/farmers	0.004
X2	Part-time/Total Farmers	1.7
X 3	Areas (ha)	12
X 4	Water scarcity	8.5

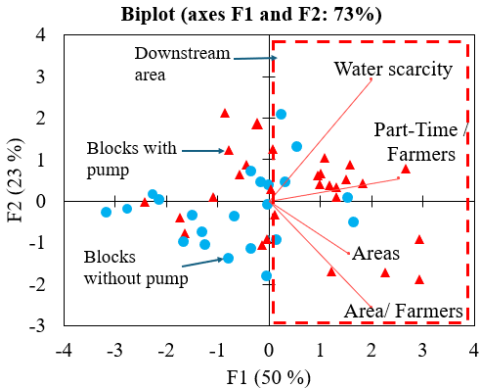

Fig.2 Relation between factors and reuse system

3.3 Actual use of pumps in the blocks

For 5 years (2016-2020), fluctuation in annual electricity cost per hectare for each pump has been observed. So, it is clarified that all the pumps are operated. Also, based on the multi-regression analysis, the relation between electricity cost and the factor was clarified. The result shows that the (*t*) value equal to 2.2 and 4.1 respectively for area and water requirement. This result confirmed that downstream blocks operate more pumps due to the large areas and water scarcity risk.

4. Discussions

In the 1970s weak social conditions affect water requirements for each block and more downstream areas. Enhancing available water resources through pump installation was considered as an option to realize equal water distribution within the irrigation scheme.

Several developing countries all over the world are also economically growing fast. Like in Japan, this growth may affect the PIM management system. Installing pumps to reuse water can be a reference for a better allocation system in those countries.

Acknowledgments

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References

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