Managing water commons and the extent of their climate resilience in Punjab, Pakistan

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Abstract

Participatory irrigation management through involvement of farmers in the planning and operation of irrigation system is considered an effective way of enhancing efficiency and equity of irrigation water. Given the ongoing challenges of water shortage and climate change, Pakistan has started reforming her irrigation system by partially transferring management from government to farmers and farmer organizations. The devolution of irrigation management from government managed system to farmer managed system is expected to bring substantial improvements due to ownership of the system and collective actions of farmers. However, the effectiveness of current reforms and collective actions of farmers in the face of climate risks needs investigation. Therefore, the current research was implemented to identify whether the management of water commons has the potential to face the water scarcity risks in the wake of climate change challenges. In addition, the study also identified the shortcomings that confront farmers' associations in managing water commons. In the end the study also proposed strategies to cope with risks posed by climate change to farmer organizations. The data on management of water commons was collected from five *Khal Panchayat* (KP) (watercourse level user association). These KPs were selected from four villages located along Gogera Branch canal in district Faisalabad of Punjab province, Pakistan. Both qualitative and quantitative data was collected in all five KPs through focus group discussions to assess the existence and strength of presence of Ostrom's design principles. The design principles existed to varying degrees across the five KPs and their strength of presence also varied. It was found that all five KP had in-built coping mechanisms to deal with water shortage issues through redrawing of Warabandi (water allocation) system. It was easier for KP to change water allocation due to collective action mechanism which allowed adaptation to changes in water availability. The improvements brought in by KP in the management of water commons are in the form of increased preparedness of farmers towards future water scarcity due to the risk of climate change. This preparedness is leveraged by Khal Panchayat due to swift and widely accepted conflict resolution mechanism, enforcement mechanism, and graduated sanctions. The collective action of KP makes it better prepared and resourced to deal with canal water scarcity and change in rainfall pattern by responding in mutually acceptable manner. It was concluded that KP were better equipped to face climate change and were more climate resilient as against government managed system whereby the response time is too long. It is also important to report that the farmers in the study area did not consider groundwater as a common pool resource and it was completely unregulated. This can have substantial negative

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effects in the future. Keeping in view the findings of this study that irrigation management is superior through KP, it was recommended to expedite and upscale the use of common pool water resource management in other parts of Punjab.

Keywords: Water commons; collective action; water scarcity; climate resilience; design principles

Introduction

Projected changes in climate pose serious threat to water resources in developing countries particularly those where irrigated agriculture provides livelihoods and subsistence to majority of their populations (Abid et al., 2015). Climate change along with extreme weather events may lead to reduction in per capita water availability, which has already drastically dropped to 990 cm^3 in 2013 from 5650 cm^3 in 1947 (Abid et al., 2016; Ali, 2013). Water scarcity due to climate change could potentially disturb the stability and sustainability of agricultural production in Pakistan, which is already under pressure to produce enough food for growing population (Bhutta et al., 2005). For instance, rising temperature may increase crop water requirements due to evapotranspiration during different crop growth stages (Abid et al., 2016). Further, declining surface water availability due to climate change may also increase pressure on ground water reserves which are already at stake due to over exploitation and no working groundwater policy (Bukhari and Sayal, 2011). Current water management practices need to be adjusted to cope with climate change, otherwise water scarcity could lead to food insecurity and hunger in the country and may put livelihoods at risk.

The water security issues persist in Pakistani agriculture despite possessing largest irrigation network in the world (Mekonnen et al., 2015). Pakistan's current surface water delivery system is supply driven (Bandaragoda, 2006; Nagrah et al., 2016), and has serious equity and water use efficiency issues (Dinar et al., 2004). The allocated water to each land unit needs to be utilized by the farmer (Rinaudo, 2002) irrespective of the need or demand, resulting in huge water use inefficiencies.

The water use efficiency problem (Watto and Mugera, 2014) due to supply driven nature of surface water in Pakistan is compounded by the top-down nature of the conventional water management system. This system excludes the main water users, farmers, from decision making in water management. The central management system also lacks flexibility in quickly responding to water scarcity challenges posed by climate change.

The surface water is a common pool resource (CPR) (Ostrom, 2015) and Pakistani farmers are mere users in this centrally management water delivery system. The farmers have to pay only a fixed *Abiana* (water charge) for water use (Nagrah et al., 2016) absolving them of any other costs and weak implementation mechanism resulting in abuse of precious water resource. This also creates problems of less water availability at tail (Usman et al., 2016) due to misuse at the head and middle. The lack of ownership and involvement in this water management system discourages farmers for applying techniques to improve water use efficiency.

Participatory irrigation management through involvement of farmers in the planning and operation of irrigation system is considered an effective way of enhancing efficiency and equity of irrigation water (Alam et al., 2012). Ostrom's work on commons has proposed that efficiency can be achieved through common pool resource management by involving the concerned stakeholders (Ostrom, 2015), in our case farmers. The sustainability of CPR institution increases as the existence of eight criteria, called design principles, increases in that particular system (Ostrom, 2015). The success of CPR management requires enabling conditions which can be assessed through Ostrom's design principles (Agrawal, 2002; Quinn et al., 2007; Yandle, 2003). The success of collective action also hinges on the strength of the presence of these design principles.

Given the ongoing challenges of water shortage and climate change, Pakistan started reforming her irrigation system by partially transferring management from government to farmers and farmer organizations (Nagrah et al., 2016). This decentralization started in 1990s whereby farmers were involved in decision making at various levels through participatory irrigation management. This participation ranged from opportunity to make canal, distributary, and water course level organizations if more than 50 percent of water users come together to form an association (Mekonnen et al., 2015). The water course level organization is called *'Khal Panchayat (KP)'* (*'Khal'* is water course and *'Panchayat'* is organization in Punjabi language). KP are authorized for conflict resolution, watercourse maintenance, monitoring, reporting of water supply status with distributary and canal level organizations, collection of water charges, and information provision on schedule of water rotation system (Mekonnen et al., 2015).

The devolution of irrigation management from government managed system to farmer managed system is expected to bring substantial improvements in efficiency and climate resilience due to ownership of the system and collective actions of farmers. However, there is little research on the role of commons in responding to climate change challenges. Therefore, the effectiveness of current reforms and collective actions of farmers in the face of climate risks needs investigation.

Thus, this research was carried out keeping in view three interlinked objectives. Firstly, the existence and strength of design principles was assessed. Secondly, the potential of water commons in the wake of water scarcity caused by climate change was discussed. Lastly, the problems in the management of water commons were identified.

Methodology

Study Area and Sampling

There are 36 districts and 27,057 Mouzas in Punjab. Mouza, a revenue village, is a unit for land organization defined by the government and consists of one or more villages. Faisalabad is the second most populous and largest mix cropping district of Punjab. It has large area for agriculture and farmers are well informed as compared to other areas of the province. So, Faisalabad was selected for this study. The data from Population Census, 1998 were used to list the Mouza as sampling unit (GOP, 1998). This data provides information on number of households in each Mouza at national, provincial, tehsil, union council not only for 1998 but it also provides information on population projections up to 2030. To prepare the sampling frame, all the Mouzas classified as urban in 1998 Census were removed. All the Mouzas have population greater than 25,000 in 2015 also removed with an assumption that they converted into urbanized area in past 17 years. Multistage stratified sampling technique was used for the selection of sample. In the first stage, an equal Probability systematic selection was used for the selection of Mouzas. This method ensures that Mouzas with low population have the equal chance of being selected as compared to large Mouzas. Further on the road, one enumeration block was selected from each Mouza and complete listing of agriculture household was conducted in the block. Finally, 25 households were selected through systematic random sampling technique from each Mouza to include in the sample. In this way, 125 households from total 5 Mouzas were selected.

Methods

Ostrom's eight design principles are "1. clearly defined boundaries", "2. proportional equivalence between benefits and costs", "3. collective-choice arrangements", "4. monitoring", "5. graduated sanctions", "6. conflict resolution mechanism", "7. minimal recognition of rights to organize", and "8. nested enterprises" (Cox et al., 2010; Ostrom, 2015; Sarker and Itoh, 2001).

The eight design principles were tested for their presence and strength based on the data collected from individual members of KP. The farmers were asked questions related to each principles and overall presence was calculated based on overall response within each KP. The strength of presence was calculated based on how the individual members evaluated each design principle.

Results and Discussion

The presence and strength of design principles

The presence and strength of design principals in all KPs is shown Table 1. According to the study findings, clear boundaries is the only design principle that is fully present at KP level according to all respondent farmers. While, the monitoring and conflict resolution are the two design principles that are least present in all KPs except KP-B. Other principles that are being followed to some extent include congruent rules, collective choice and graduated sanctions. Among KPs, KP-B is the only KP where majority of the design principles are being followed, while KP-C is the KP where adherence to the design principles is very weak. This is also shown from the average score of KPs given based on the presence of eight design principles, where KP-B received highest score of 5.8 and KP-C received lowest score of 3.32.

Table 1. Summary of strengths of all design principals at KP level

	KP-A (25)	KP-B (25)	KP-C (25)	KP-D (25)	KP-E (25)
Clear boundaries	25	25	25	25	25
Congruent rules	20	19	8	21	22
Collective choice	13	15	6	12	19
Monitoring	0	15	1	2	0
Graduated sanctions	11	10	5	16	15
Conflict resolution	2	22	3	1	0

Right to organize	20	18	17	21	17
Nested units	22	21	18	22	20
Total	4.52	5.8	3.32	4.8	4.72

Principle 1: Clearly Defined Boundaries

This was the only design principle where all the farmers agreed that each KP had clearly defined boundaries. The boundary of a watercourse is defined by the farms which are served by it. It was clearly defined with each farm having an allocation from only one watercourse. All the farmers along the KP were socially connected to each other and the water rotation system was clearly understood by all the farmers. Therefore, there was no possibility of non-members enjoying the opportunity of irrigation water use in place of other farmers. Thus, there were no free riders in all five KPs.

Principle 2: Appropriation and Provision

The appropriation and provision problems can lead to sub-optimal solutions in the management of an irrigation system. This collective action problem has two dimensions. The resource allocation (appropriation) problem and provision problem. In this study scenario, the surface water allocation needs to be governed by mutually agreed rotation system. As the water availability is limited by the time allocation from distributary, farmers in each KP need to decide among themselves how much time needs to be allocated to each farm. The provision problem is related to maintaining water stock through operation and maintenance (O&M) of watercourse.

The KP A, B, D and E in the study area had well defined and implemented water allocation system through weekly rotation system based on the time allocation in accordance with the area operated by each irrigator. However, the water allocation system was not decided by the farmers among themselves. The members had to pay irrigation charges as well as operation and maintenance expenses according to operated area – higher water fees were charged from farmers with bigger area. The government also finances part of the operation and maintenance cost such as watercourse lining. Mostly the soft infrastructure (management and labor) is provided by the KPs and hard infrastructure (irrigation and drainage facilities) is provided by the government through strategic investments.

The KP C had clearly defined water allocation system but it was poorly implemented due to misappropriation on the part of large farmers. This was due to high disparity in land ownership in this KP.

The challenges posed by climate change can lead to water scarcity in the study area. But the studied KPs did not have any coping mechanism as the water allocation system is designed by canal level organizations (Nagrah et al., 2016). However, KPs have the option of conveying their concerns to canal level organizations as the head of KP is their member. Further decentralization of authority to KPs can help in making much needed decisions to ensure flexibility in the face of water scarcity due to climate change. The transfer of authority to KPs can provide an option to the farmers whereby they can quickly change water allocation in the face of scarcity of irrigation water.

Principle 3: Collective Choice Arrangements

The collective choice arrangements varied across the five KPs. The KPs have the right to make operational rules as they are the ones affected by these rules. Theoretically, KPs are responsible for at least these five basic roles including watercourse maintenance, dispute resolution, collection of water charges, internal meetings, and voting for canal level organizations (Nagrah et al., 2016).

Practically, aside from dispute resolution mechanism other four roles were being effectively played by KP A, B, D and E. The initial dispute regulation mechanism worked well but in the case of inability of KP to solve the dispute there was less chance of solution because of complicated legal procedure.

The KP C had problems in all five roles of KP. This was because of low equity of water distribution in this KP resulting in less interest of small farmers in watercourse maintenance, collection of water charges, and internal meetings. The large farmers in this KP also were not interested in attending meetings of canal level organizations to exercise their voting rights.

It is likely that in the event of climate change more disputes will arise due to water scarcity issues. Thus, this role of KPs will become even more important in future. Therefore, it is important to transfer this responsibility to KPs for quick resolution of disputes and flexibility in decision making.

Principle 4: Monitoring

Monitoring of the rules related to water allocation (Warabandi) is necessary for effective distribution of water among all shareholders and for this purpose role of KP is very important. KP is not directly responsible for monitoring the water allocation and distribution since it is the duty of irrigation department and canal level farmer organization in general. However, KP can take measures in collaboration with canal level farmer organization and irrigation department to force its shareholders to follow the mentioned rules and to avoid any potential conflict among shareholders. Farmers in all KPs were of the view that KPs do not have the power to implement Warabindi as it is the responsibility of irrigation department to enforce such rules. However, in contrast to farmers in other KPs, farmers in KP-B reported that their KP is actively involved in monitoring Warabandi and help farmers in switching their Warabandi turns if required. It can be said that monitoring principle is not being followed by the sampled KPs.

Principle 5: Graduation Sanctions

This principle states that the members who violate operational rules are imposed with sanctions in accordance with the seriousness of the offence and its context. The KPs in the study area had two main issues on which violations usually occurred and so had two different responses to each of these problems.

First, the usual violation is of not following the water allocation schedule and water theft. The KPs A and B had the initial response of calling a meeting of KPs to solve the issue through social pressure. However, in the event of non-compliance by the violating party the dispute is referred to canal level organizations and then to police. The KP D and E had no such violations due to strong social connections. The KP E had this serious problem due to repeated violations by large farmers. The upcoming water scarcity issue in the face of climate change will complicate this issue. The water scarcity issue will test the resilience of KPs as water allocation schedule may be repeatedly violated and the sanctions mechanism need to be strong to ensure compliance.

Second, the other problem was of non-compliance by some members for watercourse cleaning for de-siltation at the start of cropping seasons. In the event that a farmer was unable to join the activity in KP A and B, the farmer had to send a laborer or pay to a fellow farmer to clean his part. However, if these actions did not work then the next step was to stop the weekly water allocation of the violator. The last and most extreme option was to socially boycott the violators. The KP D and E had only resorted to charging violators for the labor used in de-siltation. The KP C had reverse issues as opposed to the first problem. Here, the violators were small farmers. As small farmers were often deprived of water access, they did not have willingness to join the cleaning exercise. The large farmers, who enjoyed greater water use, paid for the cleaning of watercourse.

Principle 6: Conflict Resolution

Conflict resolution, the sixth design principle of CPR, is also one of the five key responsibilities allocated to KPs in new institutional reforms in irrigation sector of Punjab under 1997 PIDA Act (Nagrah et al., 2016). The presence of an effective conflict resolution is significant in current era where climate change-induced water scarcity could lead to potential conflicts over water allocation among farmers. In this study, representative farmers from five KPs were consulted to assess the adherence of conflict resolution mechanism of local KPs with the design principle of CPR and its effectiveness in resolving disputes among farmers at specific watercourse. Weak adherence to this principle was found in 4 out of 5 KPs, suggesting that no active systems are available at KP level for conflict resolution and mediation among farmers. Only in one (B) out of 5 KPs, farmers reported that KP-B is actively involved in taking measures to resolve conflicts among farmers. Farmers reported that to resolve disputes KP first call both parties to hear their concerns and after hearing they propose solutions to resolve disputes. If any of the parties are not agreed with the proposed solutions, then KP refer that case to Farmer Organization (FO), where FO dispute resolution committee become responsible for calling a meeting of both parties and other co-farmers to mediate the conflict.

Farmers belonging to selected KPs reported that most of the conflicts were reported to either allocation of water including Warabandi or timing of irrigation for particular farm and water theft. Farmers also showed their concerns on the increase in conflicts with growing demand and scarcity of water for irrigation. In extreme cases, conflict between farmers over water allocation was turned into violence that killed many farmers and damaged farms and crops. The low performance of KPs in not fulfilling its described responsibility under 1997 PIDA Act and resolving disputes among farmers is mainly due to the non-availability of any legal protection to KP to punish culprits. Even in some cases, when KP is willing to resolve a dispute, culprit farmers may not adhere to the KPs rules. In other cases, it might be possible that farmers are willing, but KP members are not ready to resolve the case to avoid conflict with farmers.

Principle 7: Rights Recognition

This principle defines that the decisions made by the KP will be respected and not affected by the outside authorities and officials. All the KPs in sampled area reported that they have right to take decisions for the betterment of watercourse and to improve irrigation rotations. Habitually, these decisions are not affected by the government officials. The KP members define and take actions regarding all matters like conflict resolution, Warabandi management, monitoring, operation and maintenance and exchange of irrigation rotations. The respondents argued that they have to call government officials and police sometime for conflict resolution but this is not happened in last 3 years in the study area. It was also observed that KPs can performed better in case of water shortage in peak seasons, as they are well aware about crop conditions and social values while living in same community.

All the members pay cost and involved in O&M process. KP chairman consulted with members and decided the rules and regulations for O&M. Government did not pay any cost of O&M operations but get involved in lining of watercourse by cost sharing at different levels. All the watercourses in sampled area were lined and completed up to tail which increased the water availability at tail ends.

Principle 8: Nested Enterprises

The complex irrigation system in Faisalabad consists of main canals, distributaries, water courses and crop fields. There is a designated officer called "Patwari-irrigation" to maintain and collection of "Abiana" and designing of Warabandi system. KP mostly involved in dispute settlement, collection of Abiana and maintaining the timing of water release. FO at canal level and area water board on higher side of the chain managing main canals and facilitate KPs to function well and more effectively. PID and FO received significant funds to operate but KP functioned with farmers on self-managed and self-govern bases to address the problems faced by the water users. KPs are functioning independently, efficiently and in well-organized manner under this big umbrella.

Conclusions and Recommendations

The collective action of farmers has the potential to address the problems in common pool resource management system such as water commons. Ostrom's design principles were assessed for their presence and strength of presence. The potential of these principles for meeting the water scarcity challenges posed by climate change was also discussed. The problems faced by watercourse level organizations (Khal Panchayat) were also pointed out. Several design principles were identified in the KPs of the study area. Only the first design principle was universally present across five KPs. Other principles varied with the second most common being the nested enterprise principle. Monitoring, conflict resolution and graduated sanction principles need significant improvement.

In the event of water scarcity due to climate change, presence of KP has the potential of better responding to this challenge because of farmers' participation in decision making and connection with canal level farmer organizations. KPs are also more climate resilient due to involvement of farmers and the opportunity of bottom-up information delivery.

However, KPs faced problems in gaining rights given to them in government acts and need government assistance in transfer of rights. Also, water allocation schedule rights are not provided to KPs. If given these rights, KPs can be more effectively climate resilient.

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