Research article

Evaluation of Participatory Irrigation Management Introduced into Dry Land Agriculture in Turpan, China

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Received 26 December 2016 Accepted 5 Nov 2017 (*Corresponding Author)

Abstract A stable supply of irrigation water is essential to ensure agricultural productivity in arid regions. To efficiently use the limited water resources, upgrading of hard infrastructure, such as reducing leakage from channels and installing drip irrigation, and of soft infrastructure, such as introducing irrigation management involving local farmers, is being pursued. This study reviewed the rationality of participatory irrigation management (PIM) in Turpan, Xinjian, China. Turpan depends for its irrigation water on streams, pumped groundwater, and karez (qanat). PIM mainly involves management of irrigation water supplied from streams. Between 2013 and 2015, interviews with Turpan City's Water Management Agency (WMA) branch office staff, PIM staff, and local farmers were conducted to collect information on water management. The findings showed that the founding of PIM organization resulted in the following benefits: (i) reduction of governing agency's burden: PIM is now in charge of work that used to be performed directly by staff of the WMA branch office (ii) Prevention of illegal practices: PIM staff are elected from among local farmers, so there is a system of mutual surveillance. (iii) Smoother implementation of water management: Previously, there were conflicts between local farmers and staff from other regions, who were unaware of the local situation. Since establishment of the PIM, local farmers have taken charge of the water management, which facilitated communication between the water administrator and farmers. (iv) Enhanced interest in water conservation: Because farmers now directly manage their water distribution and maintain their infrastructure, they are more aware of the importance of conserving water. Regarding the disadvantages, during seasons with a risk of drought, water management requires operations 24 h a day and there are many housekeeping issues, so labor shortages are a problem. This latter issue occurred because the main source of finance is from water fees, which are set by a governmental agency. As a result, the PIM team could not secure a sufficient budget to hire more staff.

Keywords participatory irrigation management, agricultural water use, interview survey, water shortage

INTRODUCTION

Irrigated agriculture is employed in the dry climate of Turpan, China. In this area, oasis agriculture was undertaken before the 1960s. After the 1960s, many dams and irrigation canals were constructed, and water was taken from many rivers for agricultural use. In addition, modern irrigation agriculture spread via the use of groundwater obtained by digging wells. However, recently, securing irrigation water has been difficult due to the increasing demands from industry and domestic users. Water shortages have also occurred because of inadequate cooperation between the sectors of land development and water resource development in China (Yamamoto et al., 2006). To prevent water shortages, the delivery rate of water has been improved by lining irrigation canals, and more water resources were developed by digging more wells (Jalaldin et al., 2005). Recently, in addition to such infrastructure, participatory irrigation management (PIM) by farmers has been introduced in this region due to the expectation that it would improve awareness of the importance of conserving water. Its introduction in this region occurred later than in other parts of China

In general, PIM aims to involve farmers themselves in irrigation operation and maintenance (Tanaka & Sato, 2003). PIM is a tool to manage irrigation water or irrigation systems to increase the efficiency of their use (Rattanatangtrakul, 2005). It can reduce government costs by reducing the number of staff (Raby, 2000). However, Pathasarathy (2000) indicated that although PIM has indeed led to better and smoother resolution of irrigation-related conflicts, reductions in government expenditure have not materialized. Many studies have analyzed the effect of PIM in these locations in monsoon areas, but the results have varied according to differences in the study area. In addition, few studies on the effect of PIM in semi-arid areas have been performed.

Moreover, there are many karezes around Turpan. A karez is a traditional groundwater system like a qanat, as found in the Middle East. The old karezes in this region were constructed 300 years ago and were used for agriculture and for water for daily uses for a long time. However, many karezes have now been abandoned due to the depletion of groundwater as a result of the digging of wells. In particular, farmers' own wells were dug haphazardly and the owners pumped up excessive groundwater. This excess water intake has also caused degradation of the regional ecology around outward flow of karezes.

OBJECTIVE

To maintain a sustainable regional community and agriculture in this area, there is a need to construct an agricultural water use system in consideration of sustainable irrigated agriculture by conservation of traditional groundwater use system. To conserve groundwater resources, improvement of water management is required in this area. And it has been widely expected that PIM can improve issues in water management. Thus, the goals of this study are to understand the situation of agricultural water use and to evaluate the effects of PIM introduced recently via a case study based on Turpan.

METHODOLOGY

Turpan district is located in the east of Xinjiang Uyghur Autonomous Region, in northwestern China, and is in a basin surrounded by mountains. This investigation focused on Meijiaoqou and Taerlang river basins in Turpan, a prefecture-level city. The climate in this location is considered to be BWk according to the Köppen-Geiger climate classification. The average annual temperature is 13.9°C, with a maximum of 49.6°C and a minimum of -28.7°C (Turpan Hydrology and Water Resources Observation Station HP, 2012). The annual discharge of each river is 80 million m3. Annual rainfall is under 50 mm, and the potential evaporation is 2,845 mm (JICA, 2006). Irrigation water depends on river intake, groundwater in wells, and karezes, the water of which is meltwater from snow and glaciers of Mt. Tienshan located to the north of the city. Irrigation methods are border and drip irrigation. The main crops are cotton, grape, corn, and wheat. Field surveys with interviews to understand changes of water supply and influence on water management by PIMs introduction were conducted from 2013 to 2015 in representatives of the water management agency, PIMs in Qiatekale Township on Meijiaoqou river basin and Yar Township on Taerlang river basin, and farmers (Fig.

1). In the interviews, in addition to above contents, we researched irrigation area, crop, problems on PIMs and etc.

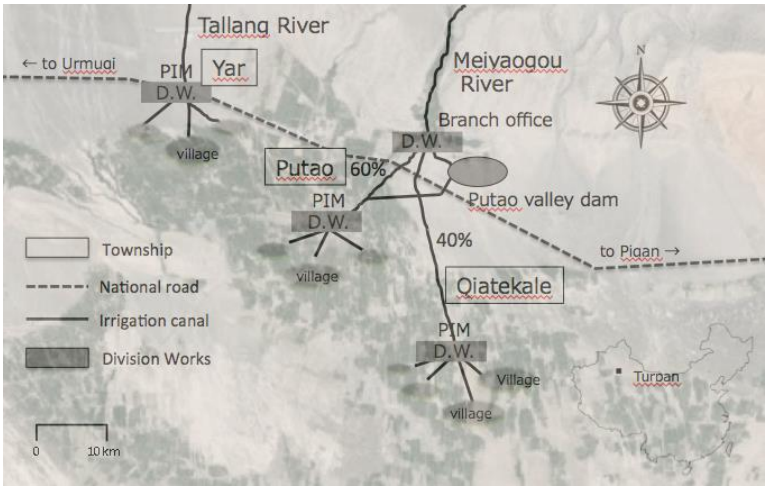

Fig. 1 Investigation area

RESULTS AND DISCUSSION

Changes of the Water Management Organization

Figure 2 shows the common water management system for intake from a river in Xinjiang. This system matches that in Turpan. Before early 2000, the branch office of the WMA had managed the water supply from water resources to each township, and a representative farmer in the township and the branch office staff had conducted water distribution in the township. After late 2000, PIM gradually became involved in terminal water management. Before introduction of PIM, branch offices at the township level had managed the water supply from large canals - primary or secondary - to farming blocks, and branch office staff and a representative farmer performed the water supply from small canals - tertiary and terminal canals - to each piece of farmland. After introduction of PIM, the branch offices managed only primary canals and each PIM managed secondary canals. PIM staff and a representative farmer dealt with the terminal water supply. In other words, farmers performed a key administrative role on behalf of government staff regarding the terminal water supply.

Crops and Water Resources

The main crops cultivated in this area are grapes, corn, cotton, and wheat. The supplied water for agriculture consists of 44% river intake and 56% groundwater from wells and karezes. The river water is mainly used for grape irrigation. The groundwater is basically used for cotton, corn, and other crops, except grapes. Farmers do not use water by mixture of groundwater and river water even if they can use both resources. The reason for this is that the groundwater is not appropriate for growing grapes due to its higher salinity than river water, and its temperature is lower than that in this area. In addition, the wholesale price of grapes is higher than for other crops. Thus, farmers can obtain an adequate profit even if they pay the fee to use river water. This fee was 0.164 CNY (approximately \$0.027)/m^3 in 2011, which consists of 0.136 CNY for the water resource fee and 0.028 CNY for the management fee. This water resource fee is a flat fee in this district, while the management fee is decided by Turpan WMA, along with the benefit area of the water facilities, length of the irrigation canal, and scale of division works of each PIM or branch office.

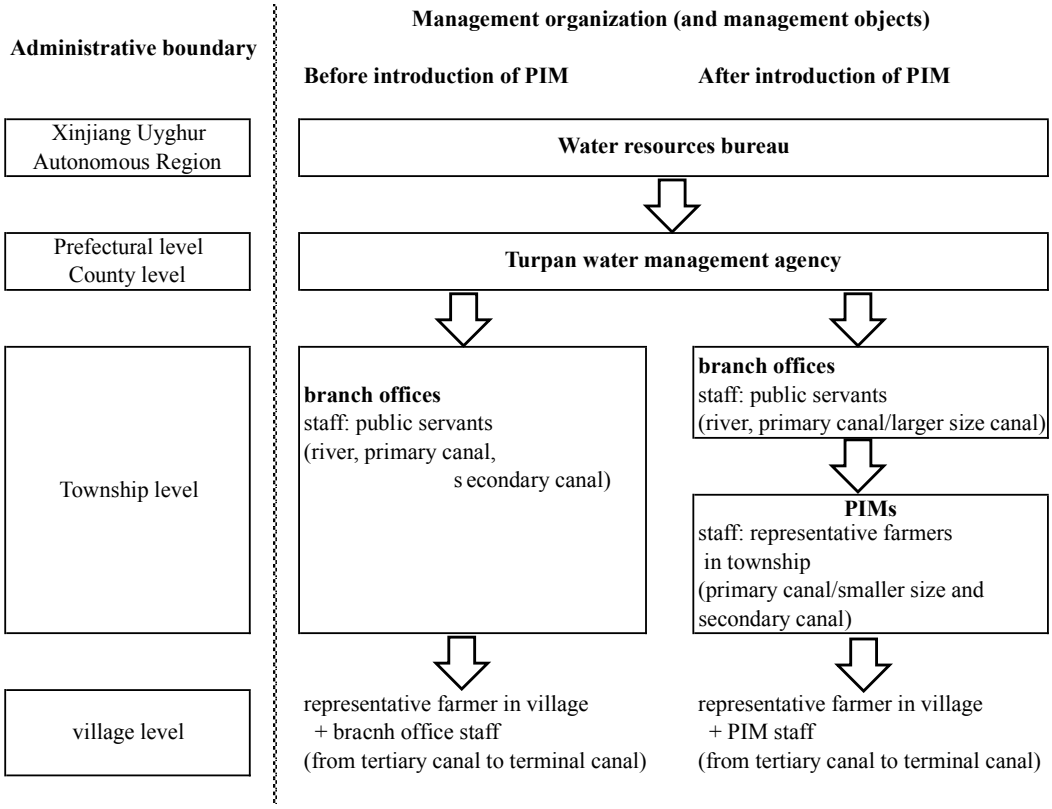

Fig. 2 Changes in water management organization before and after PIM introduction

Table 1 Outlines of each PIM

Land use system	Yar PIM	Qiatekale PIM
Established	2003	2007
Irrigation water supply river	Taerlang	Meijiaoqou
(Intake water rate to river discharge)	(100%)	(40%)
Cultivated area (ha)	5,467	6,667
Number of villages in PIM	22	12
Number of PIM staff	13 (Two vacancies)	11
Monthly salary ($)	240	240
Main crops	Grapes (90)	Grapes (30)
(% of total cultivated area)	Vegetables (10)	Corn & cotton (70)

Concerning groundwater use, the water management organization has managed only public wells and has deregulated private wells. Therefore, there was no water fee for groundwater use, and farmers only had to pay for the electricity to pump up the water. However, to protect groundwater resources, from 2011 the local government decided to prohibit the digging of new wells and to charge a property fee for those with existing private wells.

Outline of PIM in Turpan

Each PIM is an agricultural water management association operated by representative farmers in each town. Table 1 shows the outline of each PIM. Branch offices of the WMA are higher-level components of the organization of PIMs (Fig. 2). There are currently 13 staff members at Yar PIM and 11 at Qiatekale PIM. Each PIM also has a public servant from Turpan WMA acting as an accountant. Except for the loaned staff, the others are elected by farmers at the town level National People's Congress. The term of PIM chairman lasts for five years, but the chairman can be dismissed regardless of the term if they do wrong.

The main duties of PIM are to manage the water supply to villages via smaller canal, secondary or tertiary canal, to record the quantity of supplied water, to maintain water supply facilities, and to collect water fees. PIM manages only the river water and has no involvement in groundwater use. During summer, when water shortages are more likely, PIM supplies water to each village by rotation supply. The rotation system and the supplied water volume are decided in consideration of the number of wells, cultivated area, and growth situation in each village. PIM records the supplied water volume and collected water fee, as calculated by a specific method. The water fee and supplied water volume are determined each month. Some of this collected water fee is allocated for the salary of PIM staff and administrative expenses to maintain the water supply facilities. PIM has no right to decide the water fee; it is instead decided by a higher-level organization, Turpan District WMA. Moreover, it is a custom that the loaned staff from the WMA is in charge of accounting.

Merits of PIM in Turpan

PIM has attracted attention as intangible methods of rationalization of agricultural water management in China. This is because it is thought that the introduction of PIM can increase efficiency in water management by promoting voluntary irrigation management by farmers (Drainage and Rural Water Division, 2007). We identified four merits of PIM from interviews with PIM staff and farmers.

(a) Decreasing government expenditure: Before PIM establishment, each branch office of Turpan WMA had been in charge of water management in each town. Since PIM establishment, representative farmers have performed some of the management that was previously conducted at town level by the branch offices. This could allow local government to reduce personnel expenses by reducing the number of government workers.

(b) Prevention of illegal practices: Farmers were aware of cases of branch office staff undertaking illegal practices before PIM establishment. However, if such practices are identified now, farmers can remove the staff from their post because the PIM staff are representatives of the farmers and elected by a congress. In addition, it is indicated that PIM staff have less incidence of illegal behavior because they have neighborly relations with the farmers in their controlled area and are under mutual surveillance. This follows the finding in a previous study by Hui et al. (2007).

(c) Facilitating water management: Conflict about the distribution of water can more easily arise between users in arid areas where there is a chronic water shortage. In Turpan, such conflict also occurred between farmers and water management staff before PIM was established. Many staff members came from other areas and did not understand the typical water use in the townships or villages. However, establishment of PIM provided opportunities for greater understanding and contributed to smooth water use management. This effect is accepted in a previous study by S. Shindo and K. Yamamoto (2017). One identified merit was that farmers could more easily give their opinions about water distribution because PIM staff is now from the same area and understand their local customs and the details of the irrigation situation.

(d) Improvement of farmers' awareness of the importance of conserving water: After establishment of PIM, farmers are directly involved in water distribution and the maintenance of facilities. This improves their awareness of the importance of conserving water via their understanding of the present condition of regional water resources.

The results of interviews on the introduction of PIM could help to rationalize water management in Turpan. However, some problems were revealed from the interviews with PIM staff. For example, they consider it difficult having to work day and night in periods with severe water shortages. They desire an increase in staff because they feel that current staffing levels are inadequate. However, the budget prevents an increase of staff under current conditions.

CONCLUSION

We considered agricultural water use in Turpan from the perspective of change in the management organization. There are wells and karezes in this area and the pumping up of groundwater affected the water resources of the karezes. Preventing karezes was required to maintain the groundwater

level by reducing groundwater pumping via improved irrigation efficiency. PIM was introduced in this area for improving water management. From interview researches it is clear that PIM has a possibility of improving irrigation efficiency, some beneficial effects, such as the improvement of local government finances and the avoidance of water conflict. However, there are some problems that still need to overcome to ensure continuous running of PIM. Specifically, we suggest that the local government should pay a subsidy to PIM and that the automation of water supply facilities should be introduced, among others, for the sustainable management of PIM.

ACKNOWLEDGEMENTS

Xayar County Government, Xayar Water Management Agency, and Xinjiang Uyghur Autonomous Region Water Resource Management Bureau supported this research. This study is part of academic research (No. 24405039) supported by Grant-in-Aid for Scientific Research (B) from the Japan Society for the Promotion of Science (JSPS).

REFERENCES

Drainage and Rural Water Division. 2007. Operating instruction of accounting practices for water users association. Water Power Press, 58. [in Chinese].

Guo, H., Zhang, N. and Liu, F. 2007. Sustainable development model of farmer participation in irrigation management in arid region, A case study of Xinjiang Region. Bulletin of Soil and Water Conservation, 27 (4), 151-154.

Jalaldin, A., Nagasawa, T. and Yamamoto, T. 2004. Problems of irrigation system in Turpan city of Xinjiang Uyghur, China. Journal of Rural Planning Association, 6, 67-72.

Japan International Cooperation Agency (JICA). 2004. Pre-research report of sustainable groundwater resources development and use in Turpan basin, China. JICA Chinese Office, http:// open_jicareport.jica. go.jp/618/618/618_105_11770013.html.

Pathasarathy, R. 2000. Participatory irrigation management programme in Gujarat, Institutional and Financial issues. Economic and Political Weekly, 35, 35/36, 3141-3154.

Raby, N. 2000. Participatory irrigation management in Philippines, National irrigation system, Case studies in participatory irrigation management. World Bank Iinstitute, 273, 113-138.

Rattanatangtrakul, U. 2005. Participatory irrigation management (PIM) in Thailand. 19th Internatiional Congress and 56th International Executive Council of ICID [10-18 September 2005], THAICID-Multifunctional roles of irrigation water in Thailand, http://www.rid.go.th /thaicid/_5_article/2549/ 07PIM.pdf.

Shindo, S. and Yamamoto, K. 2017. Strengthening water users' organization targeting for participatory irrigation management in Egypt. Paddy and Water Environment, 15 (4), 773-785.

Tadao, Y., Nagasawa, T. and Jalaldin, A. 2006. Irrigated agriculture and the environment in the Tarim River watershed, Case study of the shaya irrigation district in the Ugen River basin. Sustainable Irrigation Management, Technologies and Policies, WIT Press, 303-312.

Tanaka, Y. and Sato, Y. 2003. An institutional case study of Japanese water users association, Towards successful participatory irrigation management. Paddy and Water Environment, 1, 85-90, DOI 10.1007/s10333-003-0016-1.

Turpan Hydrology and Water Resources Observation Station HP. 2012. Outline of Turpan, http://www.tlfswj. cn/html/kejjdxs/dixiashuidongtai/2012/0613/21.html.