Comparative Study of Social Fund Water Interventions

Alain de Janvry* [1] Sikandra Christian* Sahar Daer** [2]
Elisabeth Sadoulet*

June 30, 2013

[1]* University of California at Berkeley
[2]** Social Fund for Development

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Acknowledgments

We gratefully acknowledge the leadership of Lamis Al-Iryani in steering and coordinating the evaluation process. The data collection for this research marked the first use by SFD of the Open Data Kit data collection system on mobile phones. We extend our heartfelt appreciation to the team that led this implementation and resolved the technical issues involved : Ibrahim Alwazir, Mohammad Al-Mawary, and Samir Noman. We also appreciated the assistance of Tareq Yeslam in preparing the sampling frame. We are grateful to Ahmad Al-Barakani for coordination of the fieldwork and training, and to the enumerators and team leaders who worked on the ground. We would also like to thank SFD Water Unit head Abdulwahab Al-Ashwal and project officer Faisal Abdul-Aziz for advice and background on the SFD water programs. We are indebted to Pierre Rondot, Marie-Helene Collion, and Garry Charlier in providing support and funding for this research through the World Bank's Trust Fund.

Executive Summary

Water availability is an acute problem across Yemen. This report describes the contribution of SFD water project interventions to available water resources in rural areas of northwest Yemen. We focus on three different types of SFD water project interventions: piped water, rooftop (individual) rainwater harvesting, and communal rainwater harvesting. The latter two types of projects form an interesting contrast, as the choice of communal vs. individual rainwater harvesting is made by the community rather than being dictated by the geography.

A unique contribution of this report is to fully describe total water use by households by type of source and season. We find a median per capita water use of 20.9 litres per capita in the rainy season (19.4 litres per capita adjusted for livestock) and 16.3 litres per capita in the dry season (14.1 litres per capita adjusted for livestock).

We find that relative to total water use the contribution of SFD individual rainwater harvesting projects is substantially higher than the contribution of communal rainwater harvesting tanks (67% vs. 18% in the rainy season and 51% vs. 33% in the dry season). Distributional differences between the two schemes exist, but are relatively small. The share of households with only marginal benefits from rainwater harvesting schemes is lower than the share of households with only marginal benefits from communal rainwater harvesting projects, and communal rainwater harvesting schemes are slightly more pro-poor in their distribution of benefits than individual rainwater harvesting projects. On the other hand, due to placement and the potential for capture of benefits by elite farmers, there is some evidence that communal rainwater harvesting projects could also pose distributional challenges. We find that average fetching times from communal sources are lower for better-off households than for other households. We also confirm the classical economic logic that individually managed water harvesting tanks are better managed as far as balancing use between the wet and dry season and maximizing dry season availability compared to communal sources.

Within communal rainwater harvesting projects, we find that the type of management regime was strongly correlated with indicators of management quality. Communal sources managed by individuals were most efficient at far as maximizing water availability during the dry season, while sources managed by nobody were at least as good as sources managed by committees.

Chapter 1

Introduction

1.1 History and Description of SFD Water Project Interventions

We focused on three types of SFD water project interventions: piped water, rooftop (individual) rainwater harvesting, and communal rainwater harvesting. The later two types of projects are more directly comparable, as the choice of communal vs. individual rainwater harvesting is made by the community rather than being dictated by the geography.

Piped water projects are implemented in areas with sufficient ground water sources. The intervention includes setting up a committee to manage the piped water system and charges users 40-300 riyals per cubic meter.

Communal or individual rainwater harvesting projects are generally implemented in areas without sufficient ground water sources.[1] From 1999 until 2007, all communities that received rainwater harvesting projects were given the communal type. Since 2007, individual rainwater harvesting projects have been introduced and proved considerably more popular with communities. Given the choice between a communal rainwater harvesting tank or individual rainwater harvesting tanks, about 90% of communities choose the individual tank option. In general, a project officer noticed that communities that were unfamiliar with privately owned rainwater harvesting were more likely to choose the communal rainwater harvesting option.

The advantages of individual rainwater harvesting projects are decreased fetching time and efficiency gains from individual management and ownership. On the other hand, the subsidy from SFD is much smaller than for communal water harvesting projects. From 1999 until 2006, the SFD subsidy was 70-80% of the total cost of a communal rainwater harvesting project, increasing to 95-98.5% from 2007-2012. While the total project cost varied depending on the size of the intervention, it averaged about $150,000, implying that the community share from 2007-2012 was about $30,000-$45,000 or $300-$400 per household in a community of 100 households, falling to less than $75 post 2007. For individual rainwater harvesting projects, the SFD subsidy was only 20-30% of the total cost of about $5,000 per tank, implying a cost per participating household of $3000-$4000. In the communities we surveyed, on average 60% of households in individual projects owned an SFD funded rainwater harvesting system, implying a total cost of $300,000 per community, which is just about twice as high as the total cost of an average communal system, although the cost to SFD is only about half as

[1] Because of the old labeling system in the MIS, areas with communal harvesting cisterns supplied by springs are also here counted as communal rainwater harvesting projects.

much as a communal system. [2]

In this report we distinguish between two different types of communal water harvesting projects: uncovered pools and covered cisterns. Beginning in 2008, all SFD communal water projects in the northwest region of Yemen have been required to be covered cisterns in order to improve water quality.

Finally, we note as an important background to understanding water use in this region of Yemen that rainfall is concentrated in a clearly defined rainy season from approximately March to August, and there is almost no rainfall during the rest of the year.

Research Questions

This report is primarily descriptive and comparative. We are interested in comparing outcomes- both in terms of equity and efficiency- of water provision via communal or individual rainwater harvesting projects. The report is organized into five sections, corresponding to the following questions:

1. What is the average level of household water consumption in rural areas of northwest Yemen with SFD water interventions and what share of that total consumption comes provided from SFD sources?

2. How are water resources from SFD distributed in the community?

3. What is the average fetching time, and how does it vary among users?

4. How well are water resources managed to balance between rainy season and dry season consumption? How does the type of management and number of owners affect how well water is managed?

5. What is the perceived water quality of SFD sources and non-SFD sources and how does organization of maintenance affect water quality?

Data and Methodology

We surveyed 148 projects with SFD water interventions categorized as piped water, a communal water source, or individual rooftop rainwater harvesting tanks. We focused on these three categories, as they comprise the vast majority of SFD water interventions. Because a secondary goal of the data collection was an evaluation of the effectiveness of a community sanitation campaign, our sample is limited to five governorates in northwest Yemen, where this campaign was active.

Tables 1.1 and 1.2 below summarize the types and locations of projects included in our sample. Because a secondary goal of the data collection was an evaluation of the effectiveness of a community sanitation campaign, sampling was stratified by district, project type, and campaign presence. For the present evaluation, we re-weight the sample to make it representative of the total universe of water projects listed in the SFD MIS in the governorates chosen for the CLTS evaluation: Ibb, Taiz, Amran, Dhamar, and Sana'a and Mahweet. These

[2] Beginning this year, subsidies for individual rainwater harvesting tanks have been standardized at $750 for 10-20 cubic meter tanks or $1100 for 20-60 cubic meter tanks

governorates are all located in northwest Yemen, with roughly similar climatic and cultural features. Findings in this report relate specifically to this region, rather than being representative of SFD projects in Yemen as whole. We did not stratify based on timing of the water intervention. As a result, most of the communal rainwater harvesting projects surveyed were from before 2008.

For each project in our sampling frame, we administered a community survey and 21 household surveys.[3] At an initial meeting with community leaders, a participatory wealth assessment was carried out which grouped households in the community into fourth wealth categories (1=Ultra-poor, 2=Poor, 3=Average, 4=Better off). The sample of 21 households was randomly selected from the four wealth groups in proportion to the share of households in the community in each wealth group. [4]

[3]In most cases, a specific village or sub-village is identified as the beneficiary of each project. In cases where multiple villages benefited, a village or sub-village of between 50 households and 200 households in size was randomly chosen from among beneficiary communities.

[4]For the community survey, respondents and enumerators were mostly male and for the household survey respondents and enumerators were mostly female.

Table 1.1: Types of Water Projects in Sample

Water Project Scheme	Number of Projects	Number of Households
Rooftop rainwater harvesting	55	1120
Communal rainwater harvesting (cisterns/ pools)	54	1155
Piped water	39	818
Total	150	3093

Table 1.2: Geographic Locations of Sampled Projects

Governorate	Rooftop RWH	Communal RWH	Piped Water	Total
Ibb	30	8	13	51
Mahweet and Sana'a	1	4	1	6
Taiz	13	4	8	25
Dhamar	0	4	4	8
Amran	7	20	6	33

Table 1.3: Completion Date of Sampled Projects by Project Type

Year Completed	Rooftop RWH	Communal RWH	Piped Water
1998	0	0	2
1999	0	2	0
2000	0	6	6
2001	0	1	2
2002	0	8	2
2003	0	5	3
2004	0	8	0
2005	0	4	3
2006	0	7	1
2007	0	4	7
2008	1	1	4
2009	4	6	3
2010	16	4	5
2011	26	0	1
2012	8	0	2

Chapter 2

SFD Project Contributions to Water Use

2.1 Methodology

We estimate total water use based on responses in 4 sections of the household questionnaire: piped water use, rainwater harvesting tank sufficiency, payments to water trucks, and containers of water fetched from communal sources. Our estimates of water use are based on indirect approaches that rely on knowledge that female household survey respondents and male community respondents were likely to have about their use of water. We believe this method is more likely to be accurate overall, compared to asking respondents to directly estimate their use of water.

For piped water, we use the indicated volume from the past month's water bill if one is available. If no water bill is available (about 30% of households using piped water), we predict the volume of water used per capita based on a regression of water use on days per month that water is available from the piped system, governorate, wealth level, and washing machine ownership. For water from rooftop rainwater harvesting tanks, we asked the enumerator to estimate the size of the tank and asked the family the average tank level in the rainy season and how long it took to use up water in the tank during the dry season. Based on these responses, we estimate the volume of water used per month in the dry season. We divided total usage by the number of families who co-owned the source.[1] During the rainy season, the water level in the tank is periodically refreshed by the rains, so our estimate of the volume of water used is less precise. If the family indicated that water from the tank is always sufficient for household needs without economizing during the rainy season, we assume the volume used to equal a per capita rate of 30L per day plus the estimated needs of the animals that are watered at the household. The 30L per day rate corresponds to the SFD target for water availability. If the family indicated that water is sufficient for household with economizing, we assume perfect management and take the rate of water use in the dry season to be equal to the rate of water use in the rainy season. For water fetched from sources outside of the household, we asked households for the number of trips per day, and the volume and number of containers used to fetch water, from which we estimate total water use. This estimate is performed separately based on questions about the dry season and the rainy season. Finally,

[1]Because rooftop water harvesting tanks are covered and sealed, we do not expect water loss from evaporation or leakage.

for water purchased from water trucks, we asked households for the average amount per month paid during the dry and rainy seasons for water from water trucks, and divided this by community price of water. The price of water for the community was estimated based on the community survey by asking for the price and type of an entire water truck and dividing by the volume of water delivered by this type of truck.

2.2 Categories of Water Use by Type of Project

2.3 Per capita Average Water Use

We calculate per capita average water as the total water used by the household divided by family size. Because 58% of households own livestock that they water at home, we also calculate livestock adjusted per capita water use, based on subtracting the estimated needs of the livestock owned by the household. Because the distribution is highly skewed, we focus on the median water use in reporting summary statistics. We find a median per capita water use of 20.9 litres per capita in the rainy season (19.4 litres per capita adjusted for livestock) and 16.6 litres per capita in the dry season (14.1 litres per capita adjusted for livestock). Figure 2.1 shows a histogram of household water use per capita. As can be seen, most households used less than 50 L of water per day, but there is a long right-hand tail. The spike at 30 L per day in the rainy season is due to our assumption about households with sufficient water from rainwater harvesting tanks.

If we look at the breakdown in total water use by type of source, we see that rooftop water harvesting and piped water provide far greater shares of total water than communal sources outside of the house, both when provided by SFD and when these sources exist independently. Table 2.1 summarizes the percentage of total water used by households from different types of sources.

While there was considerable water use from individual rooftop rainwater harvesting tanks in villages where SFD intervened with a communal project (66 percent of usage in the dry season and 27 percent of usage in rainy season) the reverse is not the case.[2] This observation corresponds with the strong preference of communities for individual rainwater harvesting projects, and with a much higher intensity of water use from household level vs. communal water sources, presumably due to the labor involved in fetching water.

Regarding the total contribution of SFD projects to water resources, we find that in communal rainwater harvesting projects, the contribution of SFD projects was dramatically lower than in individual rainwater harvesting projects (18% in the rainy season and 32% in the dry season for communal projects compared to 68% in the rainy season and 51% in the dry season for individual rainwater harvesting projects.

[2]About 28% of households in projects with communal rainwater harvesting interventions owned their own rooftop rainwater harvesting system.

Figure 2.1: Water Use per capita (Unadjusted for livestock)

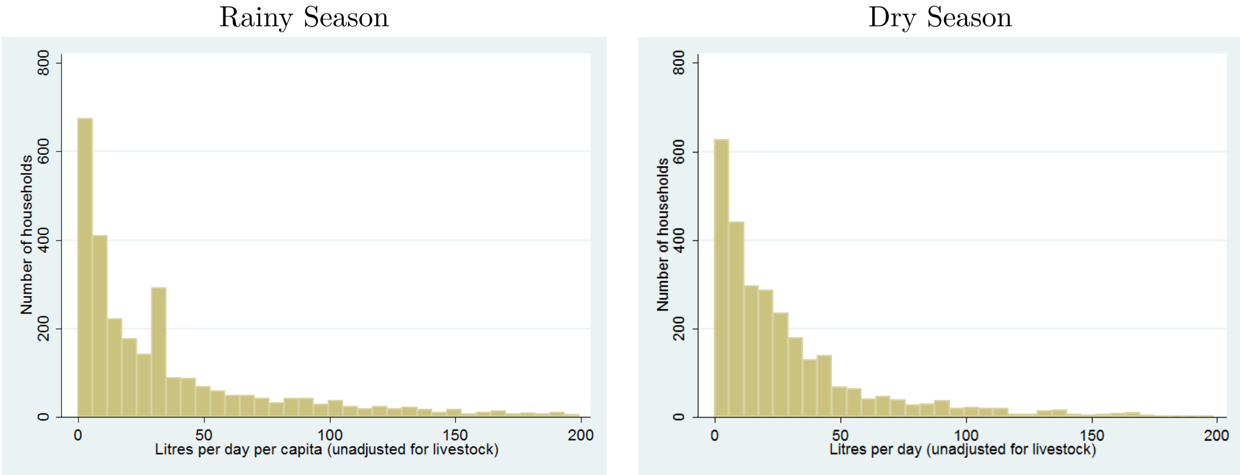


Table 2.1: Share of Total Water Use by Source (Percentage)

	Communal RWH		Rooftop RWH		Piped Water	
	Rainy	Dry	Rainy	Dry	Rainy	Dry
SFD Rooftop RWH	66.8	49.2	0.2	0.1	0.0	0.0
Non-SFD Rooftop RWH	18.8	13.0	66.0	27.3	13.5	6.6
SFD Pool or Cistern	0.9	2.1	17.9	32.7	6.6	6.0
Non-SFD Pool or Cistern	0.9	2.3	1.6	2.9	0.0	0.0
Artesian Well	0.1	0.7	0.2	1.5	1.3	2.5
Shallow Well	2.7	13.4	0.7	3.2	4.2	6.9
Spring	4.4	7.9	2.5	9.2	3.3	4.1
SFD Piped Water	0.0	0.0	0.0	0.0	62.5	65.9
Public Tap Connected to SFD Project	0.0	0.0	0.0	0.0	5.9	4.1
Non-SFD Piped Water	5.2	10.1	10.1	19.4	0.0	0.0
Water Truck	0.2	1.1	0.9	3.7	0.1	0.4
All SFD Sources	67.7	51.4	18.0	32.9	74.4	76.7

Chapter 3

Distribution of Benefits

A potential concern with use of individual rather than communal rainwater harvesting projects was that the benefits would be more concentrated among better-off households, due to the much higher cost per family. In fact, we do not find significant differences in ownership of SFD funded individual water tanks by wealth level.

On the other hand, while communal sources supply lower total amounts of water to the community than rooftop rainwater harvesting tanks, the benefits they deliver are spread more widely in the community.

Looking first simply at the share of households that benefit, the impact of individual rainwater harvesting projects is less broad than the impact of communal rainwater harvesting projects. The bar graphs in figure 3.1 show the percentage of households in the community that get less than 10% of their water from SFD sources, the share that get between 10% and 90% of their water from SFD sources, and the share that get more that 90% of their water from SFD sources. While the distributions of benefits is about the same in the rainy season, a larger share of households in individual rainwater harvesting projects (48% vs. 30%). receive no or very low benefits from the project during the dry season.

We are particularly concerned, that if the benefits of individual rainwater harvesting are more concentrated, they will go disproportionately to wealthy families. While the evidence shows that poorer families are slightly less likely to own an individual tank due to being unable to afford one, the difference is less than we expected.

3.0.1 Rooftop Rainwater Harvesting

In the communities we surveyed with individual rainwater harvesting projects, 60% of sampled households owned a tank funded by SFD. For average and better-off households, the rate was 63%, while for poor and very poor, the rate of ownership was 58%. The regression results in table ?? indicate that ownership of rooftop rainwater harvesting tanks The pie charts in figure 3.3 summarize the reasons why households decided not to get an SFD subsidized rainwater harvesting tank. For average and better off households, 16% did not a get tank because they could not afford one, while for poor and very poor households, 24% did not get a tank because they could not afford it. This difference is statistically significant and relatively sizable, but not as dramatic as we expected, given the high cost to families.

Part of the explanation of the relatively low difference in accessibility for poor and well-off households may be that in half of the communities we surveyed, community leaders indicated that there was an obligation within the community to assist the very poor in paying for the construction of a rooftop water harvesting system.

3.0.2 Communal Rainwater Harvesting

For communal rainwater harvesting, 72% of households benefited to some degree from an SFD communal source. Unsurprisingly, since the cost of benefiting is in time rather than money, better-off households were slightly less likely to benefit than average or poor households. 74% of poor, very poor, and average households benefit while only 65% of better-off households benefit. Due to the small proportion of better-off households in our sample, the difference is not statistically significant.

Of greater concern is that among households that did not benefit, 10% responded to the question about the reason for not benefiting by mentioning that they were not allowed to benefit or that local elites captured all of the water for themselves. Table 3.5 summarizes the reasons for not benefiting from communal rainwater harvesting projects.[1]

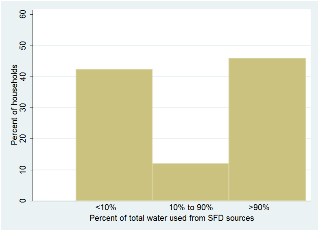
We also examined whether participation in community meetings for discussing the project was a predictor of benefits for communal sources. We do not find a correlation with meeting participation in general, but when breaking down by gender, households that sent women only to the meeting were more likely to benefit from the project and to get a larger share of their water from the project. This correlation could equally be interpreted as women who know they will depend on a communal source being more insistent on attending the meeting or women who women who attended the meeting having greater access to the communal. It is interesting that we do not observe the same pattern with men's attendance, suggesting that men's attendance is more explained by social factors unrelated to whether the household directly benefits from the source or not.

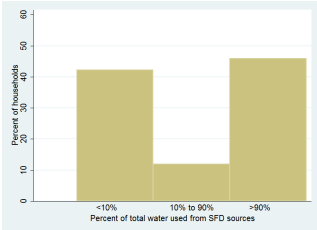
[1] Since all projects sampled were listed in the MIS as completed, SFD staff will be following up on the projects where households claimed that projects were incomplete

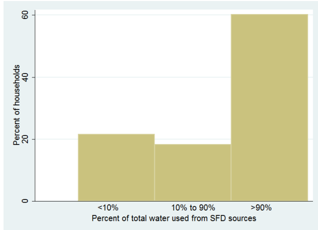
Table 3.1: Share of households that Benefit from SFD sources by Type of Project

Rainy Season

Rooftop RWH	Communal RWH	Piped Water

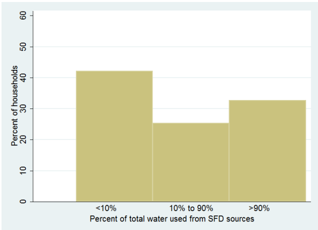


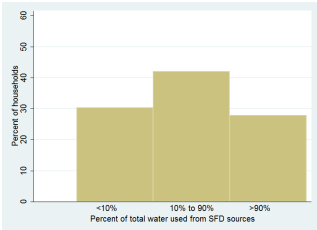




Dry Season

Rooftop RWH	Communal RWH	Piped Water





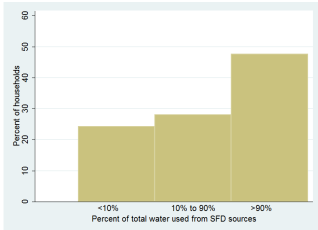


Table 3.2: Correlation Between Wealth and Probability of Owning Rooftop Rainwater Harvesting Tank

	(1) All RWH tanks	(2) SFD Funded Only
very poor (dummy)	0.0874	0.0743
	(1.37)	(0.97)
poor (dummy)	-0.0223	-0.00857
	(-0.42)	(-0.16)
better-off (dummy)	0.0616	0.0330
	(0.95)	(0.47)
Constant	0.631***	0.580***
	(12.68)	(11.31)
Observations	1095	1095

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: Average wealth is excluded category

Table 3.3: Reasons For Not Getting SFD Individual Rainwater Harvesting Tanks

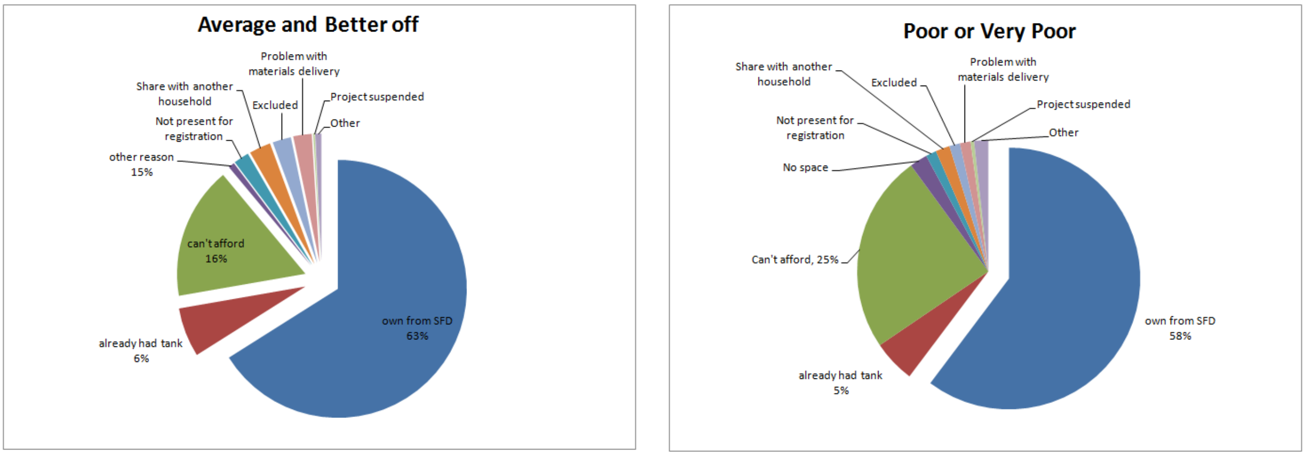


Table 3.4: Correlation Between Wealth and Size of Rainwater Harvesting Tank

	(1) All RWH tanks	(2) SFD Funded Only
very poor (dummy)	-0.966	-3.864*
	(-0.47)	(-1.70)
poor (dummy)	-1.399	-1.497
	(-1.02)	(-0.78)
better-off (dummy)	2.644	-2.210
	(1.41)	(-0.94)
Constant	30.08***	34.40***
	(19.64)	(22.36)
Observations	1123	618

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: Average wealth is excluded category

Table 3.5: Reasons for Not Using Communal Rainwater Harvesting Sources

Reason for not benefiting	**Percent of non-beneficiaries**
Source too far	21%
Have other source	24%
Water not clean	16%
Not allowed/ elite capture	10%
Insufficient water	10%
Project suspended	34%
Project in progress	14%

Note: Households were allowed to select multiple responses so percentages do not sum to 100%.

Table 3.6: Correlation Between Meeting Participation and Benefit from Communal Projects

	(1)	(2)	(3)
	Benefit	Share in Rainy	Share in Dry
Only men participated	-0.0389	-0.0434	0.0192
	(-0.57)	(-0.63)	(0.29)
Only women participated	0.214***	0.283**	0.285**
	(2.85)	(2.39)	(2.65)
Both men and women participated	0.0375	-0.00389	0.0663
	(0.53)	(-0.06)	(1.09)
Constant	0.684***	0.409***	0.366***
	(11.81)	(6.70)	(5.91)

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: Households that did not have any participants are the excluded category. First column is probability of benefiting from the SFD communal water project in either the rainy or dry season, second column is share of household water from SFD source in rainy season, third column is share of household water from SFD source in dry season

Chapter 4

Water Use from Communal Sources and Fetching Time

The primary disadvantage of communal sources is the time that women and children spend fetching water. We find an average trip time to SFD constructed communal sources of about 30 minutes. We also find that fetching time was significantly lower for wealthier families, indicating that even with a communal source, placement may lead to inequitable distribution of benefits.

4.1 Average Trip Times for Fetching Water

The median trip time (round trip including waiting) for SFD constructed communal sources for households that used these sources is 30 minutes in our sample. As figure 4.1 shows, a few households are much farther away, raising the mean distance to 37.8 minutes. The average distance to all sources used for these households was 73 minutes- far higher than the average distance to the SFD constructed communal source, indicating that the SFD source was located in a relatively convenient location. The average distance to all sources for households that did not use the SFD source was 55 minutes, suggesting that these households had better alternative sources than households that used the SFD source.

4.2 Wealth and Location of SFD Communal Sources

Figure **??** shows mean trip times to communal sources for households at different wealth levels. We see that better-off households have significantly shorter trip times than poor and average households. While it is possible that there is selection bias, due to better-off households only using communal sources if they live relatively close, the rate of use does not differ dramatically by wealth level as described above. Alternatively, it may be that better-off households live in a more central area or one that is better suited for construction of large cisterns. However, we are concerned that local elites may have influenced the placement of communal water tanks. As seen in the bar graphs, the difference in fetching time is more pronounced for SFD sources than for communal sources in general, suggesting that the difference is not driven by selection or geography.

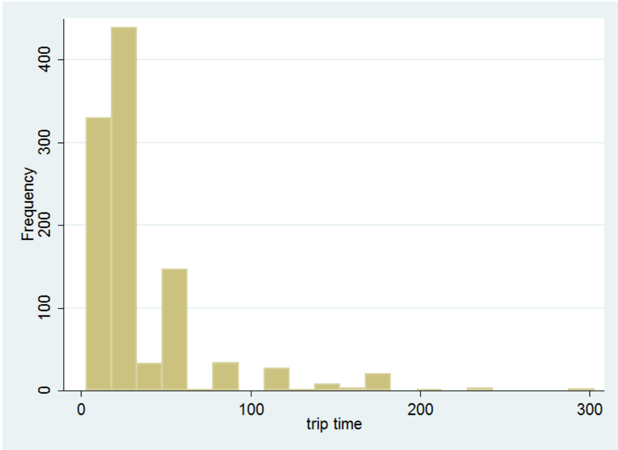


Figure 4.1: Round Trip Time in Minutes to SFD Source for Household Fetching Water from This Source

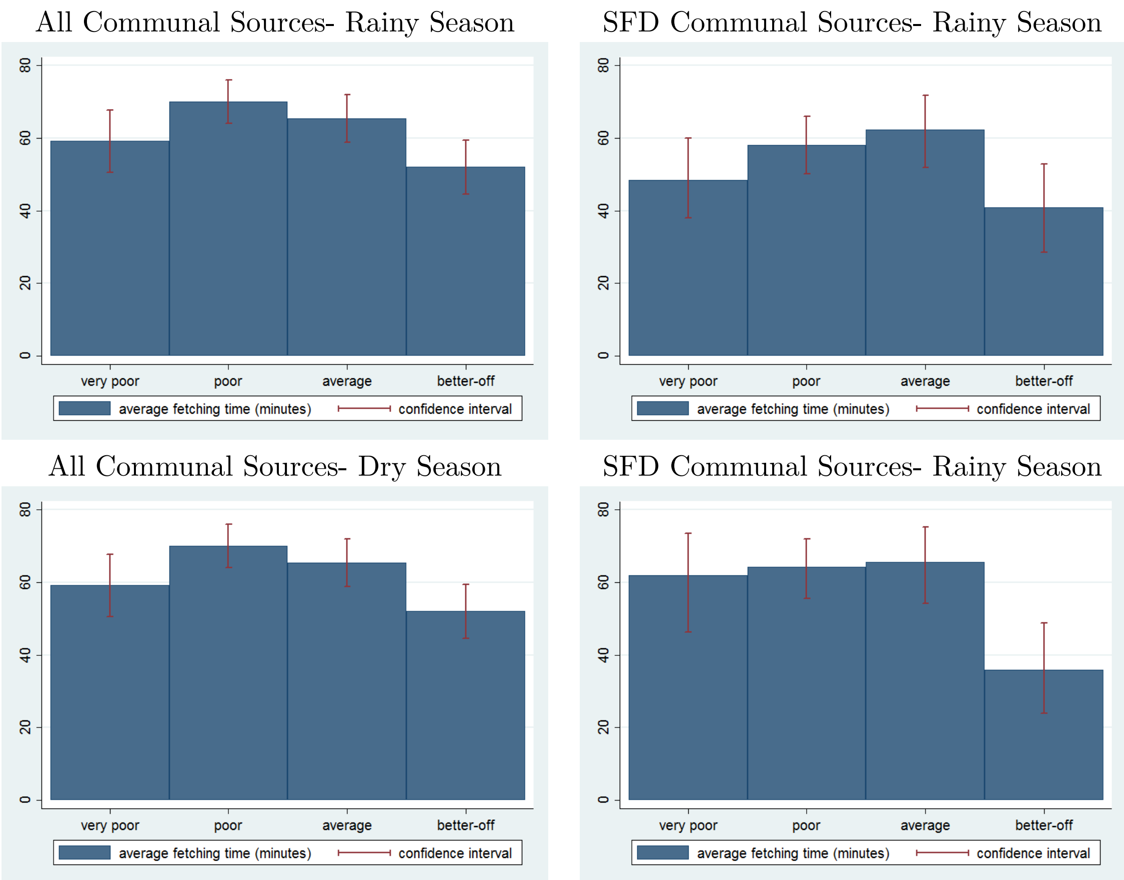


Table 4.1: Trip times to SFD Source by Wealth Level

4.3 Correlation Between Distance and Water Use from Communal Sources

Chapter 5

Water Management and Availability During the Dry Season

The optimum rational approach to management, if there are no other sources of water and the cistern is never filled to overflowing, is to use water at a constant rate throughout the year. If there are alternative sources during the rainy season, a rational manager should reduce water use from the cistern during the rainy season compared to the dry season. On the other hand, with a public good if there is a lack of central management, individual users do not have an incentive to restrict their use of water during the rainy season and water resources will be used until depletion during the dry season (Tragedy of the Commons). We compare quality of management by type of project and the assignment of management responsibility using three different indicators: the relative rate of use in the dry season vs. the rainy season; the average number of months during the dry season during which water is available; and the use of water for irrigation. We consider the use of water for irrigation an indicator of poor management for communal sources because it indicates heavy use during the rainy season and is generally associated with elite capture of water resources, since irrigation is not an intended use of the water from the project.

5.1 Rooftop Rainwater Harvesting

Within rooftop rainwater harvesting, most households own their water harvesting tank individually, but in about 19% of cases, the tank is shared among several households. We do not find strong evidence that shared ownership is worse for management than individual management.

Across all rooftop rainwater harvesting tanks, and especially in non-SFD rooftop rainwater harvesting tanks, multiple owners are associated with fewer months of dry season availability. Within SFD rainwater harvesting tanks, there are fewer situations of multiple ownership, which may explain the lack of a significant relationship between ownership and dry season management. any difference in the months of dry season availability of water. See regression results in table 5.1. However, the magnitude of the effect (0.15) is relatively small compared to the mean of 4.5 months of dry season availability, and less than 7 times the magnitude of the relationship between months of availability and household size, suggesting that the decrease in availability is a function of the greater demand for water overall, rather than poorer management.

	(1) All Tanks	(2) Non-SFD	(3) SFD
Number of owners	-0.153*	-0.165*	-0.0727
	(-1.75)	(-1.77)	(-0.63)
Number of HH members	-0.0265	-0.0229	-0.0316
	(-1.34)	(-0.80)	(-1.43)
SFD-funded	0.474*		
	(1.98)		

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5.1: Correlation Between Months of Availability in the Dry Season and Number of Owners

5.2 Communal Rainwater Harvesting

After completing the construction of communal rainwater harvesting projects, SFD turns the infrastructure over to the community. In some cases, committees were formed to manage water use, while in others a single individual (usually the sheikh or other local leader) became responsible for the project. In about 60% of projects, there was no one particularly responsible for managing water use. Table 5.2 summarizes the type of management of SFD funded communal rainwater harvesting projects.

Using months of dry season availability as an indicator of project management, we find that individual management is the most effective, followed by nobody managing, with the worst performance by committees. Mean months of dry season availability are 5.1 in individually managed projects, 3.9 in projects with nobody managing, and 3.7 in projects managed by committee. The difference in months between individually managed and the other two types is statistically significant. See regression results in table 5.4.

The same ranking appears using the ratio of rainy season usage to dry season usage as an indicator of project management. See table 5.5 and regression results, with the difference between individual and nobody statistically significant, and the difference between nobody and committee smaller in magnitude and only suggestive. See regression results in table 5.6 We also notice based on the summary statistics, that the effectiveness of management by individuals is mostly driven by lower numbers of users in the dry season, rather than lower water use per user.

On the other hand, we find that the probability of water being misallocated towards irrigation is the highest in individually managed projects, followed by committee managed projects, with projects managed by nobody having the fewest households admitting to using project water for irrigation (2% of households, compared to 4% and 6%). See regression results in table 5.7.

Finally, when asked directly about the quality of project management, respondents tended to express greater satisfaction if there was a committee than if nobody was managing the project, however when they were asked whether the project had increased the amount of water available, households in projects with nobody managing gave more positive responses.

See table 5.8.

The choice of management regime in each project area is endogenous, so we cannot claim that the differences we find are necessarily caused by the type of regime, however, these findings clearly suggest that individual management is most effective at maximizing the availability of water during the dry season, with the tradeoff of being more vulnerable to elite capture. What is more surprising, is the effectiveness of management by "nobody" or more correctly via informal community institutions.

	(1) dry season: months of water availiability
Managed by individual	1.175***
	(3.02)
Managed by committee	-0.217
	(-0.58)
Constant	3.907***
	(16.77)

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5.4: Correlation Between Months of Availability and Type of Management (Managed by nobody is the excluded category)

Table 5.2: Who is Responsible for Management of Communal Rainwater Harvesting Projects

	Number	**Percent**
Individual	**28**	**21%**
Committee	**24**	**18%**
-Project committee	3	2%
-Beneficiaries committee	15	11%
- Local authority	6	5%
Other NGO	1	1%
Nobody	**79**	**60%**
-Nobody	76	57%
-Everyone	3	3%

Table 5.3: Months of Dry Season Availability

	SFD Communal Sources by Management Type		
Months of Dry Season Availability (L/day)	Individual	Committee	Nobody
	5.1	3.7	3.9

Note: Dry season is considered to be from September-February, maximum availability is 6 months

Table 5.5: Variation in Level of Use Between Seasons

	SFD Communal Sources by Management Type		
mean use per capita (L/day)	Individual	Committee	Nobody
Among Source Users:			
Rainy	9.4	11.7	11.2
Dry	12.7	11.4	10.5
Among All HHs:			
Rainy	6.6	8.7	10.0
Dry	12.3	10.8	9.8
Percent of HHs Using Source:			
Rainy	54%	70%	71%
Dry	77%	76%	73%
Average Ratio of Rainy to Dry Season Use:			
Rainy/Dry	0.66	1.8	1.3
Rainy Share/ Dry Share	1.1	1.7	1.2

Table 5.6: Seasonal Balancing and Type of Management

	(1)	(2)
	Rainy:Dry Use	Rainy Share: Dry Share
Managed by individual	-0.641***	-0.0567
	(-3.32)	(-0.14)
Managed by committee	0.495	0.473
	(1.16)	(1.44)
Constant	1.282***	1.186***
	(9.50)	(8.81)

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: Managed by nobody is the excluded category. First column dependent variable is the ratio of household's rainy season use from source to dry season use. Second column dependent variable is the ratio of the share of household water use from the source in the rainy season to the dry season. Lower values (closer to 1) indicate more optimal smoothing of consumption.

Table 5.7: Capture of Water for Irrigation and Type of Management

	(1) How benefit: water for irrigation
Managed by committee	0.0297**
	(2.06)
Managed by individual	0.0449**
	(2.36)
Constant	0.0157***
	(2.79)
Observations	1345

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: Managed by nobody is the excluded category

Table 5.8: Satisfaction with Project Management

	Individual	Committee	Nobody
Good	61%	64%	63%
Acceptable	26%	28%	20%
Poor	12%	7%	16%
Increased a lot	40%	14%	26%
Increased	57%	75%	63%
Same	2%	9%	7%
Decreased	1%	2%	0%

Chapter 6

Water Quality

The final dimension of the water projects that we assess is the perceived water quality by type. Households were asked to rank the water quality of various sources on a scale of 1-4 with 4 as excellent and 1 as unacceptable. Figure 6.1 shows the mean quality of SFD and non-SFD sources by type.

Pools (which are uncovered) had far lower water quality than covered cisterns. SFD-funded cisterns received significantly lower marks for water quality than non-SFD cisterns. Of the three SFD cisterns with low marks for water quality, one had a aluminum cover that was rusted and not functioning, and the other two were both cisterns that collected water from mountain springs after passing through settlement areas. Further investigation is needed as to whether these designs caused the problems with water cleanliness.

Among SFD communal sources, management by nobody was associated with a lower probability of having a technician available to make repairs, and lack of a technician was also associated with lower water quality, however, overall quality ratings were not significantly different by type of management. See regression results in table 6.1.

Figure 6.1: Perceived Quality by Source Type

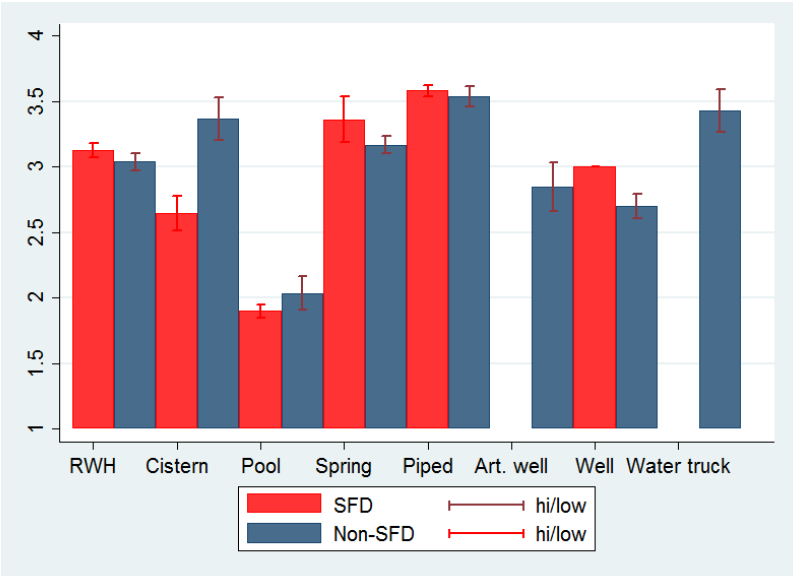


Table 6.1: Perceived Water Quality by Presence of Technician

	(1) Quality	(2) Quality- Sources Managed by Nobody	(3) Quality
Technician availiable	-0.451**	-0.507**	
	(-2.51)	(-2.30)	
Managed by individual			-0.126
			(-0.45)
Managed by committee			0.0713
			(0.30)
Constant	1.839***	1.806***	1.772***
	(18.45)	(13.96)	(13.07)

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6.2: Presence of Technician by Management Type

	SFD Communal Sources by Management Type		
Is there a technician to make repairs?	Individual	Committee	Nobody
	37%	33%	16%

Chapter 7

Conclusions

This assessment of SFD water projects shows that in the sampled communities, water availability generally falls below the target of 30 L per person. We see that rooftop rainwater harvesting projects deliver the highest level of water resources and contribute a high share of total water resources even in areas where they are not subsidized by SFD. Further, the distribution of benefits in rooftop rainwater harvesting projects is relatively equitable, and not necessarily worse than the distribution of benefits from communal sources. For communal sources individual management maximizes conservation of resources for dry season use but also the risks use for irrigation, while management via informal norms is no worse than management by committee.

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Appendix: SFD Target for Average Time to Fetch Water

One of the SFD outcome indicators is a goal of ensuring by 2015 that at least 58% of households in Commmunity Led Development programs have time to collect water of 30 minutes or less. While this report focuses only on water projects in Ibb, Taiz, Amran, Dhamar, Sanaa and Mahweet, we can say that within these type of villages, that goal has been acheived.

Assigning households with rainwater harvesting tanks that were sufficient for household needs or piped water which was available at least once per week to have a fetching time of zero, we calculated that in the rainy season, 83 percent of households have 30 minutes or less fetching time from nearest source, while in the dry season, 77 percent of households have 30 minutes or less fetching time from nearest source.

Since most households fetch water from more than one source, it is unclear given the wording of the target if the fetching times from sources other than the nearest source should be included. If we take the mean distance to all sources used in both rainy and dry season, 67 percent of households have fetching times of less than or equal to 30 minutes.