Determinants of household participation in the management of rural water supply systems: A case from Ethiopia

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ABSTRACT

Access to safe drinking water supply in Ethiopia is among the lowest in sub-Saharan Africa. While both governmental and non-governmental organizations have implemented water supply projects in recent years, many fail shortly after construction due to improper management. In this paper, we examine socio-economic, institutional and exogenous factors affecting household participation in the management of water supply systems for drinking purposes. A survey was carried out involving 16 water supply systems and 160 households within the Achefer area, in the Amhara region, Ethiopia. The results show that household contributions to water supply system management are positively and significantly affected by user participation during the project design and implementation, by advocacy provided by the project and by greater household income. Thus, for drinking water systems in rural areas to be sustainable, these factors should be included when planning water supply projects.

Keywords: Ethiopia; community participation, rural water supply, water management, water supply sustainability.

1 INTRODUCTION

Despite many years of development efforts, access to safe water supplies and sanitation services in the world continues to be extremely marginal. Over 1.2 billion (1.2 x 10^9) people worldwide (Klawitter & Qazzaz, 2005) still do not have access to clean water facilities, the majority living in developing nations, particularly in sub-Saharan Africa (Prokopy, 2005).

As part of the solution to the lack of coverage, governmental, non-governmental, international and local organizations all over the world have tried to promote safe water supply and sanitation programmes for many years (Prokopy, 2005). However, in most areas these endeavours are constrained by the lack of sustainability[1] of the water supply infrastructures (Harvey & Reed, 2007; ADF, 2005; Lockwood, 2002, Kleemeier, 2000; Nyarko *et al*., 2006). For instance, the recent figures of operational failure rates from individual African countries are indicated to be 30–60% (Sutton, 2005; Baumann, 2005; Haysom, 2006). The problem is even worse in Ethiopia, where it is quite a common phenomenon to observe non-functional water supply systems without adequate protection, such as fencing, in every part of the country (Mengesha *et al*., 2003).

The development of rural water supply schemes remains too costly for poor countries, relative to their available resources (Lockwood, 2002; Biswas, 2005; Davis & Liyer, 2002). The failure of many water supply systems developed through large-scale investments is the worst case scenario (Kleemeier, 2000; Baumann, 2005). Kleemeier (2000) noted that as many as one out of four rural water facilities are broken down or poorly functioning in developing countries and the construction of new systems cannot even keep pace with the failure of the old ones in some countries. One of the major challenges for rural water supply efforts in developing countries is to ensure that communities manage their water supply systems in a sustainable manner (Harvey, 2007).

If communities are to be considered to be the managers of their water supply systems, then we should know what potential they have and how they should be organised and supported. Since adequate protection and routine maintenance enhance the sustainability of water supply systems and improve the quality of the water from the sources (Ainsworth & Jehn, 2005), an important question to be addressed is: what factors prevent households from achieving this? Whilst

[1] 'Sustainability', within the context of this paper, is defined as the length of the useful life of a water supply infrastructure. More specifically, it is the capacity of an improved water supply system to provide continued beneficial services over time.

criticism of the policy of requiring capital cost contributions for water from poor communities is emerging (Schouten & Moriarty, 2003), it is crucial to know whether this initial participation has any positive or negative implications on future outcomes, for instance on the sustainability of water supply infrastructures.

Thus far, the focus of research has often been on the technological and institutional aspects of water supply systems. User communities in developing countries have rarely been investigated to understand how they can contribute to and benefit from such development programmess. Despite the stated intention of social inclusion, it has become clear that many participatory development initiatives do not deal well with the complexity of community differences, including age, income, education level and other social issues (Godfrey & Obika, 2004; Schouten & Moriarty, 2003).

The purpose of this paper is to identify household-level determinants of community participation in water supply system protection and maintenance. Understanding these aspects of rural water supply systems can give an insight into developing a useful strategy that could potentially address large-scale non-sustainability of newly installed water facilities in developing countries.

The paper is structured as follows. In Section 2, the methodological approach to data collection and analysis is presented. Subsequently, the results and discussions of findings are provided in Section 3. Finally, Section 4 presents a number of conclusions and policy recommendations.

2 METHODS

2.1 Data collection

A cross-sectional survey was conducted from July to November, 2008, in Achefer, Ethiopia, where improved drinking water supply systems exist. In Achefer, a total of 75 water supply systems were found, which constituted the sampling frame from which 16 water supply systems were randomly selected. The villages in closest proximity to improved water supply systems were identified, and 10 household respondents who reside in each village were randomly selected for the survey. The main criteria for the selection of the villages was the existence of a water supply system developed by Organization for Rehabilitation and Development in Amhara (ORDA), and the main criteria for the selection of the sample respondents was that they were residents of these villages. Respondents were randomly selected from the list of residents from each village, obtained from the ORDA project implementation office in Ismalah. The total sample size was 160. The household was considered to be a unit of analysis because water supply issues concern the entire household.

2.2 Model specification and data analysis

Analysing household participation and its determinants in water supply system protection and maintenance is the major objective of this paper. To achieve this, the cash contributions (CASHCONT; measured in Total Ethiopian Birr (ETB)[2]) and labour contributions (LABORCONT; measured in Total days), which were willingly provided by users during the previous three months for the protection and maintenance of water supply systems are taken as major dependent variables, to serve as proxies for the role of users in the protection and maintenance of their water supply systems.

Independent variables were identified based on the actual conditions in the area, which were assumed to explain the variations in the dependent variables across households. An increase in household socio-economic and demographic variables were hypothesised to affect the dependent

[2] 1 Ethiopian Birr (ETB) equals approximately $0.06, as of February 2013.

variables positively; these socio-economic and demographic variables included: age of the household head (HEADAGE; measured as: 1=1–15 years, 2=16–30 years, 3=31–45 years, 4=46 years and above); his or her educational level (HEADEDLVL; measured as: 0=Illiterate, 1=Read and write, 2=Elementary complete, 3=Junior complete 4=High school complete and above); household annual income (INCOME; measured as: Total ETB/year of the value of agricultural, non-agricultural and livestock holding obtained annually); household head gender (HEADGENDER; measured as: female=1, 0 otherwise); and household size (HHSIZE; measured as: number of people in the household). The theoretical standpoint for these assumptions was that, as age and educational level of household head increases, awareness about water management issues potentially increases. Women in rural Ethiopia are often shouldered with the role of managing household chores, including household water, and thus they would be expected to be inclined to contribute more for water supply management than their male counterparts. Likewise, the hypothesis that increasing income would significantly and positively influence household contributions for water supply management was pertinent to the consideration that those households which had more income would have sufficient cash and labour at their disposal for water supply system management. Sense of responsibility to protect and maintain water supply systems (SENORES; measured as: 1=Not responsible at all=0%,… 5=Highly responsible=100%), was expected to influence cash and labour contributions positively. If a household head felt responsible for the management of communal water supply systems as if of his/her own, it would be possible that he/she could assume the cost (in cash or in kind) of management of his/her water supply system. The number of alternative water sources existing in close proximity (NOALWS) was expected to influence the participation of households in the management of water supply systems negatively. This is because, as more options are available in the vicinity from which households fetch water freely, households would be less inclined to make cash and in-kind contributions to the management of the improved water supply system. Convenience of location of the water supply systems to the household (CONOL; measured as: 1=Very inconvenient,… 5=Very convenient) is hypothesised to influence the contributions of cash and labour positively. As a household head finds his/her improved water facilities more convenient (i.e. not located far away from his/her house and not involving going up or down hill to collect water from it, and so on), he/she could be willing to pay cash and contribute labour for the protection and management of that water supply system. The number of incidents of waterborne diseases in a household during the last year (INOWBDs) was also included, to evaluate its impact on increasing or decreasing the participation by households towards the protection and maintenance of their water supply systems. It was hypothesised that the incidence of water-borne diseases – often caused by water accessed from unprotected sources – would impel households to resort to using improved water supply systems, and to pay cash or contribute labour for its management. Furthermore, the frequency of using water from a water supply system for generating income for the household, such as for vegetable production (UOWFSGI; measured as: 1= Not at all,… 4=Very often) was hypothesised to influence the decision of households to contribute cash and labour for the protection and maintenance of water supply systems because, as households generate additional income using water from the water facility, they would appreciate the benefit of the improved water system and be willing to contribute part of that income for its management. Advocacy provided by local health promoters (ADVOCACY; measured as: 1=No teaching at all,… 4=Extremely intensive advocacy) was hypothesised to affect cash and labour contributions positively. The substantive reason for including this variable was the consideration that promotion and education about the inherent health and socio-economic benefits of using clean water from improved water facilities could increase the level of awareness in households which, in turn, could positively influence their decisions to contribute to water supply system management. The degree of household participation during the project design and implementation (DPARDPIMP; measured as: 1=None at all,… 5=Excellent) should influence the dependent variables positively. This variable was also included in the study as a potentially positive determinant of the cash and labour contributions, with the assumption that as a household 'closely' participates in the design and implementation of the water supply project, the head of household's sense of ownership of the water facility increases, which, in turn, could increase his/her future participation in the management of the water system. In contrast, the perceived safety of water from the source (PSOWS; measured as: 1= Not safe at all,… 5=Highly safe) and household daily water satisfaction (WASATS; measured as: 1= Not satisfied at all,… 5=Highly satisfied[3]) were expected to affect the dependent variables negatively. These last assumptions were justified by the consideration that if households perceive the water from an improved water facility is unsafe they would not be willing to contribute for its management. Likewise, if a household is satisfied with the amount of water it is getting daily from a source, it would not consider any management which might improve the amount of water from the source seriously.

The relationship between the dependent and independent variables could best be represented by censored linear regression. A linear model was selected because it allowed analysis of the link between participation in water supply system protection and maintenance (i.e., contributions) and

[3] An appropriate measurement for this variable may be to consider the actual quantity of water supplied to households (in litres per capita per annum) on the basis of which a satisfaction index could be developed. Future research may thus take this into account.

the corresponding factors, which could affect the outcomes. This assumed that the values of contributions were continuous dependent variables. The dependent variables could also be censored because there was a lower limit of zero applicable when households did not actually contribute anything within the previous three months. Quite often, rural people perceive water as a free of cost commodity and, as such, paying for it is considered as a luxury. If that is the case, low-income households may not spend any money for water supply system protection and maintenance. This situation, where the distributions of observations becomes censored as the observed values are close or equal to zero, can be analysed using the Tobit model (Greene, 2002; Marin-Galiano & Kunert, 2005). Formally, the Tobit model can be represented as follows:

$$y_i^* = \beta x'_i + e_i \qquad (1)$$

where y_i* is the latent variable, which fulfills the characteristics of the linear model, β is the unknown vector parameter to be estimated, x_i are a vector of independent variables, and the e_i are continuous random variables, which are assumed to be independently and normally distributed about the mean zero and with a common unknown variance of σ^2. If the observed dependent variable is denoted by y_i, then a Tobit model, for observations y_i, i=1, 2…n can be represented by one of the following:

$$y_i = 0 \qquad \text{if } y_i^* \leq 0 \qquad (2a)$$

$$y_i = \beta x'_i + e_i \qquad \text{if } y_i^* > 0 \qquad (2b)$$

Based on the above specifications, the unknown parameters can be estimated by maximising the corresponding likelihood function:

$$L(\beta,\sigma^2) = \prod_{y_i=0}\left(1-\Phi\left(\frac{\beta x'_i}{\sigma}\right)\right)\cdot\prod_{y_i>0}\frac{1}{\sigma}\phi\left(\frac{y_i-\beta x'_i}{\sigma}\right) \quad (3)$$

where ϕ and Φ are the standard normal density function and distribution function, respectively. The values of coefficients of a Tobit model do not directly correspond to the changes on the dependent variable as a result of a unit change of the independent variables. Rather, the model estimates a vector of normalised coefficients which can be transformed into the vector of first derivatives. The marginal effect of the explanatory variables on the observed values of the dependent variable, given the above specifications, represents the expected value of y_i conditional on y_i being greater than zero. The marginal effect of a standard case, censoring at zero and with normally distributed disturbances estimated at the means of the independent variables, is represented as the following:

$$\partial E\left[\frac{y_i \mid x_i}{\partial x_i}\right] = \beta\cdot\Phi\left(\frac{\beta' x_i}{\sigma}\right) \quad (4)$$

where Φ represents the cumulative standard normal distribution.

Because the results of this paper are of interest for policy recommendations, the marginal effect on the observed values of the dependent variables due to a 1% change given on the independent variables is a valuable result of the Tobit analysis.

The survey data were recorded and organised in a Microsoft Excel spreadsheet. The data encoding procedure was carried out strictly based on the survey questionnaire. A combination of double-entry and print-and-verify methods of data entry checking was performed to avoid errors in the recording process. Data consistency checking was also performed by considering the frequency distribution of household age, educational and gender parameters evaluated against the recent national comparative socio-economic indicators. The minimum and maximum limits of contributions, income and livestock holding values were also examined. The results confirmed that the majority of the information provided by the respondents was consistent.

STATA/SE 10.0 for Windows (StataCorp LP, College Station, Texas USA) software was used for data processing.

2.3 Methodological limitations

As noted in Section 2.1, the study is confined in one study area in Ethiopia (Achefer), implying that there is no accurate way of determining if results in a demographically-similar community elsewhere within Ethiopia, or in another African country, would differ if, for example, hydrological or institutional conditions or challenges were slightly divergent. Another limitation of the approach is related to whether all the possible determinants of household contributions are covered in this analysis. For example, it is difficult to know if conflicting expenses and needs of low-income households deter households from contributing to local water system maintenance and sustainability improvements. Additionally, other factors that might be features of water supply projects in other regions of sub-Saharan Africa, which may influence household decisions to participate in the management of rural water infrastructures, are not included in the study.

3. RESULTS AND DISCUSSION

3.1 Household socio-economic characteristics

Table 1 summarises some basic descriptive statistics of gender, age and educational characteristics of the households surveyed. The table also shows that 51% of household members are below 15 years of age. Females constitute 51% of household members but only constitute 9% of the household heads.

Educational levels are low across households. Around 63% of household members are illiterate and only 1% have attained formal education up to high school and above. Over 64% of the household heads cannot read and write. These characteristics are consistent with the report by the Federal Democratic Republic of Ethiopia Population Census Commission (CSA, 2008), suggesting that the sample can be considered representative for an average Ethiopian household in the region.

The mean household size is about five persons. Nearly all of the households make a living out of subsistence agriculture and animal farming. The mean non-agricultural income of households and the average value of total crops harvested by households are ETB 154 per year and ETB 14,047 per year, respectively (Table 2). Thus, households gain an average annual value of non-agricultural and agricultural total income of ETB 14,200 per year. The total value of livestock holdings range from ETB 0 to 26,400 across households, with a mean and standard deviation of ETB 8406 and ETB 5650, respectively.

The descriptive statistics of household socio-economic characteristics generally show that the surveyed households are composed of large subsistent farming families, most of which are without access to formal education. It also shows that farm families have relatively divergent annual household incomes. Such socio-economic characteristics are expected to influence households' decisions about contributing cash and labour for water supply system management in the surveyed region. This will be dealt with in detail in the following section.

3.2 Household contributions of cash and labour for the protection and maintenance of water supply systems

Although safe water coverage in rural areas (of developing countries) is very limited, the cost of investment in water projects and their operation and maintenance is becoming so expensive that governments, donors and implementing organisations can no longer afford them all (Kleemeier, 2000; Biswas, 2005). One of the daunting challenges in the water supply sector is securing resources to manage and maintain frequently breaking water facilities and keeping the water supply systems operating in a sustainable manner (Nyarko *et al.,* 2006). In part as a solution to this phenomenon, project-implementing organisations require at least operation and maintenance costs to be covered by user households. Two additional reasons for this are: first, the often stated goal of 'management at the lowest appropriate level', which assumes that management by the beneficiaries is easier and logical; and second, the perspective which treats water as an 'economic good' for which people should be willing and able to pay (Bhandari *et al*., 2007; Bohm *et al*., 1993). Approaches that endorse management of rural water supply systems by user communities are generally known as 'community management' (Schouten & Moriarty, 2003; Doe & Khan, 2004). Community management is a management theory that advocates demand responsive approach (DRA) based on the principle that demand for improved and sustained water services induces the involvement of beneficiaries, and this in turn reduces entailed cost in terms of initial capital outlay as well as costs of operation and maintenance. These approaches also better target the real needs of communities by incorporating indigenous knowledge at the grassroots level. They also aim at building local capacity in extending and replicating the existing services (Kleemeier, 2000). Doe & Khan (2004) has stated that "the theory behind community management as such aims to empower and equip communities to take control of their own development.” But are rural households really willing to pay (contribute) for communal water services? Will they assume management of communal water supply systems as their responsibility? If the answers to these questions are dependent on other factors, what are those determinants? These questions remain poorly answered and require detailed further investigations to be conducted.

If households are supposed to shoulder management responsibilities, effective participatory methods and support mechanisms must be formulated and implemented. This requires, among other factors, an understanding of the role of households in the protection and maintenance of water supply systems, and being able to distinguish the determinants of their contributions: the major objective of this paper. To achieve this, the contributions of cash and labour intended for water supply system protection and maintenance made by individual households during the previous three months were recorded and examined.

Village water use committees (WUCs) mainly determine and set monthly contributions, of both cash and labour, for the protection and maintenance of the water supply systems with minimum or no consultation with households. Nearly all villages set sums (of varying amounts) to be willingly paid by users of different water supply systems. Some of them, however, requested donations of unspecified amounts to be made on a voluntary basis. Accordingly, during the period under consideration (see Table 3), households contributed an average total of ETB 2.5 for three months, with a standard deviation of ETB 1.6, and also provided a total average labour of 1.3 days, with a standard deviation of 1.1 days (without including monetary fines or labour undertaken as a penalty). It is useful to note that these payments are referred to as “contributions” rather than fees for water to show that they are voluntary donations. A relevant question here is whether the amount that households are currently contributing on average covers the cost of operation and maintenance of the water supply systems. For a water source with 85 users on average paying ETB 2.5 every three months, the total annual contribution would be about ETB 850 per year. With the current cost of spare parts, and if a caretaker is also employed, this amount is not likely to be sufficient to support the protection and maintenance requirements of a water supply system. The cash amount required to sufficiently manage a water supply system (including salary for a full-time caretaker of about ETB 250 per month, and with an allowance for maintenance of about ETB 1500 per year) is estimated at ETB 4500 per year. Thus, current user contributions provide only about 19% of the estimated cost, indicating that either contributions would need to be markedly increased or outside support provided for adequate protection and maintenance.

The contributions also varied significantly across households. Cash payments, for example, ranged from ETB 0 to 6. This was due, as noted above, to the different tariff levels imposed by the respective WUCs of different villages, to delayed and partial payments, or complete refusal to pay or to contribute, and even, in some cases, due to additional contributions of cash over the determined tariffs by interested households. A number of socio-economic and exogenous factors were hypothesised to affect this variation of households' decisions about regular and timely participation. These variables and the descriptive statistics, with their description and measurement, are summarised in Table 3.

Econometric results from the Tobit model (Table 4) support the validity of using such a simple approach to analyse the determinants of households' decisions for participation in water management agendas. The analysis further confirms that the signs of most of the coefficients are consistent with the hypothesised relationships, and some are statistically significant. These help identify important characteristics explaining the decisions for regular and on time contributions (in cash and/or labour) by households for water supply system protection and maintenance, and this also indicates that some of the factors are clearly necessary for consideration in the formulation of rural water source management strategies. A number of variables appear to be insignificant but this is likely to be due to the relatively small sample size involved. Due to the high collinearity between sense of responsibility (SENORES) and degree of household participation during project implementation (DPARDPIMP), sense of responsibility (SENORES) was dropped from the regression. Additionally, the coefficient and standard error values for sigma indicate that there is a statistically significant censoring in the samples for both dependent variables in the model.

Household head gender (HEADGENDER) has a negative relationship with both cash payments and labour contributions but is not significant based on the conventional statistics. This is different from the initial proposition that women would participate more in water supply system management through cash and labour contributions. However, the descriptive data show that female-headed households are among the poorest of the surveyed households. It is more likely that they have other priorities than paying or working for water supply system management, which seeks their voluntary participation (although this effect should be at least somewhat controlled by the income variable). Likewise, the age of household head (HEADAGE) appears to have an insignificant and negative relationship with both cash and labour contributions. Household head educational level (HEADEDLVL) is insignificantly associated with both cash payments and labour contributions, contrary to the initial assumptions. Furthermore, household size (HHSIZE) has a negative impact on cash payments but a positive impact on labour contributions. This seems reasonable, as households with large family size are concentrated more within low-resource categories (ADF, 2005). However, the reason for the latter case could be that bigger households can more easily afford labour for water supply system management as they have enough for farming and other productive activities.

Total household income (INCOME) also influences the payment of cash and provision of labour, both with positive signs, as expected. This result is consistent with basic economic theory, which states that an individual's demand for most commodities or services depends on income (Mbata, 2006; Minten, *et al*., 2002). This also implies that poor households may not make payment for water a priority, as they may have to make choices to spend their limited financial resources for subsistence needs. The parameter value for advocacy provided (ADVOCACY) was also a significant factor for labour contributions (with a positive sign as expected) but not for cash contributions. This suggests that advocacy to create awareness about the opportunities for promoting protection and maintenance of water supply systems is an important component of any support framework, as it positively affects households' motivation to provide labour for water supply system management.

The number of alternative water sources in close proximity (NOALWS) also influenced the payment of cash by households with a high significance level, and with the expected negative sign. This suggests that the existence of alternative water sources (such as rivers, undeveloped springs and home-made wells) decreases households' willingness to make cash payments for sustained water services. However, at the same time, it significantly and positively increases labour contributions. This implies that the increasing presence of alternative water sources in a village decreases cash and increases the labour available for water source protection and maintenance. Since increased number of alternative water sources available to households has such contradictory effects on cash and labour contributions (with the one offsetting the other) the result is of limited relevance for policy. However, further and detailed research is required to clearly determine the effect of alternative water sources on water source sustainability. Households' level of trust in water use committees (TOWUCs) significantly influences cash payments with a positive sign, as expected. This tells us that households with a high level of trust in water use committees, believing that any money raised would be used for the intended purpose, contribute more. Convenience of location of the water supply system (CONOL) is found to have a positive but insignificant impact on both cash and labour contributions. The regression results also indicate that the incidence of waterborne diseases (INOWBDs) has a positive but insignificant relationship to both contributions. This finding supports the view that households do not link the quality of water from improved supply systems with the incidence of waterborne diseases. Thus, further educational efforts may be required to better utilise the effect of this parameter on sustainability issues.

The negative coefficient sign for the use of water from the water supply system for generating income (UOWFSGI) in explaining cash payments goes against the initial assumption that it is supposed to increase participation. However, this result is probably attributable to the small proportion of households in the study villages (3%) which have been using water 'most frequently' to generate income, such as by vegetable production; thus, the detail of the analysis is perhaps not sufficient to detect the hypothesised effect. In addition, the majority of such use involves one particular water supply system located in Luhudi village, where the WUC had set rules that required water users for micro-scale irrigation to take turns in looking after the water supply system. Because they are caretakers of the water supply system on a weekly basis, they may have been less interested in providing cash. This implies that this parameter did not influence the majority of households' decisions to make cash payments for water supply system management in the study area, at least during the study period. However, labour contributions are influenced positively by this parameter, significantly showing that those households who use water for vegetable production participated more by providing labour for water supply system management than by contributing cash (due at least in part to rules specified by the WUCs concerned).

Daily water satisfaction (WASATS) and perceived safety of water from the sources (PSOWS) have positive but insignificant effects on both contributions, contrary to what was initially hypothesised. Although these variables are insignificant, this likely reflects households' limited awareness of the inherent health and economic benefits of increased water quality. Thus, additional education about these relationships might have the effect of enhancing the sustainability of water supply systems. The level of household participation during the planning and service establishment phase (DPARDPIMP) is significantly associated with variations in both cash payments and labour contributions across households. The coefficients demonstrate the expected positive signs. This finding suggests that the inclusion of households in the early phases of a project cycle and its implementation will have a positive implication for future sustainability outcomes. This is in line with the profound importance placed on community involvement in rural water supply approaches (Gleitsmann, 2005; Gross *et al*., 2001; Narayan, 1995; Harvey, 2007; Tayong & Poubom, 2002; Fonseca, 2003). Given that the significance estimates of household head gender (HEADGENDER) on cash contributions, and household head educational level (HEADEDLVL) on labour contributions are both quite close to statistical "significance" thresholds, these variables might be important in other samples.

The marginal effect estimates reveal that the degree of household participation during project implementation (DPARDPIMP) is the first and most important variable (for a unit change in its value)[4], which exerts the greatest effect on both contributions (Table 5). An increase in the degree of participation during the project implementation phase by one unit significantly increases cash contributions by ETB 0.37 per month, and increases labour contributions by 0.13 days per month. Thus, it could be very useful for project-implementing organisations to increase the participation of households as much as possible during water supply system installation to achieve increased participation in water supply system protection and maintenance through increased cash and labour contributions.

Advocacy provided on water issues (ADVOCACY) is the other factor which exerts a large effect on labour contributions. The analysis shows that a unit increase in the level of advocacy provided significantly increased labour contributions by 0.22 days per month, whereas it increased cash contributions insignificantly.

The significance of the variables along with the magnitude of the marginal effect suggests that project-implementing organisations should advocate and create awareness of the importance of water supply system management as much as is reasonably possible[5] to achieve better participation of households through labour contributions. This is empirical evidence which supports beliefs commonly held by water development organisations.

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[4] Note that an alternative approach is to calculate a response elasticity, which would evaluate the percentage change in response (for cash or labour contributed) given a percentage change in the independent variable (with all other variables evaluated at the mean); however, this method has been omitted here for simplicity.

[5] A more complete analysis of this would include the costs of advocacy and additional awareness.

Household total income (INCOME) emerges as the third most useful variable, slightly affecting labour and cash contributions. An increase in household income by ETB 1000 significantly increases the cash contributions by ETB 0.03 per month, and labour contributions by 0.03 days per month. These effects are very small compared to the costs of water projects, although projects that increase income may become somewhat more sustaining.

4. CONCLUSIONS AND RECOMMENDATIONS

The goal of this paper was to identify the leading determinants of household participation in managing water supply systems and recommend possible solutions to the large-scale breakdown of water supply systems in Ethiopia. The results of the study have brought forth a number of major findings outlined below.

The estimated annual contributions of cash and labour indicate that the amounts currently provided on average by households are not likely to be sufficient for adequate management of the rural water systems in the Achefer Area. Additionally, the empirical analysis conducted using a Tobit model shows that households' degree of participation during the project design and implementation, the advocacy provided and household income are the leading determinant factors, due to their statistical significance in influencing either or both cash and labour contributions.

The degree of households' participation during the planning and service establishment stage has significantly influenced willingness-to-pay cash and willingness-to-contribute labour for water supply system protection and maintenance. The marginal effect estimates from the Tobit model showed that (with all other parameters unchanged) a unit increment in the degree of participation during the project design and implementation phase significantly increases cash and labour contributions (ETB 0.37 per month and 0.13 days per month, respectively). The literature on community development suggests that several hierarchies of participation can be identified based on the intensity of participants' involvement in a particular development project. These usually include requesting participants to contribute their resources (such as cash, labour and time) at lower levels, and leaving all decisions to be made by the participants with only minimal external support at the upper levels (Prokopy, 2005; Doe & Khan, 2004; Kumar, 2002). From the finding of this paper, it is possible to conclude that more organised participation of households at higher levels during project design and implementation enhances the levels of households' participation in water supply system management and, hence, boosts water supply system sustainability. This result, specific to the context of the study area, underpins the foundation of the Ethiopian Water Resources Management Policy that puts more emphasis on promotion of participatory approaches as guiding principles to ensure the economic and social benefits of water in a sustainable manner (ADF, 2005; Haileslassie *et al*., 2008).

The level of advocacy about water supply management and its consequences, such as enhanced sustainability and improved water quality, is revealed to be a determining factor of households' participation in water supply system management, significantly influencing labour contributions. The marginal effect of a unit increment in the level of advocacy provided by local promotion agents focusing on the benefits of water supply system management issues significantly increases the labour contributions by 0.22 days per month. Although this variable has no statistically significant effect on cash contributions, creating awareness through appropriate institutional support can increase the quality and sustainability of water services over time through the labour contributions that can be used for water supply system management.

Income is shown to affect the decision of households to participate in water supply system protection and maintenance. This shows the importance of recognising that an increase in annual household income increases the tendency to pay monthly tariffs and contribute labour for water supply system management, partly due to ability to afford – a fact that one can intuitively accept. Given the number of households with a lower level of economic status in the study villages, it may be useful to formulate mechanisms that can address poverty to maintain continued contributions. This might be achieved through working to develop strategies that specifically target the poor as a benchmark of service delivery and that support uses of water beyond basic livelihoods, such as micro-scale irrigation and horticultural development initiatives. Subsidies and other support mechanisms may also be designed that specifically target poor households.

It is, however, important to note that the marginal effect of increasing total income of a household by ETB 1000 per year is only an increment in the cash contributions of ETB 0.03 per month and in the labour contributions of 0.03 days per month. Hence, compared to the cost of protection and maintenance of the water sources, this does not seem a practical and economically sound measure, although it is one which, if possible to achieve, could potentially enhance the sustainability of water supply systems.

The presence of alternative sources of water is found to have a significant negative effect on cash and a significant positive effect on labour contributions. Additionally, the level of trust in WUCs has a statistically significant positive effect on cash and statistically insignificant negative effect on labour contributions. Use of water from the source for generating income is also shown to have a statistically significant negative effect on cash and significant positive effect on labour contributions. For these three variables, increasing the magnitude of any one of them has contradictory effects, positively influencing the cash contributions whilst adversely affecting the labour contributions, or vice-versa. Therefore, since both cash and labour contributions are key to the day-to-day management of the water supply systems, these results would only be marginally useful as policy measure for the sustainability of the water supply systems in the study area. Household head gender, household age, household educational level, household size, convenience of location, incidence of waterborne diseases and perceived safety of water from the sources are found to be insignificant factors in determining cash and labour contributions of households.

On the basis of the results, this paper concludes that promoting participatory approaches, which fully involve beneficiaries according to their willingness and potential, supported by the right advocacy and promotional efforts, can significantly contribute to the sustainability of rural water supply systems in Ethiopia. Furthermore, any water supply project should clearly illustrate the scope of a sustained and improved water service, along with its benefits to the beneficiaries, from the very beginning[6]. This requires a demand assessment be made after visibly advocating the benefits of the project in the earliest planning stages. In the implementation phase, households must also be aware that the project is being managed by them, and that outsiders and implementing organisations are only there to support them in their technical and financial limitations. Given that the management requirements of the observed water supply systems (maintenance and protection costs, labour and local materials such as wood) are relatively affordable by households, it seems acceptable that users should cover them; however, this fact should be promoted continuously from the beginning. This does not mean that households should be left alone: appropriate management capacity must be created to achieve a meaningful sustainability with the right support framework.

[6] This recommendation is strongly supported by Schouten & Moriarty (2003).

Finally, albeit that this research has rigorously focused on community level factors, the importance of further research is indisputable for exploring the hydro-geological aspects of water supply systems and their impacts on sustainability water services in the area. Additionally, although the direct involvement of beneficiaries in funding the construction of water supply systems may be limited, their indirect participation, such as through attending seminars in sanitation and waste management, natural resource protection, and so on, may influence communities' ability and willingness to manage local water supply systems. Thus, such factors should also be explored in future research.

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Table 1. Household gender, age and educational characteristics

		N	**Percentage**
Household member type	Household head	160	18
	Spouse of the household head	146	17
	Child	575	65
Household member gender	Male	432	49
	Female	449	51
Household member age	1–15 years	451	51
	16–30 years	231	26
	31–45 years	120	14
	46 years and above	79	9
Household member educational level	Illiterate	557	63
	Read and write	251	29
	Elementary complete	37	4
	Junior complete	27	3
	High school complete and above	9	1

Total number of people within surveyed households=881

Table 2. Income and livestock holding of households

	Minimum	Maximum	Mean	Standard Deviation
Total annual non-agricultural income, ETB per year	0.0	10,000.0	153.6	839.1
Total value of crop harvested, ETB per year	900.0	45,340.0	14,046.7	8,102.7
Total income, ETB per year	900.0	45,340.0	14,200.3	8,043.1
Total value of livestock holding, ETB	0.0	26,400.0	8,406.3	5,649.9

N=160

Note: The descriptive statistics of the total annual household income (the sum of non-agricultural income, value of crop harvested and livestock holding) are provided in Table 3

Table 3. Descriptive statistics of household contributions and proposed explanatory variables

	Minimum	Maximum	Mean	Standard Deviation
CASHCONT	0.0	6.0	2.5	1.6
LABOURCONT	0.0	5.0	1.3	1.1
HEADGENDER	0.0	1.0	0.1	0.3
HEADAGE	2.00	4.0	3.12	0.8
HEADEDLVL	0.0	2.00	0.37	0.5
HHSIZE	1.0	10.0	5.5	1.8
INCOME	900.0	45340.0	14200.0	8043.1
ADVOCACY	1.0	4.0	2.8	1.0
NOALWS	0.0	4.0	0.5	0.8
TOWUCs	1.0	5.0	4.1	1.2
CONOL	1.0	5.0	3.3	1.2
SENORES	1.0	5.0	4.0	1.3
INOWBDs	0.0	4.0	0.2	0.6
UOWFSGI	1.0	4.0	1.3	0.7
WASATS	1.0	5.0	3.8	0.8
PSOWS	1.0	5.0	3.6	0.9
DPARDPIMP	1.0	5.0	4.0	1.2

N=160

Table 4. Tobit estimates of the determinants of cash and labour contributions by households for water supply system protection and maintenance

	Cash contribution	**Labour contribution**
Determinants	**Coefficient**	**Coefficient**
HEADGENDER	-0.63	-0.24
HEADAGE	-0.19	-0.11
HEADEDLVL	0.30	-0.29
HHSIZE	-0.03	0.03
INCOME	0.03*	0.04***
ADVOCACY	0.12	0.32***
NOALWS	-0.28*	0.25**
TOWUCs	0.19*	-0.05
CONOL	0.03	0.07
INOWBDs	0.06	0.16
UOWFGI	-0.35*	0.33***
WASATS	0.07	0.02
PSOWS	0.05	0.06
DPARDPIMP	0.45***	0.18**
Constant	-0.31	-1.64
Sigma	1.40	0.96
Uncensored obs.	140	135
X^2	72.03	76.22
Pseudo R^2	0.12	0.15
Log-likelihood	-266.68	-208.86

***, **,* indicate significance at 0.01, 0.05 and 0.1 levels, respectively

Table 5. Marginal effects of determinants on cash and labour contributions

	Cash contribution	**Labour contribution**
Determinants	**dy/dx**	**dy/dx**
HEADGENDER	-0.49	-0.16
HEADAGE	-0.16	-0.07
HEADEDLVL	0.24	-0.20
HHSIZE	-0.03	0.02
INCOME	0.03	0.03
ADVOCACY	0.10	0.22

NOALWS	-0.23	0.18
TOWUCs	0.16	-0.03
CONOL	0.03	0.05
INOWBDs	0.05	0.11
UOWFGI	-0.28	0.23
WASATS	0.06	0.02
PSOWS	0.04	0.04
DPARDPIMP	0.37	0.13
Scale Factor for Effects	2.51	1.39

Note: Marginal effects reported here are for the mean values of the independent variable