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THE ROLE OF COMMUNITY INSTITUTIONS IN THE MANAGEMENT OF WATER INFRASTRUCTURE IN THE CONTEXT OF MADHYA PRADESH, INDIA

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ABSTRACT

Since the 1990s, India substantially invested in participatory watershed development. An important element of related projects is the rehabilitation of small-scale water harvesting infrastructure.Despite its multipleeconomic and ecologicalbenefits, many communities fail to sustainably manage the structures. Among other factors, a favorable local institutional framework has been identified as a critical precondition for improving the management. This is more critical when common-pool resources are affected which are prone to social dilemmas. Typically mechanisms to support communities in this regard are blueprint solutions such as community water funds or organizational capacity development of Water User Associations. Little attention is paid to supporting communities in developing rules related to water and water infrastructure management. The latter requires a good understanding of local water management rules.

This paper assesses the rules related to common water infrastructure in a case in Madhya Pradesh/India. The presented research uses four sources of data which are a) key informants' interviews, b) individual interviews, c) discussions from a learning game intervention, and d) Foundation for Ecological Security (FES) data. This is relevant from a water management perspective as it may hint at entry points for community-based governance mechanisms. The paper demonstrates a simple assessment framework which can be applied across South Asia and can be input to improving the sustainability of future watershed programs. Our assessment revealed multiple examples of rules related both to the maintenance of water infrastructure and the utilization of water. There is evidence that some farmer invest in maintaining the structures. This indicates that possible solutions are not far to seek. However, the existence of rules and reports on maintenance efforts are not reflected in the state of the infrastructure. There is a need to better understand under which conditions communities manage to establish effective water governance that effectively improves management.

Keywords: *Capacity development, Facilitation tools, Sociallearning, Watershed management, India*

INTRODUCTION

There is an urgent need for a fundamental paradigm shift towards sustainable agricultural practices (Rockström et al., 2017). While there is a huge pool of sustainable agricultural technologies available (see e.g. www.wocat.net), their adoption rates are very low in most developing countries (Tey et al., 2017). Among other factors, a favorable institutional framework has been identified as a critical precondition for improving adoption (Chartzoulakis and Bertaki 2015; Tey et al., 2017). This is more critical when common-pool resources are affected which are prone to social dilemmas.

Recognizing the close link between poverty and natural resource degradation, India invested more than US$ 500 million during the 1990s (Farrington et al., 1999) and more than US$ 1 billion the following decade (Deshingkar and Farrington, 2006) in participatory watershed development. Principally designed to reduce soil erosion and control gully formation (Joshi et al., 2004; Joshi et al., 2005), watershed development programs typically include a complex set of soil- and water- linked technologies. These technologies range from in situ soil and moisture conservation structures such as contour and graded bunds, continuous contour trenches, etc., to rehabilitating degraded soils in both commonly and privately held lands. There is strong evidence that such interventions have the potential to achieve a wide range of societal goals – among others, improved productivity, soil protection and efficient use of water (Wani et al., 2008; Rockström et al., 2010; Garg et al., 2011; Garg et al., 2012; Singh et al., 2014; Karlberg et al. 2015). However, despite the obvious potential these technologies hold, many communities fail to sustain the benefits over time as they grapple with efforts to collectively run and maintain the structures (Wani et al., 2008; Joshi et al., 2005; Singh and Goyal, 2019).

Even though watershed projects in India use participatory approaches, scant attention is paid to enhancing the capacities of communities to design or transform institutions and compel them to ensure the sustainability of infrastructure investments (Vashisht, 2008). Members of watershed communities and staff of project implementing agencies (PIAs) are trained in organizational and technical skills such as community mobilization, project management, supervision of civil works, water audit and crop planning, maintenance of books and accounts of the watershed association/committees, water charge estimation and collection charges, as well as the planning, operation and maintenance of irrigation systems. The lacuna lies in

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the disregard for enhancing capacities for participatory development of rules for water allocation and infrastructure maintenance, one of the reasons for the swift erosion of infrastructure and capacity to consistently generate benefits following project conclusion (Chaware, 2018).

Community rules are critical while managing common structures as it is difficult to exclude members of the community from partaking of its benefits. Even though the entire community can benefit from a well-functioning infrastructure, there are strong incentives to free-ride (Hardin, 1968). Studieshave shown that even a small number of free-riders in a community can quickly undermine overall cooperation (Vollan 2008; Falk et al., 2012; Hayo and Vollan, 2012; Vollan et al., 2013; Gatiso et al., 2015; Javaid and Falk, 2015; Falk et al., 2016). Among some of the typical challenges experienced in such situations arethe unequal distribution of benefits, the dearth of enforcement mechanisms, and expectations of external help (Kerr 2002; Ostrom 2005; Hope 2007). Often, communities are not even aware that they have the means to address a problem.

This paper assesses the rules related to common water infrastructure (CWI) in a case in central India. This is relevant from a water management perspective as it may hint at entry points for community-based governance mechanisms. The paper demonstrates a simple assessment framework which can be applied across South Asia and can be input to improving the sustainability of future watershed programs.

Conceptual framework

We place our assessment in the context of concepts of natural resource management (NRM) and collective action (Figure 1). In NRM research distinguishes between

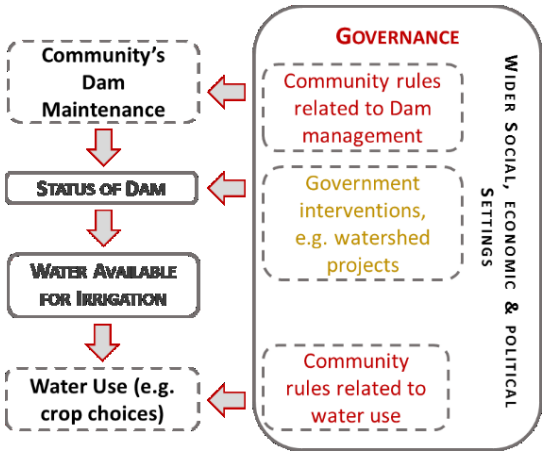

Fig. 1: CWI management in connection to governance

provisioning and appropriation actions (Hinkel et al., 2015; Costanza et al., 2017). We slightly refine them and differentiate between enhancing actions, where people support the creation, maintenance, and improvement of resources, and appropriation actions, where people subtract from available resources (Falk et al., 2018). In the context of community water infrastructure, enhancing options would be for instance the maintenance of the CWI; appropriation actions would be the use of water including the choice of crops which have different water requirements. Both types of actions require special attention given that jointly used community water infrastructure is typically a common pool resource. Common pool resources are characterized by attributes of strong subtractability and difficulty in excluding from use. The fact that it is difficult to exclude a community member from using water of a community CWI creates incentives to freeride on the maintenance of the infrastructure. An individual's enjoyment of benefits is not directly linked to her maintenance effort. The situation becomes more severe in combination with the attribute of substractabilty. As one person's use reduces other people's ability to enjoy the water, the difficult exclusion leads to an over-extraction of water, an example of what Hardin (1968) called the Tragedy of the commons (Ostrom, 2009).

This constellation is not a dead-end. There is strong evidence that communities can sustainably manage these challenges. Critical are thereby effective institutions which coordinate everybody's enhancing and appropriation actions (Ostrom, 1990). In the context of our research, benefits are enjoyed locally and the coordination challenges can therefore be placed at the local level. Taking into account public budget constraints, the logic of subsidiarity, therefore, points at paying attention to community-level rules related to infrastructure maintenance and water use.

Study Site

We studied the management of Community Water Infrastructure (CWI) in Mandla district ofMadhya Pradesh state in India (Figure 2) to better understand the institutional dimensions of the challenges, opportunities,and obstacles related to addressing poor water and CWI management. In the context of Mandla, this referred mainly to check dams, village ponds, and small community tanks. The size of the common water infrastructure in the study sites was in the range of 360 to 18,000 cubic meters. The study informed the testing of innovative interventions, specifically learning games, which are not the subject of this document (Bartels et al., 2019).

Methods

The presented research uses four sources of data which are labeled below as S_1, S_2, S_3 and S_4 representing a) key informants' interviews, b) individual interviews, c) discussions from the learning game intervention, and d) FES data, respectively.

As a first step [S_1], a small group of key informants, especially community leaders, were interviewed on questions (please see question in detail in Appendix 1) related to historic and current CWI management issues. The

Fig.2: Location of the study area.

main objective was to understand the accessibility of common water resources in the community and the rules for maintenance and allocation of benefits. Also part of the survey was an external assessment of the state of water infrastructure conducted by experienced FES field staff. The survey was conducted 90 villages which were randomly selected from the list of Bichya Block villages based on the 2011 Census. Descriptive statistics are used to describe the basic features of the data in a study. Village leaders were asked in open questions about the presence of different types of water management related rules. The answers were coded into rule categories.

In the second step [S_2], 840 individuals in 60 of the 90 aforementioned communities were asked basic questions related to their past actions with regard to water and CWI management. The respondents within each community were purposely selected farmers who lived close to a water harvesting structure and thus involved in agriculture and water harvesting.

The third important data source [S_3] for this report were records of discussions that emerged during the learning game interventions between the respective 14 game participants in each of the 60 aforementioned communities. The facilitators of the games took summary notes of all discussions. These notes were intuitively coded on the community level afterward by the authors based on the understanding of the context and the content. More information on the game intervention can be found under (Bartels et al., 2019; Falk 2019)

Data collected by the NGO FES was the fourth source of data [S_4]. In June 2018, field officers of FES surveyed 154 villages where the NGO is implementing activities. Village leaders were queried about the presence of different types of water management-related rules.

This paper presents mainly descriptive statistics of the data described above. Conspicuous patterns were confirmed using appropriate significance tests. Data were analyzed in STATA 14.

RESULTS

Assessment of status of infrastructure

The expert observation of dams revealed that in two-third of the Mandla sites the CWI was in a bad condition. This picture is in contrast to the fact that key village informants of half of the study sites reported maintenance activities over the previous years. There was no statistically significant difference in most dam condition variables depending on the reporting of maintenance action. More than three-fourths of the maintained CWI were still reported to be in a bad state, with only a quarter of them in a decent state following maintenance [S_1]. The only exception are the feeder channels where reported maintenance showed a positive effect (Wilcoxon rank-sum test: $z = 2.509$; Prob > $|z| = 0.0121$) (Figure 3). Our data allow us to only speculate about potential reasons for these observations. A likely explanation is that farmers focus maintenance activities on feed channels only. Understanding the reasons for this would require further in depth research. It may be that the communities are not prepared to make more substantial monetary and labor investments into the main walls or sluice gates to really create an impact. The underlying cause of this may be a limited feeling of ownership for the structures. Another potential explanation could be that communities need better technical advice on how to best repair their CWIs.

The key informants' perceptions are in line with the NGO experts' ranking of the state of CWI (Figure 3). The latter ranked three-fourth of the CWI as having lost a considerable bit of their capacity due to siltation. Fifty-seven percent of the CWI were reported to have lost considerable capacity due to the overgrowth of vegetation. Nearly half of the CWIs had poor to very poor earth walls. Half of the main walls were in moderate condition. Approximately a third of the sluice gates were rated to be in poor or very poor condition. Two-thirds of the feeder channels were also rated poor or very poor [S_1].

During the discussions from the learning game intervention, a majority of the communities' perceived the condition of CWI to be poor. Many members of the community were not interested in participating in the maintenance work as they argued that water infrastructure would benefit only a few community members. Once the infrastructure was neglected for a period of time, the reparation costs shot up, overstraining the communities. As a result, farmers had to depend for help from a government program or other organization [S_3].

Based on theindividual interviews with farmers, it was revealed that hardly any respondent made monetary payments for CWI maintenance [S_2]. There is no significant

difference between CWI in good or bad state. Providing own labor were found to be a more common way of contributing to CWI maintenance. Figure 3 shows that contributions had no bearing on the good or bad state of the CWI[S_1, &S_2].

Labor contributions were found to be linked to water allocation. Farmers who received water in the last year contributed 16% more labor compared to those who didn't receive water [S_2].

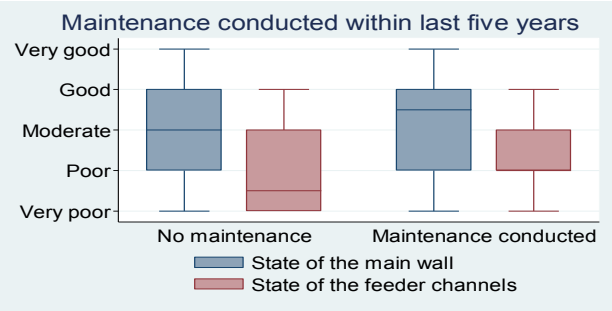

Fig.3: State of the CWIdepending on theirmaintenance over the last five years.

Water uses

To understand the management of water and CWI, it is important to understand the importance of different types of uses. The survey with key informants [S_1] in the community revealed almost unanimously that the most widespread use of water was for livestock watering and domestic use. Almost half of the communities used common water fishing. Typically, larger CWIs are used for irrigation purposes. Other water uses were often related to biodiversity such as drinking water for wild animals and birds (17%) (Figure 4)[S_1]. Figure 5 shows a typical CWI in the study area.

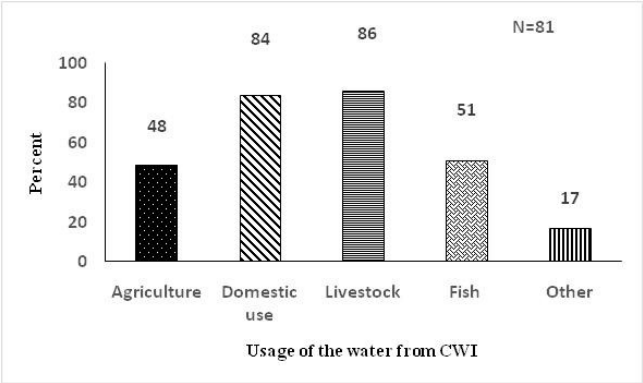

Fig. 4: Usages of CWIs expressed in share of CWIs in the study sites used for the respective purposes

Assessment of institutions related to water and CWI management

Rules and common practices related to CWI maintenance

Respondents felt that in the past, communities would make greater efforts to collectively maintain CWI. Even in the early 1990s, they would participate actively in maintenance activities. The decline in involvement has come about due to the availability of other water sources such as common hand pumps, private bore wells, and open wells. Also, in

Fig. 5: Typical CWI in the study area which is used also for irrigation purposes.

resources for critical irrigation for post-rainy season crops such as wheat, chickpea, lentil, and vegetables as well as for villages in the forest, the forest department claims responsibility for the maintenance of water resources

crowding out community efforts [S_3]. Only 15 out of 90 study sites reported that community-based organizations were given the responsibility to maintain the infrastructure [S_1].

Still, in 78% of the discussion sessions during the learning game, people stated that their community takes care of minor maintenance work of water resources and in operating the gate. In about 88% of the sessions participants reportedly contributed voluntary labor to maintain the infrastructure [S_3]. Nevertheless, the individual interviews reveal that maintenance efforts in the communities are not equally shared. Only a bit more than one quarter of 840 respondents contributed labor to maintenance activities (Figure 6). Hardly any respondent made monetary contributions [S_2].

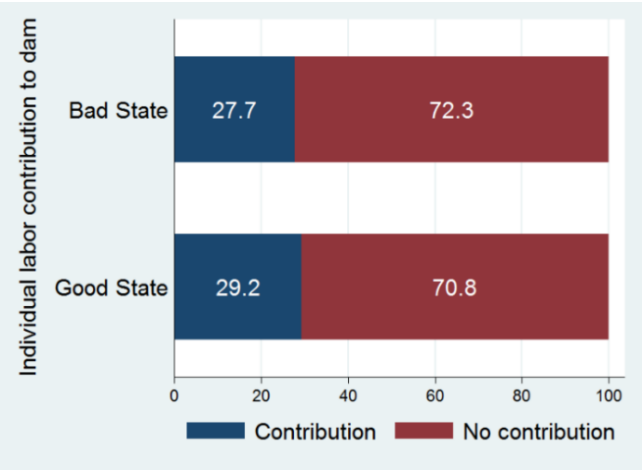

Fig.6: Labor contribution depending on the state of the CWI.

Encroachment of land adjacent to common water resources was found to be a major challenge in the study area. Once such land is encroached upon, the occupiers try to protect it. Maintaining the CWI would threaten their ability to cultivate the land. This creates tense situations that make it even less likely for the infrastructure to be maintained sustainably [S_4].

The aforementioned water resource-related benefits would suggest that a relatively large group of the communities benefit from the structures. Yet, it was reported that they refuse to contribute to the maintenance because benefits do not accrue to them. This raises the question whether water is unequally distributed or whether the actual beneficiaries hide their preference for water use as they attempt to free-ride on the efforts of others.

When communities collectively make efforts to manage water and CWI sustainably, the prevention of free-riding gains importance. In some villages, it was reported that households who do not help in the work are charged a fine proportional to the day's wages. One group reported that an uncooperative person was ostracized. The villagers hoped that it would motivate the person to cooperate in the future. Communities generally avoid restricting access to water as this is considered to be too harsh a response [S_3].

Who are the main players in the maintenance of water infrastructure? Panchayats are seen as playing key roles. Village leaders and elders play prominent roles, especially in the organization of water user groups and the formulation of rules. The general respect they enjoy within the communities also allows them to resolve conflicts. The committees often formed with NGO facilitation are also critical [S_1andS_3].

In one community, the panchayat had signed a contract with a self-help group. This community-based organization distributes income received from the sale of fish among the group members and takes care of the maintenance of the water body [S_1].

FES assisted 89 communities in the study area in formulating water and CWI related rules and regulations. Half of the communities reported any such rules. Thirty-eight communities formulated maintenance rules. A third of the communities prepared rules to maintain cleanliness surrounding water bodies. Ten percent laid down rules to remove and prevent encroachment on land adjacent to water infrastructure (Figure 7, [S_4]).

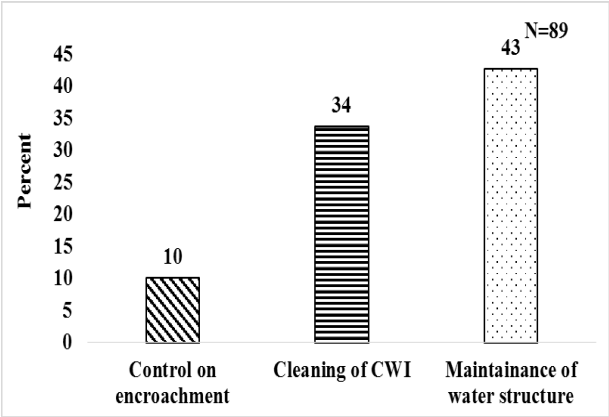

Fig. 7: Frequency of CWI water usages rules reported in communities

During the time of the study, almost half of the villages benefited from government or NGO-facilitated watershed programs [S_1]. For instance, FES conducted major repairs on 82 water bodies, including 28 stop dams in 154 Mandla villages. The work included providing new gates, supporting the desilting of dams/ponds, and turbine repair. FES also facilitated the setting up of committees to manage common property resources [S_1, andS_4]. Water user groups were formed consisting of three to five community members whose land is adjacent to the water infrastructure.FES assisted the communities in planning future maintenance work; for instance, byestimating the cost of maintenance [S_1]. FES assisted communities in organizing village level committee, which provides space

for the community members to discuss and deliberate on CWI and other common resources related issues. FES was working in 154 communities in Mandla district. Out of these, 144 communities established village level committees, and 89 formulated water management rules. However, not all FES-supported communities reported compliance with the rules. Most groups did not perform the required maintenance work or did not manage the sluice gates. A case of poor management resulting in water logging and preventing farmers from cultivating part of their land was reported. Some committees stopped functioning. A third of the communities and water user group members encroached on land of CWI streams. Only 9 out of the 89 communities agreed on rules related to such encroachment [S_4].

Important for CWI management have been also water user groups, which are groups of CWI beneficiaries. Creating water user groups led to a wider perception that the group owned the CWI. Nevertheless, landless community members who are also dependent on the stop dam for water for domestic use and water for livestock were not included in the water user group. While the perception of limited ownership may spur incentives for the group to increase management efforts, it deters non-members of the group from making contributions [S_4].

One case has been reported where people from two habitations jointly maintained a CWI even though it was perceived to belong to one of the habitations. Members of the second community were willing to make investments as they perceived to receive benefits from the CWI [S_3].

Rules and common practices related to water use and distribution

Villagers reported common rules related to the use and distribution of water. One-fourth of the FES focus communities reported having rules to prioritize different types of water use (Figure 7, [S_4]). Typically, the order of priorities for the communities is water for livestock, drinking water, and domestic use. A common rule prevented people from outside the community from using CWI water. It was found that villagers plan water use following the closure of the dam gate by the end of the rainy season [S_1]. Almost half of the FES focus communities designed water allocation rules (Figure 7,[S_4]).

Three communities revealed that the planning is done by the panchayat; one group mentioned the importance of elders and traditional leaders in the planning, and three respondents highlighted the importance of community meetings in this process [S_3]. Water user groups seemed to have been active, especially in communities that received external support. Natural resource committees in three communities initiated the preparation of water use rules [S_1].

Community key informants reported that during community meetings estimated available ground and surface water are

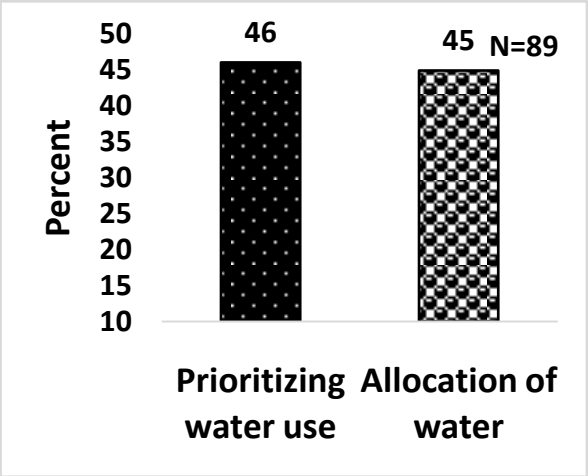

Fig. 7: Frequency of CWI water usages rules reported in communities

distributed to different uses, ensuring there is enough left in CWI for domestic use and fishery. Water for irrigation is only released once basic water needs are met. In three communities, water user groups took a call on the crop to grown depending on the estimated availability of water [S_4]. Also, rules regarding when private pumps could lift water were made. In order to maintain a certain level of water in CWI for the dry season, the community restricted water use during certain months. Once the water level falls below a threshold, water use restrictions are imposed [S_3]. In some communities, the Natural Resource Committees allocate water as long as sufficient water is available. In some communities was reported that priority is being given to community members who cultivate water-efficient crops leading to an expansion of the cultivated area in the post-rainy season [S_4].

Another restriction imposed was pumping water into tanker trucks. It is not clear how far this rule was complied with as there are very few reports of fines imposed on people lifting water at the wrong time of the year [S_1andS_3].

Communities also formulate rules on the use of silt removed from CWI. Only community members were allowed to take silt from the community water resources [S_3]. Preference was given to farmers whose farms had poor soils [S_4].

Few conflicts were observed among community members regarding benefit allocation from common water resources. Upstream-downstream conflicts were reported, especially during the dry season. In one community, three upstream farmers extracted large amounts of water from the CWI to cultivate a water-intensive crop, creating conflicts within the community [S_4]. In one case, the panchayat was limiting water extraction across a topographic gradient and charging fines if rules were not complied with. A particular case of fish dying in a tank created conflicts between farmers and other community members, with fishermen laying the blame for this on the washing of livestock. As a

consequence, the panchayat banned all kinds of washing - even of clothes – in that tank [S_1]. In another community, conflicts arose between fishermen and farmers, with the former wanting sufficient water levels for the fish and the latter wanting to usewater for irrigation. This was resolved with the panchayat permitting the irrigation of fields, on the condition that farmers ensure the maintenance of water level in the CWI for fish [S_1]. In a very similar way also different habitations of the same community got into conflicts. The issue was negotiated and the two groups jointly formulated rules to jointly maintaining the CWI and placing restrictions on how much water farmers may pump for irrigation [S_4].

Flooding also cropped up as a problem related to CWI maintenance. At one site, fields near a water body got waterlogged due to heavy rain. To do away with excess water, farmers opened the CWI gates without the panchayat's permission, causing flooding further downstream. This case could not be solved locally and had to be taken to the magistrate's office [S_4].

CONCLUSIONS

Our assessment confirmed that CWI in Mandla district of Madhya Pradesh state in India is in a poor state. Interestingly, there is sufficient evidence that at least some communities have rules related to water and CWI management. There is even evidence that some farmers invest in maintaining the structures. However, the evidence is not reflected in the state of the infrastructure. This result can be explained in two ways: (1) the inadequacy of the maintenance work done and (2) the function between maintenance work and functioning of infrastructure has an S-shape and the farmers' investments do not reach a level where it shows impact. The inadequacy of the maintenance would imply that better engineering advice is required. Current extension support seems to be the strongest in this field. The second explanation leads to the conclusion that maintenance efforts need to be increased calling for institutional development.

The assessments of benefits received from CWI indicate that a wide range of benefits are or could be enjoyed at the local scale. From this follows that also social dilemmas related to enhancing the infrastructure and appropriating water from it appear to a significant degree at the local scale. This calls for stronger local institutions and self-organization to resolve the poor management.

Our institutional assessment confirms the great scope to improve water and water infrastructure governance. There are multiple examples of rules related both to the maintenance of water infrastructure and the utilization of water. Hence possible solutions are not far to seek. It is remarkable that the most widespread standard institution of most watershed projects – namely the establishment of water funds – was not prominently mentioned in any of our data sets. There is evidence that such funds often undermine farmers' willingness to contribute to maintenance (Bouma, 2008). This is unfortunate. The funds could play an important role in addressing the challenges of insufficient or inadequate community maintenance work. Communities seem mobilize quit well labor contributions. These efforts are in recent years supported by the Mahatma Gandhi National Rural Employment Guarantee Act Scheme (MGNREGA). Yet, it remains a challenge for farmers to raise funds for materials which need to be purchased. The water funds could fill this gap but it seems that communities are too insecure to use the funds which often lie idle in bank accounts.

We need to better understand under which conditions communities manage to establish effective water governance that offers economic growth, productivity gains, and protection from the potential negative impacts of climate change. We further need stronger instruments to support participatory institutional change processes which ensure that rules fit to the local context and are owned accepted by specific communities (Falk et al., 2019; Bartels et al., 2019).

ACKNOWLEDGEMENTS

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APPENDIX-1

Questionnaire for the baseline assessment of actual management practices of stop dam management in Mandla District MP/India

Informed Consent: It is necessary to introduce the community members to the survey and obtain the consent of all prospective respondents to participate. The prospective respondent should be community leader, Water User Association members, and farmers. Be sure to obtain verbal consent before interviewing them.

My name is _____ and I am part of a research team from International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), and Foundation for Ecological Security (FES). We are working on the project having main objective to enhance sustainable water management at scale by improving capacities of the rural communities.We have selected 90 communities randomly for our research from Bichiya block of Mandla district of Madhya Pradesh. Out of these, in 60 communities we are playing an experimental game related to managing the surface water. This survey includes questions about the management (rules for maintenance, benefit allocation) of common water resources in your community. This discussion will last for approximately 30-45 minutes.

Your participation in this study is completely voluntary, and you may leave the discussion at any time. The questions are not personal or sensitive, they are about the community in general. Nevertheless, you are free to refuse to answer any questions if you feel uncomfortable. You are free to leave at any time, but your assistance in answering all our questions will help us greatly and is very appreciated. You may ask us any questions about the study before agreeing to participate, or at any point during the discussion. This discussion is for research purposes only, and all the information obtained will be kept safe in our files. You will not be identified in any presentation of the study reports. Only our study team ICRISAT, and FES will have access to the data, and all personally identifiable information will be erased after publication. Don't worry about trying to think about a "right" or "best" answer. We are very interested in your knowledge and experiences, as we do not know much about this area. Please just share with us any of your thoughts or ideas.

Village name : _____

Date : ___/___/___

Interviewer : _____

Interview partner

- □ Village leader/Panchayat
- □ Farmer/Dam user
- □ Water User Association member
- □ Other (Specify)

1. **Has your stop dam received any maintenance within the last 12 months?**
   - □ Yes
   - □ No
2. **If yes, please state briefly what kind of activities have taken place?**
   - □ Removing silt
   - □ Repairing the earth walls of the dams
   - □ Removing vegetation
   - □ Repairing the main wall of the dam
   - □ Repairing sluice gates
   - □ Other (please list in bullet points)
3. **Within the last 12-month, which groups or organizations contributed to the maintenance of the dam?**
4. **Within the last five years, which groups or organizations contributed to the maintenance of the dam?**
5. **Are there any rules or common practices related to the maintenance of the dam? Please describe them as detailed as possible.**
6. **Do you remember any traditional old rules or common practices for dam management around your place? Please describe them!**
7. **Please list all types of benefits anybody enjoys related to the dam!**
8. **Within the last 12 month, which individuals, groups or organizations received water from the dam? (Please name the households who used the dam water for irrigation.)**

Individuals, groups, or organizations	Purpose of water use

9. **If the dam is not used for irrigation, could it potentially be used for irrigation?**
   - □ Yes
   - □ No

10. Are there any rules or common practices related to the water extraction? Please describe them!

11. Have there been any conflicts around the dam within the last 5 years?

In addition, it would be good if some engineer could give a rating of the dam condition and an estimate of the amount the specific dam can store when being well maintained (can be rough estimate).

Capacity reduced due to siltation	□ *Not* □ *very little* □ *little* □ *much* □ *very much*
Capacity reduced due to overgrowing vegetation	□ *Not* □ *very little* □ *little* □ *much* □ *very much*
State of the earth walls	□ *very good* □ good□ fair□ poor□ *very poor*
State of the main wall	□ *very good* □ good□ fair□ poor□ *very poor*
State of the sluice gates	□ *very good* □ good□ fair□ poor□ *very poor*
State of the feeder channels	□ *very good* □ good□ fair□ poor□ *very poor*

APPENDIX-2

Questions asked to individual game participants before the game session:

Question	Response options
Age	1. Youth (15-24) 2. Adult (25-64 years) 3. Seniors (65 years and over)
Sex	1. Female 2. Male 3. Other
What is the highest education level you have completed?	1. None 2. Primary 3. Secondary 4. Highschool 5. Associate or College 6. Post graduate
Do you have a role in the community	1. yes 2. no
If the previous question was answered with yes, which role do you have?	
Did you contribute over the last 12 month labour into dam maintenance?	1. yes 2. no
Did you contribute over the last 12 month money into dam maintenance?	1. yes 2. no
If the previous question was answered with yes, how much did you invest into the dam in the last 12 month?	
Did you received water for irrigation from dam in last 3 years?	1. yes 2. no
How many people have their field between your field and the dam?	
Size of your field in acres	
Over the last three month, when you needed help on your field or in the household, which of the other players did you ask for help?	

Questions asked to group of game participants after the game session:

1. What do you think about the game?
2. What do you learn for your real life?
3. Are people in real life jointly maintaining old dams or trenches?
4. How do you think could the rules of the game be changed in order to achieve a better result?

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