Water Policy 22 (2020) 686–701

Impact of socio-economic and water access conditions on life satisfaction of rural farmers in Faisalabad district of Pakistan

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Abstract

The current study is designed to see the effects of water access on the well-being of the farming community in rural areas of Pakistan. The data were collected from 300 households of ten villages in rural Faisalabad, Pakistan where the population is facing serious water quality and access issues due to industrial pollution, lack of clean water supply system and limited access to fresh water for agricultural use. We employed ordinary least square and ordered probit methods to measure the association between water access variables and households' well-being. We found that source and quality of drinking water, access to irrigation water, and percentage of crop water requirement fulfilled, and water expenses were statistically significant influencing the households' well-being. The study concluded that water access conditions strongly influence the life satisfaction and water access conditions must be considered in future research. Acknowledging the contribution of village-level economic activities to economic growth, a strong policy is proposed to re-evaluate the existing rural water supply strategy to enhance the households' well-being and enhance livelihood generation among neglected pro-poor farmers in rural areas of Pakistan.

Keywords: Households' well-being; Rural Pakistan; Water access

Introduction

Water is critical for socio-economic development and human survival as a source of livelihood generation particularly for 850 million rural poor engaged in agriculture, but unequal distribution, water pollution, water scarcity and climate change have resulted in different water access conditions (Bates

doi: 10.2166/wp.2020.004

et al., 2008; Namara *et al*., 2010). Although the efforts to ensure access to water have been recognized and accepted globally with the commitment to halve the percentage of people lacking access to drinking water by 2015 in the United Nations Millennium Development Goals (MDGs), there are still more than 660 million people using an unimproved source of water. Further, 40% of people around the world are facing water scarcity and access to safe drinking water is uneven between urban and rural areas (UNDP 2015). The differences in the access conditions to drinking and agricultural water coupled with water pollution and depletion may influence the subjective well-being[1] of populations differently among water users (Sullivan *et al*., 2003; Han & Zhao, 2005; Castillo *et al*., 2007). These differences indicate the need to understand the relationship between water access and subjective well-being for water poor populations in the developing countries where water scarcity, lack of quality drinking water and water access, in general, is a fundamental issue (Brookshire & Whittington, 1993; Guardiola *et al*., 2013). The scarcity of water demands more efficient and sustainable use to ensure access to productive use of water resources (Chipfupa & Wale, 2019). Self-reported well-being or life satisfaction approach is an important instrument for welfare analysis to approximate individuals' utility and to explain the determinants of well-being in water supply systems putting more emphasis on water-related environmental attributes (del Saz-Salazar *et al*., 2019). Poorly managed wastewater treatment substantially affects water quality leading to multiple health impacts (Adhanom *et al*., 2018). Studies show that individual perception on water-related disease, water shortage, total water use and distance to water resources greatly affects the lives of rural people in the presence of changing climatic and environmental conditions (Marcantonio, 2018).

Water insecurity, lack of access to water measured by distance to available water resources, water needs fulfilled and allied health issues are important factors affecting human life and development. The threats to humans from water access issues are expected to increase in future due to climate change. Lacking access to improved water-related services and benefits negatively affects the well-being of the population even beyond health (Mehta, 2014; Pachauri *et al*., 2014; WHO, 2017; Marcantonio, 2018; Adam *et al*., 2019). There is an emerging consensus in the literature that water is strongly linked to human well-being. A strong body of literature has broadened the focus on understanding the linkage between multidimensional aspects of water and human well-being as well as other development sectors. It will be helpful to fulfil the physical needs, instrumental and intrinsic benefits and to contribute in capacity building of water sectors for a community's well-being (Gimelli *et al*., 2019). Jepson *et al*. (2017) has called for a reconsideration of water scarcity for well-being to support the sustained development of human capabilities and well-being in their full breadth and scope. Great emphasis is increasingly being placed on understanding this relationship. However, precisely what constitutes 'well-being' remains largely unclear. Marcantonio (2018) has emphasized that design of a critical water policy for subsistence farmers facing challenges of water scarcity, climate change and environmental degradation is the need of the hour. Water is considered necessary for direct or indirect life satisfaction (Alkire, 2002; Costanza *et al*., 2007), but research literature has not generally paid too much attention to measuring the association between water access and life satisfaction, with a few exceptions (Bookwalter & Dalenberg, 2004; del Saz-Salazar *et al*., 2019; Gimelli *et al*. 2019).

[1] Subjective well-being (SWB) is an 'umbrella' term that comprises the concepts of 'life satisfaction' and 'happiness', hence, these are used interchangeably when explaining the different evaluations people make regarding their lives (Veenhoven, 2012; OECD, 2013).

The empirical results of these studies have established that lack of enough clean water, water quality, quantity and related management issues significantly affect the subjective well-being.

Pakistan is a country where the likelihood of water scarcity driven by climatic change alone is greater than 90% and this may reduce water availability by more than 10% (Vinke *et al*., 2016). The majority of fresh water resources originates outside its geographic border and has very limited water storage capacity. The groundwater resources are continuously depleted, lowering the water table, water availability and quality, and thus greatly threatening the provision of basic human rights and source of livelihood generation. The higher environmental degradation of surface water and aquifers led by poor sanitation conditions and untreated disposal of industrial water and household sewage are very common threats to human life (Sullivan *et al*., 2006; Green *et al*., 2011; Jemmali & Sullivan, 2014; Vinke *et al*., 2016). According to the water scarcity and stress index[2], Pakistan's annual per capita water of 1,090 m^3 (Kamal, 2009) threatens economic development and human welfare (Falkenmark, 1986) and it will be a water-scarce country in 2035 (Khan, 2014). The increasing issue of water and water resources unsuitable for irrigation and human consumption due to water pollution as a result of unplanned industrial development, improper and in discriminate disposal of industrial effluents in water resources is aggravating the situation profoundly (Ibrahim & Salmon, 1992; Abbas *et al*., 2007). Groundwater is a major source of drinking water in rural areas of Pakistan and it may be an important factor affecting life satisfaction depending upon its quantity and quality. The water access issue is more extreme among rural residents who constitute 60.01% of the total population of Pakistan but only 23.5% have access to clean drinking water (Altaf *et al*., 1993; Rosemann, 2005). The current study is designed in rural areas of Faisalabad, Pakistan where the rural water public policies have not kept pace with economic development in the region and have to bear high economic and environmental costs (Altaf *et al*., 1993) and rising water poverty due to climate change and industrial-led water pollution which are expected to increase the vulnerability of rural farmers (Nadeem *et al*. 2018).

First, this study contributes to the literature because it considers both drinking and irrigation water access in contrast to previous research that mainly focused on residential water. Second, the study focuses on the rural areas because the lack of quality drinking water is a more important issue for poor people (Watkins, 2006). According to the best of our knowledge, this is a pioneer study on evaluating the effects of limited access to quality drinking water on the lives and livelihood of poor people engaged in agriculture. Finally, it is the first ever water-related life satisfaction research in Pakistan of its kind, and will provide a basis for future research to secure the economic and social well-being of the community through water-related public policy. It will be helpful in understanding the complexity of the system of drivers and impacts that affect human well-being through water scarcity and will provide a basis for future research in this direction.

The rest of the paper is organized as follows: the second part describes the study area and water access conditions, the third part explains data collection and variables' description, the fourth part presents the methodology and results and the final part concludes the research finding and suggests policy implications.

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[2] Water scarcity starts from annual per capita water availability of less than 1,700 m^3 and water stress condition is suffered below this level.

Study area and water access in the selected villages

We selected Faisalabad, being the third most populous and industrial city of Pakistan. Geographically, the study area is located in the Rechna Doab, i.e., the area between the rivers Ravi and Chenab with an area of 5,856 km^2. The district is of prime importance in the agrarian economy because it has the largest agro-based textile industrial set-up (also known as city of Textile and Manchester of Pakistan) with intensive development in a diverse group of industries.

The quality of drinking water in Faisalabad in general is unsatisfactory because the water quality parameters are beyond the permissible limits of the World Health Organization (WHO), Pakistan Standard Quality Control Authority (PSQCA) and other international standards (Kahlown *et al*., 2007). The issue is most acute and is rising with the passage of time in rural areas due to lack of public water supply (Altaf *et al*., 1993).

The study area has already attracted the attention of researchers on different aspects of water pollution and its impacts (Hassan & Bhutta, 1997; Kahlown *et al*., 2007; Azizullah *et al*., 2011; Iqbal *et al*., 2013; Taj *et al*., 2013; Nasir *et al*., 2014). The second issue of water access is the limited supply of surface water from Nasrana Distributary Canal for agriculture, which is the main source of livelihood generation in these villages. The brackish underground water aquifers and water pollution from industrial waste is creating a worse situation. The contamination of groundwater resources from industrial effluents through Paharang drain is creating pressure for surface water resources due to rising population demand and intensive cropping (Taj *et al*., 2013). The selection of the study area for water-related research on village life has strong policy significance because what is happening in these villages will likely occur in many other villages in the near future (Altaf *et al*., 1993) and will provide scientific understanding and guidance for future policy decisions for community well-being.

Data collection and variables' description

Sampling methodology and data collection

This study employed cross-sectional data collected from 300 farm households. These farm households were taken from ten villages of Faisalabad district. The selected villages are located on the western side of the city at different distances from the intersection point of Paharang drain (polluting source) and Nasrana distributary (only freshwater source) near Aminpur Road, as shown in Figure 1 for our case study. The Paharang drain collects untreated wastewater from heavy polluting textile industry (Rehman *et al*., 2009) as well as household sewage which percolates into soil and groundwater aquifers while passing through these villages and ultimately discharges to the River Chenab on the western side, whereas the Nasrana distributary is the only source of irrigation water. The Punjab Irrigation and Drainage Authority (PIDA) controls each Mogha (an outlet on the canal/distributary for discharge of a specific amount of water to the farmers) under the umbrella of a Water Users Association (WUA), elected by farmers with land on that specific Mogha. The voters' list of farmers with land on each Mogha for holding an election is developed and maintained by PIDA. We collected the voter list of all WUAs of ten villages. From the list, we randomly selected 300 farm households. Data were collected using a structured questionnaire.

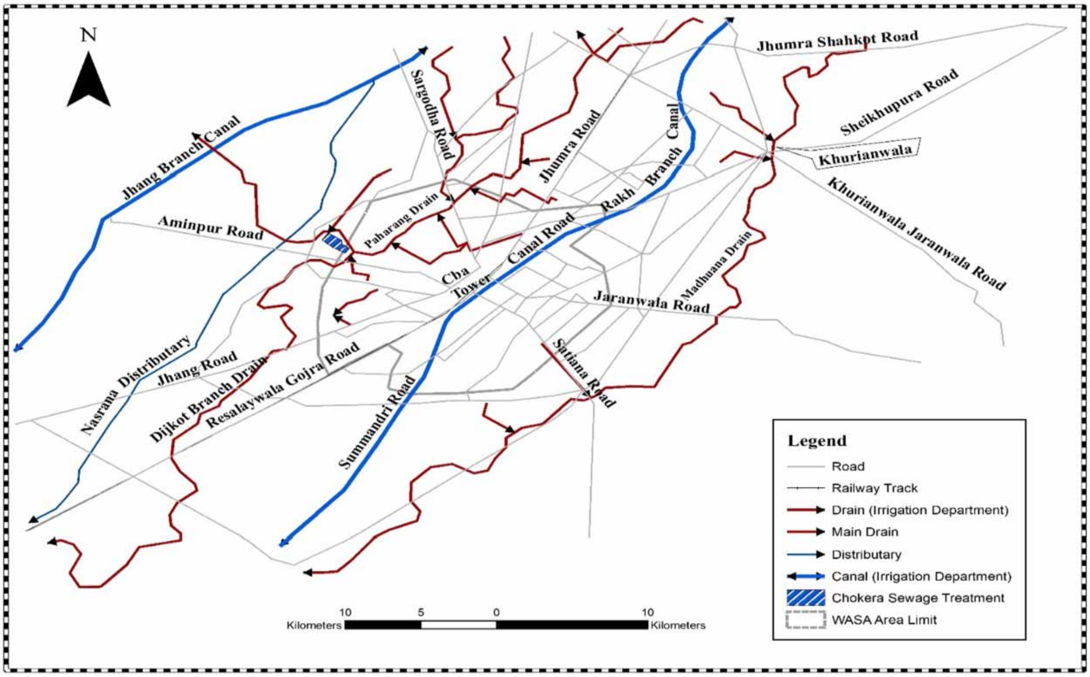

Fig. 1. Location of selected villages in the study area.

Variables selection and description

We measure respondents' subjective well-being (SWB) by asking the question: 'Generally, how happy are you with your life?' The self-reported happiness level is measured on a scale of 1–7 where 1 is very unhappy, 2 mostly unhappy, 3 somewhat unhappy, 4 neither happy nor unhappy, 5 somewhat happy, 6 mostly happy and 7 very happy.

The first variable related to water access is source of drinking water available to households. There is no clean water supply system from the state institutions so the major source is groundwater for domestic use. A common practice by villagers is fetching water from hand pumps installed close to a canal. This variable affects life satisfaction (Bookwalter & Dalenberg, 2004) and is measured as a dummy variable where 1 indicates that respondents use only groundwater for their domestic purposes (in other words do not have access to other clean sources of water) and 0 if households use some other sources of clean water. We expect that the groundwater source affects subjective well-being negatively due to bad quality water. The perceived quality of drinking water, widely used in water-related research (Guardiola *et al.*, 2013, 2014) is the second water variable, measured on a scale of 1–5, with 1 being very bad, 2 bad, 3 satisfactory, 4 good and 5 very good. Since the perceived quality is a categorical variable in nature, moving from bad to good quality water, we expect a positive influence on subjective well-being. The irrigation water access has a positive influence on income and livelihood which ultimately affects life satisfaction. The variables on irrigation water access are selected in the light of literature (Lawrence & Meigh, 2002; Heidecke, 2006; Sullivan *et al.*, 2006; Komnenic *et al.*, 2009; Forouzani & Karami, 2011). The main source of irrigation water is canal water for these villages, so variables include access to irrigation water source, cumulative percentage of water demand fulfilled by canal water in winter and summer seasons and water expenses incurred on purchase of water to fill the gap between supply and demand of crop requirement. The access to canal water is proxied by time required to fetch water from source to the place of use. This variable was originally measured by five time scales where 1 = time needed more than 30 minutes, 2 = 21–30 minutes, 3 = 11–20 minutes, 4 = 1–10 minutes and 5 = no time. We merged the last (4 and 5) into one variable and now it becomes 0–10 minutes (then we call 1 very bad access, 2 bad access, 3 good access and 4 very good access to irrigation water).

This variable broadly measures the water access taking into account the water distribution efficiency, the farmer's land situation with respect to water source (as upstream or downstream farmer) and the distance between water source and farm (Latif & Sarwar, 1994; Forouzani & Karami, 2011). A positive effect is expected while moving from bad to good water access condition. The third variable on irrigation water access is how much (%) crop water requirement is fulfilled in summer and winter seasons on a scale of 1–4 where 1 is 0–25%, 2 is 26–50%, 3 is 51–75% and 4 is 76–100%. We combine both scales by summing up so a higher value of variable[3] (WDs) represents higher satisfaction with water demand fulfilled as well as with life and vice versa. The last variable is water expenses (thousand Pak Rupees) spent by each household on purchase of water for irrigation of crops deficient in water. This variable may have either a positive effect (as it can increase water availability) or negative (expense as economic burden).

To avoid any spurious relationship between water variables and life satisfaction, we have included certain socio-economic variables in our analysis as control variables. These variables include age, health, employment, community relationships, and community trust and income level. The age is measured in number of years. The literature is not conclusive because we find positive, negative or U-shaped effects on happiness level (Graham & Pettinato, 2000; Cheng *et al.*, 2014; Guardiola *et al.*, 2014). We use the health variable to capture wide ranges of household health problems following the literature (Becker, 1964; Castriota, 2006; Guardiola *et al.*, 2014). The health variable takes a value of 1 if for severe sickness, physical disability, mental disorder and water-borne diseases and 0 otherwise. We measured the levels of a respondent's relationship with wife/husband, other family members and relatives, friends and colleagues on a scale of 1–5 where 1 was used for very bad, 2 bad, 3 neither good nor bad, 4 good and 5 very good relationships. We measured the individual effects of all relationship variables separately and found that some of these domains of relationships have positive while others have negative effects on life satisfaction; we then developed a relationship index. The index was developed by adding the perceived relationship levels where the higher the value, the higher the relationship level and vice versa. The literature has established that being in a caring relationship improves happiness level as opposed to simply being in a string of less close relationships (Blanchflower & Oswald, 2004; Lelkes, 2006; Pichler, 2006; Dolan *et al.*, 2008) and we expect the same effect of relationship index on happiness. Trust, a dimension of cognitive social capital, is measured by a composite index constructed by combining the perception level of general trust in community members and the community leader. The respondents are asked: 'Would you say that most of the people in your community can be trusted?' and 'Do you trust your local leader?' where answers are sought on a 1–7 Likert scale with 1 being not at all trusted, 2 little trusted, 3 somewhat trusted, 4 indifferent, 5 trusted, 6 highly trusted and 7 fully trusted. The perceived ranking on both questions were

[3] Lowest scale is 1 while highest is 8.

added to calculate a composite index value for community trust; the higher the value, the more the trust level and vice versa. The literature has established a positive association between trust and happiness (Helliwell, 2003, 2006; Bjørnskov, 2006; Yip *et al.*, 2007; Dolan *et al.*, 2008) and we expect the same direction of association in our case study. We measure total income (Pak Rs) of each household from different sources, add up and then divide total income by the respective family members to calculate per capita income. We take the log of the per capita income to produce a continuous income variable as a proxy of a scalar one (McBride, 2001; Guardiola *et al.*, 2014).

Econometric models

We are interested to estimate three relationships: first, the influence of drinking water variables on SWB is estimated, second, the effect of the irrigation water variables on SWB, and impact of all water variables collectively on the SWB are examined while controlling the same socio-economic variable in all models. A simple regression model represents this relationship below:

$$SWBi = \beta_0 + \beta_1 Agei + \beta_2 Healthi + \beta_3 Employmenti + \beta_4 Relationshipsi + \beta_5 Trusti + \beta_6 Incomei + \beta_7 DWSi + \beta_8 DWQi + \beta_9 IWAi + \beta_{10} WD\mathrm{si} + \beta_{11} WaterExp + \varepsilon i$$

The coefficients (β_{1-6}) and (β_{7-11}) correspond to parameters of controlled and water variables, respectively, while error term is captured by (ε_i). Subjective well-being is measured as cardinal (generally by psychologists) as well as ordinal (usually by economists) in the research literature (Cheng *et al.*, 2014). The results are not sensitive to treating SWB as cardinal or ordinal (Ferrer-i-Carbonell & Frijters, 2004; Knight *et al.*, 2009; Cheng *et al.*, 2014), but for making our results more robust and conclusive, we adopt both the cardinal and ordinal approaches through OLS and ordered probit techniques with robust standard errors to overcome heteroscedasticity problems (Gujarati, 2009).

Results and discussion

Table 1 shows descriptive statistics of the analysis. Average age is around 54 years. A higher mean value of health depicts the bad health issues among respondents. Similarly, a higher index on relationship and trust in community highlights a better situation on these social issues and the expected sign of these variables on life satisfaction are in line with previous literature. Self-reported life satisfaction in Figure 2 highlights that a majority of the respondents are dissatisfied regarding water-related variables. A majority of the respondents are of the view that the drinking quality of available water is very bad (Figure 3). Figure 4 shows bad irrigation water access among farmers while the crop water requirement fulfilled is not beyond 50% (Figure 5). This shows the existence of water issues in the rural areas under study.

In Table A1, a higher correlation coefficient among certain variables (drinking water source and drinking water quality, water expenses and income, irrigation water access and trust) may lead one to suspect the existence of a multicollinearity problem among these variables and can give spurious regression results. To overcome the problem, we perform a multicollinearity test; VIF (variance inflation

Table 1. Summary of descriptive statistics.

Variables	Mean	Std. dev.	Min	Max
Age	53.67	12.35	25	87
Health	0.97	0.17	0	1
Employment	0.58	0.49	0	1
Relationships	27.58	2.59	19	32
Trust	7.89	3.29	2	14
Income	4.98	0.45	3.69	6.67
Drinking water source (DWS)	0.38	0.48	0	1
Drinking water quality (DWQ)	1.84	0.99	1	5
Irrigation water access (IWA)	2.27	1.34	1	4
Water demand fulfilled (WDs) %	2.70	1.13	1	8
Water expense	17.35	39.67	0	450

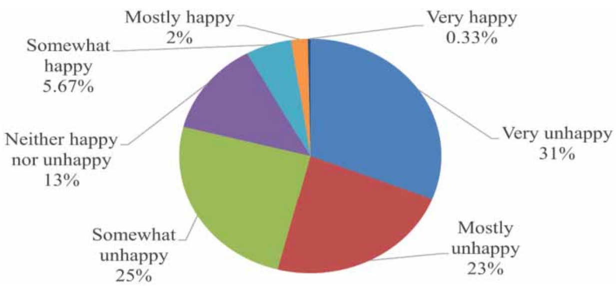

Fig. 2. Self-reported life satisfaction among households.

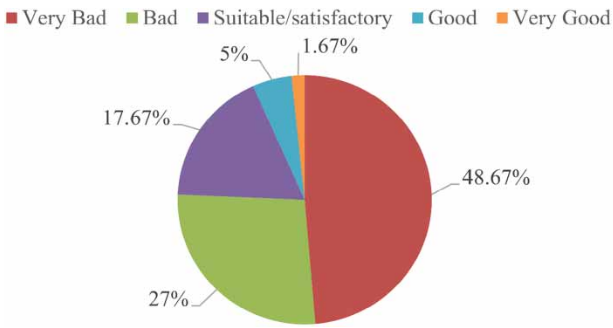

Fig. 3. Self-reported quality of drinking water by households.

factor) and see that the problem of multicollinearity does not exist as the highest value of VIF does not violate the rule of thumb (Gujarati, 2009). We develop three models for applying ordinary least square (OLS) technique by controlling certain confounding factors in each model in order to avoid any spurious results to confirm the relationships among the water variables and subjective well-being. The first model explains the influence of drinking water variables on SWB; the second model elucidates the association

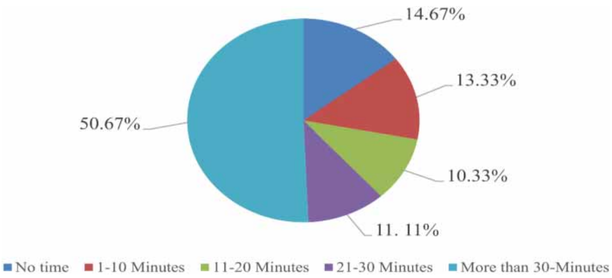

Fig. 4. Irrigation water access among households.

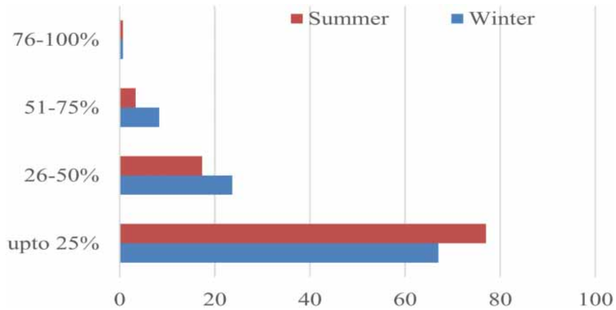

Fig. 5. Irrigation water requirement (%) fulfilled from canal.

between irrigation water variables and SWB while the third model explains the association of all water variables with SWB keeping the control variables constant in all models. Table 2 presents the OLS regression results for all three models.

In the first model, we are much interested in the significance and sign of the coefficients (β_7 and β_8) measuring their effects on the happiness of farmers. We are expecting a negative impact of groundwater drinking source due to its bad quality but a positive relationship between the quality of available water and happiness when its subjective perception increases from bad to good quality. Both of these variables have statistically significant effects on happiness according to our expectation. The negative and significant coefficient of the drinking water source (−0.344) shows how strongly it affects the happiness. Households attach a high association between water source and their happiness level, and we conclude that there is high demand for a clean water supply system from the state and nothing has been done for adaptation by the community. The positive and significant coefficient of perceived quality of drinking water (0.195) confirms that good quality water enhances satisfaction level significantly. The results on access to drinking water variables are in line with previous studies (Bookwalter & Dalenberg, 2004; Guardiola *et al*., 2013, 2014).

The second model explains the effects of various irrigation water variables on happiness level. In this model, we are expecting the positive impacts of canal water access; percentage of irrigation water requirement fulfilled and a negative impact of water expanses on happiness level. The previous studies show that irrigation access water has a positive effect on income and livelihood (Smith, 2004; Senaratna Sellamuttu *et al*., 2014) which will result in higher happiness among farmers. The positive and significant coefficient of irrigation water access (0.103) confirms its importance for the life satisfaction of rural

Table 2. OLS estimates for subjective well-being.

Dependent variable: SWB Variables	Model 1	Model 2	Model 3
Age	0.00	0.00	0.00
	(0.00)	(0.00)	(0.01)
Health	− 0.81**	− 0.88**	− 0.86**
	(0.34)	(0.36)	(0.33)
Employment	0.13	0.11	0.12
	(0.16)	(0.16)	(0.16)
Relationships	0.07**	0.06**	0.06*
	(0.03)	(0.03)	(0.03)
Trust	0.09***	0.08***	0.08***
	(0.02)	(0.02)	(0.02)
Income	0.56***	0.61***	0.62***
	(0.16)	(0.18)	(0.17)
Irrigation water access		0.10*	0.12*
		(0.06)	(0.06)
Water demand fulfilled (%)		0.06	0.08
		(0.06)	(0.06)
Water expense		− 0.00**	− 0.00**
		(0.00)	(0.00)
Drinking water source	− 0.34**		− 0.38**
	(0.16)		(0.16)
Drinking water quality	0.18**		0.21**
	(0.08)		(0.08)
Constant	0.58	0.42	0.08
	(1.16)	(1.16)	(1.17)
Observations	300	300	300
R-squared	0.15	0.15	0.17

Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

farmers and is in line with expectations and previous research. Although a non-significant but positive coefficient of water demand fulfilled establishes a positive association with happiness level, a lower coefficient value (0.0642) may lead to the conclusion that farmers are not satisfied with the available amount of water as it fulfils only a part of crop water requirements. The negative and significant coefficients of water expenses (−0.00235) draws the conclusion that farmers are not willing to spend money on the purchase of water to fill the supply and demand gap in crop water requirement. This variable has dual impacts on happiness; negative effects can be attributed to an additional economic burden and use of bad quality groundwater due to seepage of untreated wastewater (Aftab *et al*., 2000; PCRWR, 2006) will affect crop yield negatively, ultimately lowering subjective well-being. The third model highlights the collective influence of drinking and irrigation water variables on happiness level. Similar results are expected for water variables as those in models 1 and 2. We have found rather better water variables' association with happiness in this model. A higher significant coefficient value of all water variables in the third model confirms the effects of water access on life satisfaction.

The results for control variables are generally consistent with prior expectations and are in line with previous literature (Yip *et al*., 2007; Dolan *et al*., 2008; Guardiola *et al*., 2013, 2014). Health, community relationships, community trust and income have consistent and significant results while age and employment, although non-significant, are consistent in all three models. Health problems affect the SWB negatively which may lead to the conclusion that overall health problems are in alarming conditions among respondents where bad quality water and lack of clean water sources may be held responsible for water-related diseases at least. The community relationships, trust and income of the households are positively, consistently and significantly influencing the SWB in all models. A higher string of relationship affects more strongly the SWB than less close relationships (Blanchflower & Oswald, 2004). Our results show that having a higher degree of close relationships has a positive influence on happiness level. Social trust (trust in most other people) is associated with higher life satisfaction, and our results are in line with previous findings (Helliwell, 2003, 2006; Bjørnskov, 2006). Income and SWB are generally positively associated (Easterlin, 2001; Dolan *et al*., 2008). The same results are reported in our estimates but the rising coefficient of income is interesting. Income may be less important in the case of drinking water and we can conclude that people are no more willing/able to spend their income on getting clean drinking water, and its effect on happiness is lower compared to that of irrigation water where if income is spent, it will increase crop yield and thus its influence on happiness is more prominent. Income has multiple avenues of influence through improvements in agriculture intensification via productivity enhancement, employment generation for farm labour, agro-based economy expansion and diversification of rural livelihoods (Smith, 2004).

Generally, in regression, the value of R^2 increases with the addition of new variables unless the additional estimated coefficients are, unusually, exactly zero; but an increase in R^2 does nothing to improve the measures of fit in the model while the adjusted R^2 is important for improving the measure of fit of the model (Stock & Watson, 2007; Gujarati, 2009). From Table 2 we observe that with the addition of variables, the values of robust R^2 increases in model 3 when water variables (both drinking and irrigation) are added compared to models 1 and 2 having separate drinking and irrigation access water variables. From the table we see that the water coefficients and measure of fit for models is high in the case of drinking water variables as compared to irrigation water. This helps us to conclude that the drinking water issue is more complex and more deeply rooted as compared to irrigation water access. The high coefficient on source of drinking water also highlights that no adaptation measures exist among rural households, at least for drinking water. The overall increase in water-related variables coefficients' values and R^2 in model 3 strengthen the conclusion regarding the importance of water for life satisfaction and also the correct specification of the econometric model. Our results, as a whole, in the three models are consistent with previous studies, accepting that water access affects subjective well-being and is still a very common issue and provides a sound base for water-related happiness research in developing countries (Brookshire & Whittington, 1993; Guardiola *et al*., 2013, 2014).

Table 3 reports the ordered probit results for subjective well-being. The sign and significance of the control variables in Tables 2 and 3 are the same except for relationship which is less significant in the case of ordered probit but still with the same sign. The sign and significance of water variables for source of drinking water, drinking water quality and water expense are the same and rather the significance level of irrigation water access improves in ordered probit estimates. The results on water demands fulfilled are somewhat different as at the higher % of water demand fulfilled, the sign changes from positive to negative and becomes significant in the case of ordered probit estimates compared to positive and non-significant in OLS. We can attribute this negative impact to the negative association of

Table 3. Ordered probit estimates for subjective well-being.

Dependent variable: SWB Variables	Model 1	Model 2	Model 3
Age	0.00	– 0.00	0.002
	(0.01)	(0.01)	(0.01)
Health	– 0.79**	– 0.82**	– 0.84**
	(0.38)	(0.39)	(0.35)
Employment	0.10	0.10	0.11
	(0.14)	(0.14)	(0.14)
Relationships index	0.04*	0.04*	0.04
	(0.02)	(0.02)	(0.03)
Trust	0.08***	0.06***	0.07***
	(0.02)	(0.02)	(0.02)
Income	0.45***	0.53***	0.53***
	(0.15)	(0.16)	(0.16)
Reference category: IWA = Very bad			
IWA = Bad		– 0.13	– 0.11
		(0.24)	(0.24)
IWA = Good		0.50**	0.57***
		(0.21)	(0.21)
IWA = Very good		0.24	0.29*
Reference category: WDs fulfilled (lowest level)		(0.17)	(0.16)
2.WDs fulfilled		– 0.08	– 0.09
		(0.44)	(0.50)
3.WDs fulfilled		– 0.11	– 0.09
		(0.47)	(0.52)
4.WDs fulfilled		0.17	0.18
		(0.47)	(0.52)
5.WDs fulfilled		0.11	0.16
		(0.56)	(0.62)
6.WDs fulfilled		0.29	0.46
		(0.55)	(0.59)
7.WDs fulfilled		– 0.87*	– 1.07*
		(0.47)	(0.55)
8.WDs fulfilled		– 0.90*	– 0.55
		(0.50)	(0.56)
Water expense		– 0.00**	– 0.00**
		(0.00)	(0.00)
Drinking water source	– 0.29**		– 0.34**
Reference category: DWQ (Very bad)	(0.14)		(0.15)
DWQ (Bad)	0.00		0.02
	(0.16)		(0.16)
DWQ (Satisfactory)	0.34**		0.48**
	(0.17)		(0.18)
DWQ (Good)	0.64*		0.76**
	(0.38)		(0.38)
DWQ (Very good)	0.20		0.06
Observations	300	300	300

(*Continued.*)

Table 3. (*Continued.*)

Dependent variable: SWB Variables	Model 1	Model 2	Model 3
Pseudo R^2	0.05	0.05	0.06
Log pseudo likelihood	− 449.22	− 446.27	− 439.94

Robust standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

water expenses on subjective well-being where the fulfilment of maximum level of water requirement is possible only at the expense of income.

Conclusions

The estimates of the study show that water directly affects the subjective well-being of farm households. Lack of irrigation water access, lesser demand fulfilled and water expenses to fulfil the crop water requirement are important factors for determining water and subjective well-being. Water poverty in rural areas affects the lives of poor families and places strong emphasis on considering water access as a determinant of subjective well-being of farm households. The lack of access to satisfactory water supplies is common and a severe issue in rural areas of Pakistan. The water is not only necessary for life, but also affects the development of people and nations, so water-related happiness research strongly provides the basis and guidelines for future policy decisions. The planning process, lack of implementation of successful development projects and flawed institutional network are commonly held responsible for water resource issues.

Supplementary material

The Supplementary Material for this paper is available online at https://dx.doi.org/10.2166/wp.2020.004.

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Received 7 January 2020; accepted in revised form 17 April 2020. Available online 29 June 2020