大規模水田灌漑地区の用水反復利用が土地改良区の配水活動に与える影響
Effects of water reuse system on Land Improvement District activities for water distribution in a large paddy irrigation scheme in Japan

○エペリペゼ アドニス ルセル*，上村 亮平**，石井 敦***，佐藤 政良***
○ EKPELIKPEZE Adonis Russell*, KAMIMURA Ryohei**, ISHII Atsushi***, SATOH Masayoshi***

1. Introduction

In developing countries, PIM (Participatory Irrigation Management) has been required for higher and sustainable agriculture productivity but with less success. In the case of paddy irrigation, much water is drained at the same time as the water application. Therefore reuse system can help PIM by applying water sufficiently to farmers under scarce water conditions.

Regarding the water reuse system of the irrigation scheme, much research has already been executed. For example, Okamoto (1978) has already developed a method for estimating the total water requirement by evaluating the water reuse systems among small irrigation blocks. Di Wu (2019) evaluates the effect in irrigation systems of return flows for reuse using the SWAT model. Despite valuable research as above, the effect of the actual water reuse system on LID (Land Improvement District) activities has not been adequately clarified.

In this research, we select Oka Zeki LID as a large paddy irrigation scheme with a water reuse system in Japan and evaluate the effects of the water reuse system on water efficiency and LID activities for water distribution.

2. Methodology

To evaluate the effect of the water reuse system on water efficiency we compare the minimum water requirement before and after the improvement of the reuse system using the water balance approach. We also made a simulation of previous and current water reuse system irrigation schemes and clarify the irrigable areas with less labor work. For this simulation, we made a conceptual map for each water reuse system, based on the Oka Zeki irrigation project design map (1960) for the previous system and LID's irrigation block map for the current system. We also made an interview with LID officials to confirm the network.

To evaluate the effect of the water reuse system on water distribution management, we made a comparison of operations costs and staff numbers before and after the improvement of the reuse system. For this analysis, we used LID's annual reports data about water distribution management.

3. Outline of the research area

Oka Zeki irrigation scheme covering around 1600 ha of paddy field, is located in Ibaraki Prefecture. Supplied by the Kokai River Oka Zeki suffers from water shortage, due to the large withdrawal of Fukuoka Zeki upstream. With urbanization mainly in Toride city from the 1970s, many farmers began to work in cities for other jobs, which negatively impacted Mura's governance. Therefore the reuse system was improved in the 1980s. According to the conceptual map, it was clarified that before the irrigation scheme has 63 blocks in the previous system, based on the Mura boundary with 5 reuse blocks. Currently, the system is divided into 96 blocks, and 65 pumping stations are supplying reuse water to 52 blocks as shown in Fig.1.

4. Results
1) Water reuse system

The simulation with four different available water conditions was executed for each conceptual model, as detailed in Fig.1. The irrigable area of both systems was calculated following the
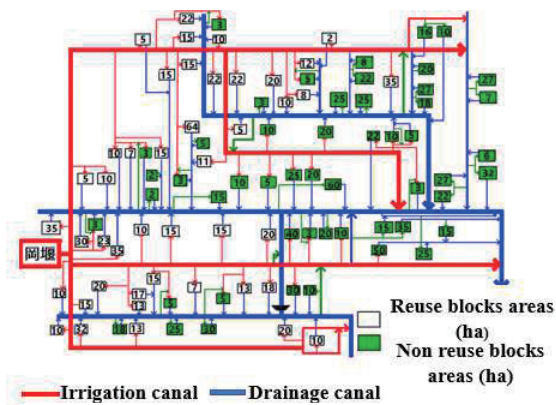
Fig.1 Conceptual map of Current system

procedure below.

1- The assumption of 20 mm/d of water applied, and 5 mm/day as evapotranspiration and less labor work for water distribution.

2-Acreage base approach dividing available water according to irrigable areas ratio, from the main canal to the secondary canal.

3- Upstream first and downstream the next focusing on water distribution from the secondary canal to each block.

The water requirement computation obtained from each system's result shows that 3.4 m^3/s is required for the previous system against 2.1 m^3/s for the current system as shown in Fig.2. By installing the water reuse system, Oka Zeki has succeeded in decreasing its water requirement up to 40%.

2) Effect on Water distribution Management

Installing pump stations the total operation cost increased as well as the energy cost, but the operation cost per pump decreased in the current system. To cover the high energy cost, the LID budget has been increased with subsidies and
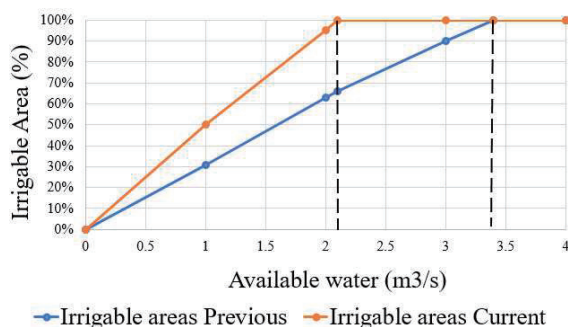

Fig. 2 Irrigable area simulations

donations.

On the other hand management work has decreased. Referring to the annual budget, the cost for water distribution activities involving gates operation and administrative work has decreased from 3 million yen before the 1980s to less than 2 Million yen after the improvement of the water reuse system as shown in Fig.3. In addition, the number of LID officials has been decreased from 10 in the previous system to 5 persons in the current system.

The water reuse system for LID in the Oka Zeki irrigation scheme has been regarded as an effective system for decreasing water distribution management activities.

5. Discussions

The results have clarified that the reuse system improves water efficiency by more than 40 %. This is suggested to be important for easy water distribution by LID. The energy cost becomes higher but has been compensated by subsidies and donations. This support has enabled farmers to agree for implementing the water reuse system.

As the next challenge, the effects on water distribution activities inside each irrigation block should be clarified. Also, the implementation of a reuse system without compensation support remains a problem.

References

Okamoto M (1978), Yojoki no Hitsuyou Suiryou, Suiri no Kaihatsu to Chosei, Jicho-sha, 597-608
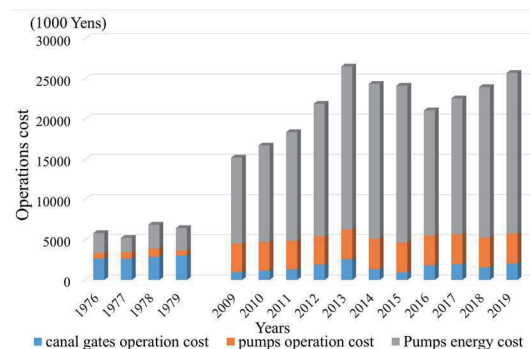Di Wu (2019), Reuse of return flows and its scale effect in irrigation systems based on modified SWAT model.

Fig. 3 Cost operations before and after 1980s