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Estimating the economic and environmental benefits of a traditional communal water irrigation system: The case of *muang fai* in Northern Thailand

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ABSTRACT

The *muang fai* irrigation system is a traditional, small-scale, communal irrigation system that has been practised for centuries in northern Thailand. The *muang fai* is governed by a set of pre-established rules which, to a large extent, resemble Ostrom's (1990) well-known principles of effective common property resources. The system is now being challenged by the introduction of various alternative irrigation methods, including privately-owned underground pump irrigation. This paper compares the *muang fai* system with underground pump irrigation in terms of its yield, capacity to generate revenue and water use efficiency. For this purpose, we collected farming and socio-economic information from 481 farmers in northern Thailand who are either in the *muang fai* system or are underground pump users. We used this data to apply the Propensity Score Matching (PSM) technique to estimate the difference in yield, farm revenues and water use efficiency of farms using different irrigation systems. Using Kernel matching, for example, we found that *muang fai* participation increases average farm revenue by about 6080 Baht (US$1000) per hectare per year (40.6%). We also found that *muang fai* participation can conserve 48% of water. Both the revenue increase and gain in water use efficiency are statistically significant and robust to various different matching techniques.

1. Introduction

It is a common observation in many locations in developing countries that modern irrigation methods are replacing traditional irrigation. These modern systems take many forms, ranging from large-scale concrete dams to small-scale pumping of water from underground sources. Modern systems offer various advantages, not least of which is flexibility in the timing of applications of water to crops. Despite this trend towards displacement of traditional irrigation systems, such systems still persist in some locations. In northern Thailand, the local *Lanna* people still practice *muang fai*, a traditional, small-scale, communal irrigation system that was established centuries ago. Farmers in the region actively engage in this system that relies on surface water from rivers and streams, and is managed through community-based participation that has undergone little change for generations. The question examined in this paper is: why it is that *muang fai* is still a significant contributor to agricultural production in the region, despite modern irrigation alternatives being available?

A starting point is to observe that irrigation systems in the different regions in Thailand are normally set up to suit the geographical condition of the particular region. Rain-fed agriculture is still practised in northeast Thailand, whereas major dam irrigation is the standard in western Thailand. Other types include pond-based systems in the east and mixed orchard farming systems on the southeast coast. While the geographical conditions in northern Thailand are favourable for *muang fai* this cannot be the sole explanation for its continued use, because the use of modern petrol pumps to harvest water from underground is also practised in the region.

In northern Thailand farmers are primarily employed in rice farming, orchards, or growing cash crops. Water is a necessary resource for their agricultural activities, and it is needed throughout the year. An initial reading of the situation would suggest that the flexibility offered by modern irrigation systems would make them highly suited to this environment (de Fraiture and Giordano, 2014). Indeed, irrigation using water pumped from underground sources is common. Nevertheless, *muang fai* persists as a class of

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farmer-managed irrigation system, sometimes called communal, traditional or even the people's irrigation systems. There is a large body of evidence from many countries showing that systems like this can survive for generations, and effectively function to provide water for agriculture (Manor and Chambouleyron, 1993). Such evidence was used by Ostrom (1990) to develop the Theory of Common Pool Resources (CPR), which states that common pool resources, like water for irrigation, can be managed independently and effectively by their users without being privatised or handed over to a centralised government. From a large number of success stories, Ostrom (1990) highlights several principles that need to be followed for a common pool resource, like irrigation water, to be managed effectively. As will be explained, the *muang fai* system closely fits these principles. The concept of social capital, particularly its relevance in common property resources such as water, has typically been linked in the literature with such participatory irrigation management (PIM). PIM enshrines the need to promote farmer "participation" in the management and planning of irrigation projects (Khalkheili and Zamani, 2009). It strives to overcome property right problems and close the income gap between rich and poor farmers.

Prior to the emergence of modern irrigation in 1969, encouraged by the Royal Irrigation Department of Thailand, local agricultural communities in northern Thailand had widely adopted and practised a more-than-700-years-old traditional, communal irrigation system called *muang fai* (Surarerks, 1986). Wichienkiew et al. (2003, p.120) and Surarerks (2006, p.44) also note that the *muang fai* system has a long history, where people in the community have been applying local knowledge to the practice of irrigation in managing water for agricultural purposes.

These authors describe the arrangement of *muang fai* water allocation which is generally based on a queuing system. Each household receives a queue card, which states when they can use water from the weir. If they do not want to use the water when it is their turn, they can exchange with other members of the village. Each day, water is let out of the headwork area and is distributed to one part of the weir area, starting from the top to the tail end (usually the distribution corresponds to a group of about five farmers per day). Water from the weir is distributed to each farm along the irrigation canals, which have been constructed to pass through farmland areas.

Traditionally at each farm, there was a water entranceway that allowed water from the *muang fai* canal to go through the farmland. The water entranceway was blocked when it was not their turn. These days, the vast majority of *muang fai* members use a pump to transfer water from the main canal to their farm channels. Each person who holds a queue card for a particular day has the right to pump water onto their farmland. They have to stay and oversee that the water flow is not excessive. If they waste water without watching it while it is running, they are liable to be fined.

To have the right to use water from the *muang fai* system, villagers have to register to be a member, otherwise they do not have any rights to withdraw water from the *muang fai* canal even though water could be passing through their farmland. At present, there are no volume-of-use charges. The only costs are the annual fees that *muang fai* members have to pay. These fees are designed to cover operating, maintaining, and improving the system.

To a large extent, the *muang fai* irrigation system is governed by rules that resemble Ostrom's (1990) Design Principles of effective Common Pool Resources (CPR). First, the rules are clearly defined and prescribed. These written rules have been practised and passed on from generation to generation with few modifications. Second, resource allocation differs between *muang fai* irrigation systems, depending on the local conditions.

Third, decision making is democratic. During regular, normally monthly meetings, irrigation-related matters are discussed by all members and disputes are typically settled through voting. Fourth, either all users or assigned members are responsible for monitoring and sanctioning. If water flows excessively to the plot of one member and that member fails to monitor it effectively, sanctions will usually be applied.

Fifth, sanctions are graduated, i.e., mild for the first violation and stricter if it is repeated. Persistent violation can lead to membership termination. Sixth, there is normally a conflict resolution mechanism. Meetings are held regularly allowing members to discuss various disputes and seek resolution. Seventh, outside authorities recognise the members' right to self-organise. Outsiders, including government officials, are not allowed to attend or even observe regular *muang fai* meetings. Finally, members' responsibility is proportional to the benefits they receive. For example, the amount they must contribute to system maintenance is proportional to the size of their land.

Appendix 1 summarises some important principles of *muang fai* management that accord with Ostrom's (1990) Design Principles. Sarker and Itoh (2000) demonstrated the effectiveness of irrigation systems in Japan based on these principles. However, except for largely descriptive studies such as Wichienkiew et al. (2003), Pantana et al. (2004), Surarerks (2006) and Ounvichit et al. (2008), there is little analysis of community-based irrigation in northern Thailand. These studies generally focus on either demonstrating the role of individuals in the irrigation system or the structure of participatory management.

The co-existence of *muang fai* and irrigation that uses water pumped from underground sources enables a kind of natural experiment to be performed to test whether such a traditional system still has advantages over its alternative. The sources of such advantage could include good quality water from surface streams, extensive traditional knowledge of how to manage the water system that is reflected in the long-established rules of the *muang fai* and knowledge sharing among members about problems such as water shortages and crop failure. Moreover, even though the significant advantage of pumping from underground is that water is available just when it is needed, the *muang fai* water distribution schedule provides some stability because it has a fixed rotation order that allows farmers to be certain about when they will receive their share of water. Hence, the objective of this paper is to compare *muang fai* (a representative of traditional communal water irrigation systems) with pumping irrigation water from underground (a privatised system with modern technology). Two criteria were applied: economic benefit (measured by yield and revenue generated), and environmental benefit (measured by water use efficiency).

We have organised this paper as follows. Methodology and data collection are discussed in Sections 2 and 3, respectively. The results are presented in Section 4, and lastly Section 5 summarises the findings.

2. Research methods

While various methods are available for analysing small-farm irrigation projects (Jiracheewee et al., 1996; Mainuddin et al., 1997; Singh 2014), none provided a useful means of directly comparing two systems of irrigation. This led us to the Propensity Score Matching (PSM) method that we applied to estimate the impacts of becoming a *muang fai* member. This method was borrowed from the literature on impact evaluation (Ravallian, 2001), and involved estimating the differences in yields, gross revenue and water use efficiency between farmers of the *muang fai* and farmers using underground pumping, where such differences are attributed only to their differences in irrigation system, isolating the effects of other factors such as farming and socio-economic characteristics. In this

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