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The right to water in rural Punjab: Assessing equitable access to water through the Punjab rural water supply and sanitation project

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Abstract

Although India is poised to meet its Millennium Development Goal for providing access to safe drinking water, there remains a worrying discrepancy in access between urban and rural areas. In 2006, 96% of the urban population versus 86% of the rural population obtained their drinking water from an improved water source. To increase access to potable water in rural areas, the World Bank and the state of Punjab have implemented the Punjab Rural Water Supply and Sanitation Project (PRWSS) to improve or construct water supply systems in 3,000 villages deemed to have inadequate access to clean drinking water. This study aimed to examine whether the right to water was fulfilled in six towns in rural Punjab during implementation of the PRWSS. The normative content of the right to water requires that water be of adequate quantity, safety, accessibility, affordability, and acceptability in terms of quality. While our findings suggest that the PRWSS improved water quality, they also indicate that access to water was limited due to affordability and the low socioeconomic status of some people living in the target communities.

Introduction

> Access to safe water is a fundamental human need and, therefore, a basic human right. Contaminated water jeopardizes both the physical and social health of all people. It is an affront to human dignity.
> —*Kofi Annan, former United Nations Secretary-General*[1]

Worldwide, 884 million of 6.7 billion (approximately one in eight) people do not have access to clean drinking water.[2] Although access to safe drinking water has increased in recent years, substantial improvements are required to reach the Millennium Development Goal (MDG) of halving the proportion of individuals without sustainable access to safe drinking water by 2015.[3]

In India, the percentage of the population using improved drinking water sources (defined as household connections, public standpipes, boreholes, protected dug wells, protected springs, and rainwater collections) in 2006 was 89% (96% urban, 86% rural) compared with 81% (85% urban, 79% rural) from 1990 to 1998.[4] Given these improvements, it is likely that India will meet its aggregate level MDG target for clean water by 2015 (overall 91%).

Yet while India has been on track to meet its MDG goal, nearly 130 million people in India still do not have access to clean water.[5] This suggests that approximately 14 million children under the age of five are exposed to unsafe drinking water and are thus at high risk for diarrheal disease and mortality.[6] In fact, India's worldwide rank of 49 for the under-five child

mortality rate has not changed from the *State of the World's Children* report in 2000 to the report in 2010.[7,8] Additionally, disparities have been observed for access to adequate sanitation in India. In 2008, the UNICEF Joint Monitoring Programme estimated that approximately 54% of the urban population had access to improved sanitation, whereas only 21% of the rural population had access (defined as facilities that ensured adequate separation of human excreta from potential drinking water sources).[9]

The right to water framework

According to the UN Committee on Economic, Social, and Cultural Rights, an individual's right to water includes "sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic issues."[10] Fulfillment of the right to water requires water that is available, of sufficient quality, and accessible. Water availability is defined as having enough water for personal and domestic issues, including food preparation, sanitation, and washing clothes. Water quality is defined as being free from substances, including microorganisms, chemicals, and other hazards that threaten a person's health. Finally, water accessibility is defined as physical and economic access to water. Thus, a person should have enough water for personal and domestic issues (water availability) and this water should be safe (water quality), regardless of cost (water accessibility). For many in India, there are threats to all three elements of an individual's right to water: a decrease in water availability, a lack of access to water—particularly in rural areas, and potential threats to water quality.

Background on water programs in India

The government of India has long recognized the lack of access to clean water as a major problem. Under the Indian Constitution, water supply and sanitation are the responsibility of each respective state within India, although the first national water supply and sanitation program was introduced as part of the government's health plan between 1951 and 1956.[11] By the mid-1960s, the national government had requested states to identify villages with scarce water supplies that were geographically difficult to access. The Accelerated Rural Water Supply Programme introduced in 1972 (later replaced by the Minimum Needs Programme in 1974 and 1977) provided grants to states for implementing rural water supply programs in rural and inaccessible locations.[12] Although these programs and policies have improved rural water access, there still remains large variation in access between states. For example, though the first National Water Policy for India was adopted in May 1987, there are currently no official state water policies in Punjab, with the most recent draft written in 2008.[13] In the state of Maharashtra, the first official water policy was not enacted until 2002, but previous laws enacted in the 1980s focused on local participation by emphasizing the role of farmers in water supply management.[14]

Although states are largely responsible for the water supply in their jurisdictions, two national ministries, the Ministry of Rural Development and the Ministry of Housing and Urban Poverty Alleviation, serve in advisory capacities and have limited roles in financing and designing programs. Nevertheless, local city water boards, parastatals (organizations that are partially or wholly government-run) in urban areas, or community committees in rural areas carry out most water supply projects.[15] Water access and quality remain highly variable on a regional level, in part related to the multiple actors responsible for water delivery.

More recently, India has been trying to address the problem of access to water by increasing water supply and reducing extraneous water use. To achieve these ends, many institutions have encouraged a transition from government-led supply driven projects to decentralized projects driven by local demand. This has been applied to World Bank-sponsored initiatives in India, beginning with the Karnataka project in the early 1990s and continuing with projects in Uttar Pradesh, Andhra Pradesh, Tamil Nadu, Madhya Pradesh, and Maharashtra.[16] In general, these projects have been successful in increasing the number of people using upgraded water sources, but the impact on health and hygiene-related behavior has been varied. In Maharashtra, the project increased the number of marginalized households using piped water but did not have any effect on hand washing, home water treatment, or diarrheal disease.[17] In contrast, a program in Maharashtra in the 1990s documented reductions in the incidence

of diarrhea. However, for this program, improved health was found to be associated with participation in hygiene classes, suggesting that health education may play an important role in the effectiveness of water improvement programs.[18]

Punjab Rural Water Supply and Sanitation Project

With respect to water supply in rural Punjab, water accessibility has increased via the development of hand pumps in rural communities. Such publicly funded rural water supply projects include the Minimum Needs Project, Accelerated Rural Water Supply Program (1972-73), Rajiv-Gandhi Submission Program, and Swajaldara (1999). However, due in part to persistent problems with access and the potability of the water obtained through the hand pumps, the World Bank approved credit for the Punjab Rural Water Supply and Sanitation Project (PRWSS) in December 2006.[19] This project focused on transitioning away from past state-led projects toward a model where operations, maintenance, and funding are decentralized to the village level.

The primary aim of the project was to improve the water supply in 3,000 villages in Punjab that were deemed to have less than full coverage, defined as less than 40 liters per person per day. To become part of the PRWSS program, villages had to be willing to invest 10% of construction fees, and thereafter generate the funds to cover all expenditures for the operations and maintenance associated with ensuring an adequate water supply. The 10% up-front investment for construction was reduced to 5% in villages where more than 50% of the population was from a historically disadvantaged group. In situations where the water supply upgrade entailed the construction of a water pump, the village had to be willing to donate the requisite land. Each selected village was also required to form a local water committee, the Gram Panchayat (local government) Water and Sanitation Committee (GPWSC), responsible for oversight of the project, including selection of technologies, collection of funds from the village, arranging construction, and ensuring ongoing operation and maintenance. At the household level, gaining access to the village's upgraded water supply required a number of fees, including a security fee—although a reduced security fee is allowed for underserved villages or populations—as well as funding for construction of a water tap, piping, and a monthly service fee of approximately Rs100 ($2.14 USD).[20] Upon project approval, local contractors would construct and maintain the water scheme, in contrast to past projects where state engineers carried out these tasks.[21]

While similar projects have been implemented throughout rural India and have enhanced rural access to water, few studies have assessed whether these projects have improved attainment of the right to water in terms of availability, accessibility, and quality. In an economic evaluation of the World Bank program in Maharashtra, Pattanayak and his colleagues concluded that the number of households using piped water and private pit latrines increased due to this project, with socially marginalized people benefitting most from the increase.[22] However, this study did not examine the quality of the water provided by the program versus publicly available water to ensure that water availability, quality, and sufficient quantity existed for everyone.

The purpose of this study was to examine whether the right to water was realized among those living in villages included in the PRWSS World Bank program in Punjab. In particular, the study assessed the quantity, accessibility, safety, affordability, and acceptability of quality of water according to the UN human rights-based framework.[23] The study also examined the degree of equity in the realization of the right to water in a rural area in Punjab targeted by the PRWSS project; this was accomplished by disaggregating the assessment of the right to water by participants' socioeconomic status.

METHODS

Setting

The study area included six rural villages in the northwestern Indian state of Punjab. The selection of villages was based on their having incomplete water supply coverage and representing geographically distinct areas of the state. The villages selected from the Ludhiana district in central Punjab were Rajoanna Kalan, Malsian Bhai Ke, and Barsal. The villages selected from the Gurdaspur district, along the India-Pakistan border, were Mastafapur and Kot Mian Sahib. From western Punjab, the village of Babhel Kurd in the Faridkot district was selected.

Based on the 2001 census, 66% of the state's 24.3 million residents lived in rural areas, including 80% of the state's Scheduled Caste population.[24] In 2006, the mean annual per capita income of Punjab was Rs 28,605 (652 USD).[25] The majority of water supply in rural Punjab is derived from hand pumps, which are used by approximately 78% of households in the state. Despite the availability of hand pumps, in 2001 only 43% of the 14,605 households supplied by state programs met the criteria of being "fully covered," defined as having access to at least 40 liters of publicly supplied water per day.[26]

Study population and design

At the outset of the PRWSS project, the state of Punjab had classified all of the selected villages as having incomplete water supply coverage. Five out of the six surveyed villages participated in the PRWSS. While all five participating villages had initiated PRWSS projects, the degree of implementation varied by village. The villages of Rajoanna Kalan, Malsian Bhai Ke, and Babhel Kurd had initiated water services under the PRWSS project, but project completion was still pending in Mastafapur and Kot Mian Sahib. While the duration and extent of project implementation varied, all villages had completed the process of collecting security deposits from households desiring to buy into the project's services. Surveys were also conducted in the village of Barsal, which was not part of the PRWSS project.

Households in the selected villages were approached for participation in the study during mid-morning to early afternoon between June and August 2009. The study team randomly selected a point in each village and approached consecutive houses, with the goal of recruiting 300 households. From this initial target, 243 households were surveyed (more than 80%). This was largely due to residents not being home during the day when the survey was conducted. Among those prospective households that were asked to participate, more than 95% agreed to take part in the survey. To be included in the study, respondents were required to be over the age of 18 and have lived in the village for at least five years. Informed consent was obtained from all respondents and participants were interviewed by trained local volunteers. Institutional Review Board (IRB) approval was obtained from the Office for Research Subject Protection at Harvard Medical School.

Additionally, five water samples were collected from each village for microbiological analysis. Collection sites reflected the predominant sources of water use within the village. Water samples were collected based on quality control procedures from the Punjab Agricultural University using a sterile technique involving the following steps: 1) water source cleaned with alcohol-soaked cotton; 2) flame placed directly on source for 10 seconds; 3) water source run for 10 seconds; 4) sterilized glass collection containers opened under flame; 5) water sample collected; and 6) container closed under flame and delivered to the Punjab Agricultural University for same-day analysis. Samples were assessed for the presence of fecal coliform and bacteria, including *Campylobacter jejuni*, *Clostridium sp.*, *Listeria sp.*, *and Yersinia enterocolitica*. Water was considered potable if none of these contaminants was present. Consent for water sampling of household taps and community water sources was obtained from household respondents or the village head, respectively.

Assessment

Survey questions were adapted from an instrument used in a 2008 analysis of water access in Port-de-Paix, Haiti.[27] The study in Haiti also relied on a rights-based approach to water, that is, ensuring that it is accessible, affordable, and of acceptable quality and quantity.[28] Survey questions were translated into Punjabi and modified for local relevance using focus groups with rural village residents. Survey questions included assessment of socio-demographic characteristics, economic status, the local water supply, household patterns of water usage and treatment, costs of water, sanitation, hygiene, and general health status. To examine participatory development (community engagement in the process of water supply selection, implementation, operation, and maintenance) of the local water system, respondents were asked about their awareness of village water operations and means of voicing complaints regarding the water supply. In villages where PRWSS projects had

been initiated, the survey explored participation in the new system, and if applicable, reasons for not participating. Participation was defined as living in one of the five villages participating in the program (all except for Barsal) and households contributing funds to "buy into" the program. Based on the study questionnaire, low socioeconomic status was established as not having a toilet in the home, having roof made of thatch or "other" material, or having walls made of mud or "other" materials. Within the self-reported data on the questionnaire (that is, without microbiological analysis), water from an unimproved drinking-water source was defined as being obtained from hand pumps or unprotected wells. Improved drinking water sources included a household connection, protected well, or rainwater. This definition of improved drinking-water source was based on the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP) framework and adapted for the local context (where some categories of the JMP definition did not apply to the target area, and with the corresponding knowledge that hand pumps in the area did not necessarily provide safe drinking water).[29]

Statistical analysis

Table 1: Descriptive statistics of demographic and socioeconomic characteristics of study population

Demographic Information		**Percent or Mean (Range)**
Gender of survey respondent, n= 241*	Female	59.3
	Male	40.7
Number of members in the household, n=243		5.7 (1-16)
Gender of head of household, n=243	Female	33.6
	Male	80.3
Socioeconomic Information		
Materials that make up roof of house, n= 224	Iron or mixed steel	29.5
	Concrete	44.2
	Thatch	17.4
	Other	8.9
Materials that make up walls of house, n=237	Mud	45.2
	Wood	15.6
	Cement	45.2
	Bricks	47.7
	Steel	5.5
	Other	4.7
Toilet in house, n=232	No	39.2
	Yes	60.8

*Sample size less than n=243 reflects missing data.

The data were analyzed using SAS Version 10.1 and descriptive statistics were generated, including frequencies/percent for categorical variables and mean/range for continuous variables. Univariate analyses were also performed to examine the association between program participation, roof, housing, or having an indoor toilet and a number of outcomes, including water quality, quantity, knowledge about the program's status, and health status.

Results

The majority of the 243 respondents of the survey were female (59.3%), although the head of household was predominantly male (80.3%). The level of poverty was significant, as reflected by 45.2% reporting that mud was a component of their walls; 17.4% reported thatch in their roofs, and nearly 40% did not have a latrine in their home (see Table 1). With respect to access to water, the primary sources of water included hand pumps (69.9%) and household tap connection (32.6%). Nearly 58% reported that the quantity of accessible water had decreased in the past five years.

Although the majority of respondents reported having access to water, it is unclear to what extent the water was potable. Approximately 39% reported that the quality of water had decreased over the past five years. However, 61% indicated that the quality

Table 2: Accessibility and quality of water

Water Accessibility		**Percent**
Sources of water (where respondents most frequently obtain water)	Private connection n=224*	32.6
	Hand pump, n=229	69.9
	Public connection, n=230	1.7
	Rainwater, n=230	0.44
	River and spring, n=239	0.41
	Other, n=229	3.1
Has water quantity increased or decreased in past five years? n=210	Increased	20.5
	Decreased	57.6
	Can't say	17.6
	Stayed the same	4.3
Water Quality		
Has water quality increased or decreased in past five years? n=233	Increased	61.4
	Decreased	38.6
Reported treating water, n=200	Never	66.0
	Sometimes	17.5
	Often	6.0
	Don't know	10.5
Have access to materials needed to treat water, n=134	Never	50.8
	Sometimes	15.7
	Often	8.2
	Don't know	25.4

*Sample size less than n=243 reflects missing data.

Table 3. Affordability of water: Household survey results

Water Affordability		Percent
Change in price of water over 5-year period, n=193*	More expensive	67.9
	Less expensive	8.3
	Stayed the same	4.3
	Can't say	17.6
How much do you pay per month for the new connection? n=102**	50-100 Rs	92.2
	100-150 Rs	6.9
	150-200 Rs	0
	200-250 Rs	0.98
If connection was cheaper, would you have gotten it? n=148**	No	21.6
	Yes	78.4
If you think you can't afford the connection, give reasons why not, n=110**	Very costly	74.6
	You need money for other uses	14.6
	Money spent on medical expenses	3.6
	Money spent on social obligations	7.3
If you can't pay for the connection, what do you do? n=129**	Use a hand pump	83.0
	Borrow water from neighbors	15.5
	Take water from rivulet/water channel/etc.	1.6
If water is made available at all times, are you willing to pay more? n=176**	Yes	40.9
	No	59.1

*Sample size less than n=243 reflects missing data.
**Only towns with World Bank project were included.

had improved during this same time period, which may be partly due to the PRWSS program initiated in 2006. Nearly 63% of respondents reported that they had never treated their water and 10.5% indicated that they didn't know if they treated their water. More than 50% mentioned that they never had access to materials for treating water (see Table 2).

Affordability was also an important factor for respondents in deciding to participate in the program. Approximately two-thirds (67.9%) reported that the price of water increased over the past five years, with a majority of respondents from towns with the PRWSS program reportedly paying 50 to100 Rupees per month. Within the towns receiving PWRSS, 78.4% of respondents said they would have gotten the connection if it were cheaper, reporting the costly connection (74.6%) and the need to use money for other purposes (14.6%) as key factors in why they could not afford the connection. Of those who could not pay for the connection, 83% used a hand pump as their water source (see Table 3).

Participation in the program

Participants who were enrolled in the World Bank program were more likely to have toilets in their houses (Odds Ratio (OR): 2.0; 95% Confidence Intervals (CI): 1.2- 3.6, p=0.01) and more likely to have access to potable water (OR: 3.2; 95% CI: 1.9-5.5; p<0.0001). In addition, participants in the program also reported an improvement in water quality in the past five years (OR: 1.4; 95% CI: 1.1-1.8; p < .01). Additional information on variables associated with program participation is presented in Table 4. Based on this analysis, factors related to participation in the PRWSS program included access

Table 4. Demographic, socioeconomic, and water accessibility characteristics, by program participation

Demographic Information		Participation % or Mean (Range) n=106	Non-Participation % or Mean (Range) n=137	P-value
Gender of survey respondent, n= 241*	Female	48.1	41.6	0.317
	Male	51.9	58.4	
Number of members in the household, n=243		5.7 (5.2, 6.1)	5.7 (5.3, 6.1) 0.87	
Gender of the head of household, n=243	Female	80.2	80.3	0.98
	Male	19.8	19.7	
Socioeconomic Information				
Materials that make up roof of house, n= 224	Iron or mixed steel/	49	56.4	0.27
	Concrete/			
	Thatch/Other	51	43.6	
Materials that make up walls of house, n=237	Mud/	57.6	49.6	0.23
	Wood/ Cement/ Bricks/ Steel/ Other	42.4	50.4	
Water Accessibility				
Sources of water: Where respondents most frequently obtain water	Improved drinking water source, n=229	53.7	11.3	0.0001
	Unimproved drinking water source	46.3	88.7	
Has water quantity increased or decreased in past five years? n=173	Increased/same	41.1	22.0	0.0068
	Decreased	58.9	78.0	
Water Quality				
Has water quality increased or decreased in past five years? n=233	Increased	70.9	53.9	0.008
	Decreased	29.1	46.1	
Reported treating water, n=200	Never	63.0	62.04	0.29
	Sometimes	13.0	21.30	
	Often	5.4	6.48	
	Don't know	13.0	8.33	
Have access to materials needed to treat water, n=134	Never	53.9	48.8	0.0907
	Sometimes	7.7	20.7	
	Often	13.5	4.9	
	Don't know	25.0	25.6	
Report of gastrointestinal problems in the past two years n=223	Yes	52.0	66.4	0.0298
	No	48.0	33.6	

*Sample size less than n=243 reflects missing data.

to an improved drinking water source and reporting that water quality had increased or stayed the same in the past five years (reflecting the time period of the program). In addition, having access to materials needed to treat water and indicating that water quantity increased or stayed the same in the past five years were associated with program participation, although these factors were marginally statistically significant (see Table 4).

Socioeconomic status and water accessibility and quantity

Study participants who reported having walls made of mud or "other" materials were more likely to say that the price of water had increased in the last five years than those who reported having walls made of wood, cement, bricks, or steel (OR: 2.3; 95% CI: 1.4-3.8; $p < 0.001$). People who had mud or "other" walls were also more likely to report that they would have gotten the PRWSS connection if it were cheaper than respondents who had wood, cement, bricks, or steel walls (OR: 2.3; 95% CI: 1.1 – 5.8; $p < 0.05$). Respondents who had a toilet in their house were more likely to be willing to pay more if water were available at all times than those who did not have a toilet in their house (OR: 0.78; 95% CI: 0.61-1.02; $p = 0.07$). In addition, those with toilet facilities in their homes were more likely to know who to approach to make a formal complaint or speak with someone about water (OR: 0.77; 95% CI: 0.61-0.96, $p < 0.05$).

Socioeconomic status and water quality

Respondents who had walls consisting of mud or "other" materials were also less likely to report sometimes treating water than those who had walls of wood, cement, bricks, or steel (OR: 1.6; 95% CI: 0.93-2.7, p=0.09). Also, respondents who had roofs made of iron, mixed steel, or concrete were more likely to have access to an improved drinking water source compared with those who had roofs made of thatch or "other" (OR: 0.55, 95% CI: 0.36 -0.84, $p <0.01$). Respondents who did not have a toilet in their house were more likely to report that water quality has decreased in the past five years compared with respondents who had a toilet in their house (OR: 1.4; 95% CI: 1.1-1.7, $p < 0.01$).

Results from water sample analysis

A sample of water was taken from water tanks associated with the World Bank project, public hand pumps at different depths, and wells in Malsian Bhai Ke, Barsal, Kot Mian Sahib, Mastafapur, Rajoanna Kalan, and Babel Khurd. In Malsian Bhai Ke, the water tank associated with the World Bank Project was potable, defined as being devoid of coliform and assayed microbiological contamination, while a household hand pump that was ten feet from the latrine with a reported depth of 80 feet was not potable, containing traces of coliform and *Listeria sp.* Water from sampled private taps in Malsian Bhai Ke was found to be potable. In Barsal, two of four sampled household hand pumps were not potable, with both containing coliform and one contaminated with both *Listeria sp.* and *Y. Enterocolitica*. Additionally, a public water source using a submersible pump was found to be non-potable. Submersible pumps are used to actively pump water from depths greater than those accessible by hand pumps. Unlike publicly funded hand pumps, the submersible pumps are generally purchased by the household. In Rajoanna Kalan, two of the four sources—a water tap and a public hand pump—were not potable due to *Y. Enterocolitica* contamination and traces of coliform, respectively. The other two, a tap pit and a source from the World Bank project, were potable. In Kot Mian Sahib, two of three household hand pumps and two out of two submersible water pumps were not potable and were positive for traces of coliform. In Mastafapur, all five tested water sources—including a submersible pump and hand pumps—were not potable and tested positive for coliform. These descriptive results indicate that while nearly all of the World Bank-associated water sources were potable, other sources of water, including the commonly used household hand pump, are frequently not fit for consumption.

DISCUSSION

The findings from this study indicated that the World Bank program in Punjab, India did not fulfill the right to water for all citizens in participating villages. Although the PRWSS project has generally demonstrated an ability to improve access to improved water sources for those who enroll, there was a substantial number of non-participants. This group was more likely to be poor—as indicated by

not having toilets in their homes. Thus, for PRWSS to ensure that everyone in the target areas fully realizes their right to water, increased emphasis should be placed on expanding coverage of the program for households that are more impoverished to recognize and address existing structural inequalities that may impede prospective participants' right to water.

Water quality

While still in its early stages of implementation, the water supplied by the PRWSS project appeared to be of good quality. PRWSS members regularly inspected the water tanks in each village for quality. However, the quality of the publicly available water was compromised, with the majority of samples being non-potable. Specific chemicals such as arsenic were not included in this study, but there was a significant presence of coliform and other bacteria. In addition, all five water sources from Mastafapur—including submersible water pumps—tested positive for coliform. The findings of poor water quality from hand pumps in these towns were consistent with other studies that have also found pollutants in water throughout India.[30] Furthermore, these findings were consistent with participants' self-reported assessment of water quality, where participants in the program reported an improvement in water quality over the past five years compared to respondents not participating in the program.

There was one case where a private water connection established by the PRWSS project was found to be non-potable. This sample was taken from a household in Babhel Kurd, a village where many residents voiced frustration with a local company contracted to construct the water supply system. In interviews, several households that had bought into the program and were located on the opposite end of the village from the central water supply complained that there was little to no water flow, and when water did flow it appeared to be discolored and filled with soil. In addition, residents did not know who to go to in order to voice their concerns. Unlike past water supply projects, which were provided through state or national bodies, PRWSS contracted construction out to local companies. However, given the geographic variability in industry, wealth, and population density across Punjab, the new construction format may have permitted village-level disparities in access to the new water supply projects based on the local economic and social inequalities across rural Punjab. These local disparities may also reflect the long-term structural inequities experienced by different social classes in India, that is, those who were living in poverty or had less socioeconomic resources historically were also less able to buy into the demand-focused design of the PRWSS.

The self-reported improvement in water quality appeared to be consistent across several World Bank projects. In Karnataka and Maharashtra, respondents self-reported that their health improved, although this varied by province—Karnataka reported an average improvement of 45% while Maharashtra reported an improvement of 54%.[31] These self-reported health improvements were also reflected in a decrease in the number of reported diarrhea cases. Additional research on World Bank projects in Karnataka and Uttar Pradesh comprised of 1,523 households found that 68% of households in Karnataka and 70% in Uttar Pradesh reported being satisfied with the new water provision scheme.[32]

Water access, availability, and quantity

Over 57% of respondents reported that the water quantity had decreased in the past five years, suggesting that the general accessibility of water may be at risk in future years. This decrease is likely to continue, as 103 of the 137 geographically defined blocks of groundwater in Punjab (out of the total 839 blocks in India) were declared over-exploited and nine were declared critical or semi-critical.[33] This lack of groundwater availability will be important when implementing current programs or planning future water projects to ensure adequate access to water in India.

Evidence from this study suggests that the PRWSS project had been successful in expanding clean water supply into rural villages. Of the households surveyed in villages covered by a PRWSS project, approximately 40% had contributed money. This substantial enrollment rate is indicative of the demand for clean water access, despite the fact that water supply was only made accessible for less than three hours a day. In Karnataka and Uttar Pradesh, 48% and 81% of the households in the respective villages had contributed to the project.[34] When including those households that did not buy into the project for financial reasons, approximately 99% of households in towns covered by PRWSS demonstrated interest in

an upgraded water supply.

For those households that did not buy into the upgraded water supply, high costs appeared to be the predominate barrier to enrollment. Approximately 78% of eligible households that did not enroll stated that they would have joined if obtaining a connection were less expensive. Thus, not surprisingly, disparities in access to the upgraded water supply seemed to fall along socioeconomic lines. Using existence of a household toilet as a proxy for socioeconomic status, the non-enrolled group was disproportionately composed of poorer households. For households to enroll into the upgraded water supply, they were expected to pay a security deposit that is generally less than Rs. 1000 (US$22.50), a monthly payment of less than Rs.100 (US$2.25), and a highly variable cost for actually constructing a tap and a connection to the central water tank that may exceed Rs. 2000 (US$45). While subsidies that reduced security fees by half were in place for underserved villages and scheduled caste populations, there were no such subsidies in place for monthly fees or construction expenses. The combination of a security deposit and construction fees could have resulted in a significant upfront financial burden that may have served to deter poorer households from accessing the program.

Water supply programs: Where do we go from here?

Enrollment fees for rural water supply services have been shown to be inversely related to the financial sustainability of a project.[35] In the context of Punjab, these findings may suggest that the cost of enrollment, which may have prohibited some individuals from accessing the program, may be detrimental toward the project's long-term sustainability. While few respondents complained about the monthly charges, several commented that construction fees were unaffordable. Given the potentially high up-front fees faced by poor households, subsidies targeted toward construction costs may be warranted.

Previous work has suggested that households' contribution toward the capital costs of water services is positively related to equity of access within the village.[36] An increased sense of ownership and capacity to promote access to water by underserved populations may result in equity improvements. The gains in equity may be accounted for by an increased sense of ownership over the water service and stronger grounding to oppose curtailment in services amongst underserved groups.[37] An alternative strategy may involve village water committees paying the upfront construction costs and recovering the costs through interest-free repayments with a monthly service charge. Through this arrangement, villages may adjust payments to a locally appropriate rate and promote a sense of ownership over the water service. The committee would have an incentive to help households overcome enrollment fees so that membership in the project can be expanded. Increased enrollment would improve monthly cost-recovery and promote the financial sustainability of the project. The current evaluation rubric for PWRSS projects does not assess the number or percentage of households in a village that have received taps, providing little incentive for villages to create innovative mechanisms to maximize coverage.[38] An addendum of metrics or incentives that promote full coverage of households within a village may foster innovative thinking on how to help all households gain access to an upgraded water supply.

Given these findings, water quality may be a significant concern for households that are unable to buy into an upgraded water supply. Based on the survey data, poorer households were more likely to be dependent on hand pumps or unprotected wells for their water usage. Unlike higher-income households that may elect to defer joining the project based on satisfaction with water drawn from costly submersible pumps, poorer households were largely dependent on free water sources most at risk for poor quality, susceptibility to depletion, or contamination with pesticides or pathogens. Given the descriptive data about the poor water quality provided by hand pumps, submersibles, and wells, households that were unable to buy into the PRWSS water supply were left dependent on a potentially unsafe water supply.

While operations and maintenance responsibilities were decentralized to the village level, it is unclear whether the PRWSS project adequately engaged local communities in decision making. One of the potential benefits of decentralization was to promote participatory development by transferring responsibility and accountability to the village Gram Panchayat, and the GPWSC. The localization of control to the village level potentially made water supplies more responsive to village needs and increased accountability for sustainable water supply.[39] Despite these potential benefits, 60.3% of those surveyed in all villages did not know who to

go to in order to issue a formal complaint regarding water supply. These data suggest that households may not be adequately informed about local operations and means of voicing their concerns. Non-enrolled households were found to be less likely to know where to go with a formal complaint regarding the water supply than enrolled households. While the directionality of this association is difficult to discern, it is concerning that households dependent on the non-upgraded water supply were less likely to know where to go to voice their concerns.

This potential disparity in awareness raises the question of whether the model of decentralization currently employed in the PRWSS project is sufficient to promote participatory development. While Punjab is among the most affluent states in India, significant disparities in land ownership and income do exist within rural villages. The 2005 GINI coefficient for rural Punjab was .253, with the lowest 40% of rural households spending Rs. 441 per month, as compared to Rs. 1295 per month by the richest 20%.[40] The combination of disparities in income and information regarding the water supply system may place the projects at increased risk for capture by local elites.[41] While participatory development is a key component of PRWSS projects, the evaluation criteria for individual projects do not directly assess community education or awareness.[42]

There are several limitations of the present study. First, the results are based on a cross-sectional survey due to resource constraints. A longitudinal assessment of the introduction of the PRWSS program and the right to water outcomes would yield a more rigorous analysis. Second, the recall period for gastrointestinal problems of two years is long and would possibly result in random misclassification, since it may be difficult to remember brief periods of gastrointestinal illness during that time frame. However, this type of misclassification biases the results towards the null, when a significant association was observed between self-report of gastrointestinal problems and program participation. Third, although the selection of water samples for microbiological analysis was not representative of the water supply for the six villages and only involved 30 samples, the finding that nearly all World Bank program sources of water supply were potable, provides preliminary findings that the World Bank program was generally able to achieve the goal of safe water quality, a key concern of the target area prior to the project. Finally, it is important to note that this is not a formal evaluation of the PRWSS project. Rather, we intended to examine to what extent the right to water was achieved in a target area of the project.

In summary, the program in the Punjab region improved water quality but did not ensure that everyone had an equal realization of the right to water. Future programs in Punjab should take into account the specific barriers poor populations face in accessing the upgraded water supply and support community-devised solutions to maximize access. Assessing outcomes related to the economic sustainability as well as equal access to the program among the targeted participants may result in improving water quality as well as ensuring the right to water for the most vulnerable communities.

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22. See note 17.

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