

Collective Action in Decentralized Irrigation Systems: Evidence from Pakistan

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Summary. — Pakistan, home of the world's most extensive irrigation system, has followed a global trend in irrigation to devolve management from government to farmers and farmer organizations. We implement the most extensive survey of irrigation management ever conducted in Pakistan to examine variation in farmer participation in managing local irrigation systems under the new governance regime. Building on and adding to previous work in Pakistan and elsewhere, we examine the effects of privately accessed groundwater, groundwater quality, surface water, and other factors along 5 different community management responsibilities, including roles that existed prior to decentralization (maintenance of the watercourse and dispute resolution) and new roles that were created after (voting to elect representative at the higher level, collection of water charges, and holding internal meetings). Each responsibility represents a collection action problem for the community. We find that while group leader education is important in successful execution of the roles, voting has in general been taken up enthusiastically while water charge collection remains, not surprisingly, low. We find a previously unreported inverse-U shaped relationship between groundwater availability and farmer participation, and that availability of high groundwater quality (less-saline) groundwater significantly reduces participation, as does high variation in canal water supply within a growing season. We also find, contrary to expectation, that communities in the tail reaches of the system, known to receive worse canal water service, more actively participate in managing their local irrigation systems. The findings have important implications for the continued push for decentralized surface irrigation management in South Asia and elsewhere as groundwater irrigation continues to expand and equitable access to surface water remains a policy concern.

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Key words — Asia, Pakistan, groundwater, water user associations, devolution

1. INTRODUCTION

In the late 1990s, the provincial governments of Pakistan adopted laws and policies supported by international donors to transform their centralized irrigation departments and experiment with new forms of local governance. The move in Pakistan was part of a broader and continuing trend to decentralize irrigation system management and give greater responsibility to farmers in that management (Bardhan & Mookherjee, 2008; Ramesh, 2013; Senanayake, Mukherji, & Giordano, 2015). Under the reforms, known variously as Irrigation Management Transfer (IMT), Participatory Irrigation Management (PIM) or Farmer Managed Irrigation Systems (FMIS), responsibility is transferred from government to farmers or groups of farmers within Water User Associations to actively manage local irrigation-related resources, collect water charges to finance system maintenance, and coordinate water use with higher structures in the irrigation system.

Empirical evidence of the achievements of reform through increased farmer participation is mixed (Senanayake *et al.*, 2015; Shyamsunder, 2008). This is also the case in Pakistan where studies, although limited in scope and methodology, have found varied outcomes on system financial performance (cost recovery), quality of operations and maintenance, reliability of water delivery (Haq, 2010; Latif & Tariq, 2009), and effect on farm productivity (Raza, Ashfaq, Zafar, & Baig, 2009). It is clear though that reform success in terms of improved irrigation management, farm productivity and farmer incomes depends in part on whether farmer participation is able to fill the management space vacated by the government. A key question is thus what prompts and sustains effective participation in a decentralized and devolved system?

Meinzen-Dick, Raju, and Gulati (2002) found that water scarcity, access to markets, leadership potential, and size of the community play an important role in emergence of farmer organization at the secondary canal level. While this work focused on why farmer participation and organization emerge, it leaves open the questions of whether and why farmer participation and organization continues after reform implementation. Other studies that have discerned empirical regularities in community cooperation in managing irrigation-related public goods using statistical methods have focused on the case of India (Bardhan, 2000; Mishra, Ghosh, Nanda, & Kumar, 2011), Mali (Vandersypen *et al.*, 2008), and Philippines (Araral, 2009; Fujjie, Hayami, & Kikuchi, 2005). Araral (2009) makes several significant improvements in methodology,

*The authors wish to thank the participants of the Association of Environmental and Resource Economists sessions at the 88th Annual Conference of the Western Economic Association International, held in June 28–July 3, 2013 at Seattle, Washington, for their constructive comments. Also, comments and suggestions received from John Eckalbar, Hasan MacNeil, Ruben Sargsyan, Pete Tsournos, and Kai Wegerich were useful in improving the manuscript. We also thank the organizers and participants of the Center of Water and Environment Lecture and the Anthropology Forum (both at CSU Chico) for providing a platform for constructive discussion. The data used here were collected by the International Water Management Institute with financial support of the Embassy of The Netherlands, Islamabad. The views presented here are those of the authors and do not necessarily represent the views or policies of the International Water Management Institute or the Embassy of the Netherlands. Final revision accepted: February 29, 2016.

most notably a large sample size and rigorous testing of interaction effects.

This study contributes to this literature in three key ways. First, we study the effect of privately accessed groundwater on the degree of collective action for public irrigation systems. Surface irrigation economy of South Asia, including Pakistan, has been transformed by groundwater use in recent decades. As of 2011, of the 19.41 million hectares of irrigated land in Pakistan, canals alone irrigated 34% of area, 43% was irrigated by “canal, tubewells and wells” and 22% are irrigated by wells outside formal canal commands (Pakistan Bureau of Statistics, 2012). Surface water is managed as part of the formal irrigation system as described above, but groundwater, accessed by millions of individual farmers using their private resources to install and operate diesel-powered groundwater pumps, is essentially unmanaged (Shah, 2008; Shah *et al.*, 2009). As Shah (2008), p. 137 notes, this extensive groundwater use effectively informalizes the water economy and takes most water appropriation and use outside the formal control of the irrigation bureaucracy. The decentralization of Pakistan’s irrigation system, and the discussion surrounding its mechanisms and effects, was entirely focused on the management of surface irrigation systems, even though the primary source of irrigation for many farmers is groundwater. We investigate how dependence on groundwater affects the efficacy of decentralized institutions.

Second, we improve our measurement of availability of surface water by including measures of its supply variability in addition to the standard water supply measures. Variation in canal water supply is an important aspect of performance of service delivery and is known to have important effects on agricultural production and farmer incomes. Studies on collective action in irrigation so far have only examined the effects of total canal water delivery, whereas variability of water received may also have a strong affect on productivity and willingness to participate in maintaining the irrigation system.

Third, we measure collective action of farmers in managing their irrigation systems along 5 different domains, each of which relates directly to the responsibilities awarded to farmers since the transfer of irrigation management. Two of these domains, maintenance of watercourse channel and dispute resolution within the watercourse community, are formalization of traditional watercourse community roles while the other three, collecting seasonal water charges, holding internal meetings, and electing farmer representatives, are new responsibilities for communities. Comparison of performance across the new and the old responsibilities measures provides insights into the challenges of adapting to new roles especially as we find that certain community characteristics are correlated with improved performance in one role but not in another.

One of the prominent features of the statistical collective action literature is the disagreement across case studies on the effects of various resource or community characteristics on successful collective action. For example, size of the community is seen as positively influencing collective action in some case studies (Araral, 2009), while it may have a negative effect in other settings (Meinzen-Dick *et al.*, 2002). This may be taken as a shortcoming or an indication of the ad-hoc nature of this literature even though the goal should not be to find generalizable universal results but rather to find micro-situational variables that work in a particular socio-ecological context (Ostrom, 2005, 2011). In our statistical case study we compare the effects of resource and community characteristics across multiple indicators of collective action, which suggests an alternative explanation of this apparent

disagreement. We propose that it is the underlying nature of the task or activity that may explain the differences in results of a community or resource characteristic.

We use a large data set of 1845 watercourses in Pakistan, which like Araral (2009) allows us the degrees of freedom to test the effects of a large number of independent variables. We selected our sample watercourses randomly and collected data on the performance of each selected farmer group including non-performers. As noted by Araral (2009) and Agrawal (2001), this sampling strategy helps avoid selection bias.

Watercourse-level farmer organizations around the tertiary irrigation system are the fundamental building block of the decentralized irrigation management (Uphoff, 1986). Farmers sharing a watercourse are located in one or more neighboring villages so we are able to control for watercourse community characteristics in a more fine-grained analysis. This strategy has a distinct advantage over Meinzen-Dick *et al.* (2002) and Mishra *et al.* (2011) who analyzed performance at the secondary-level canal systems, and therefore could not examine watercourse-specific and associated village-community-specific factors that may explain the incidence of and variation in farmer organization performance.

Finally, to the best of our knowledge, this is the most extensive statistical case study of farmers’ participation of irrigation management in Pakistan since the irrigation system was decentralized and several key responsibilities have been devolved to farmer groups. There is a growing belief that the present form of irrigation decentralization in Pakistan has not achieved the intended goals and that alternatives need to be considered (Government of Pakistan, 2012). While the Government of Pakistan has continued to reiterate its commitment to the reforms process, it has identified lack of concrete evidence on performance of farmer organizations as hindering its ability to formulate improved approaches (Government of Pakistan, 2012). A direct consequence of this knowledge gap is the frequency with which the regulatory framework is being modified and experimented with at the provincial level in an attempt to “fix” the performance issues of the new organizations. However, without a clear understanding of farmers’ participation in irrigation management, it is not clear what the best paths forward might be.

The rest of the paper is organized as follows: Section 2 gives an overview of the literature on empirical studies of collective action for natural resource management, focusing on irrigation-related studies; Section 3 presents our methods and results. Section 4 concludes with a discussion of results in the broader context of irrigation management transfer.

2. COLLECTIVE ACTION FOR LOCAL PUBLIC GOODS: THEORY AND EVIDENCE

Collective action problems as described by Ostrom (2005) refer to settings in which individuals select strategies, e.g., level of effort to maintain the local canal, based on a calculus that maximizes their private material benefits, but individual strategies are interdependent in that the final outcome, e.g., the state of the canal, is a result of everyone’s effort and generates benefits to the entire community. Ostrom (2005) referred to social dilemmas as situations where individual chose strategies that yield Nash equilibria that generate lower joint outcomes than could have been achieved. Research on determinants of cooperation among self-interested agents on provision of local public goods or management of common property resources has suggested a large set of variables that could potentially

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