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DIFFERENCE IN IMPROVED WATER SOURCE ADOPTION BETWEEN URBAN AND RURAL HOUSEHOLDS IN CAMEROON

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Abstract: Many households living in developing countries still collect water from unimproved sources. The situation is particularly worse in rural areas. This study analyses the differences in improved water source adoption between urban and rural households in Cameroon. Our analysis uses data from the fifth Cameroon Demographic and Health survey conducted in 2018-2019. Results from logit regressions suggest that the use of improved water source increases when the head of household is a woman. It also increases with education, access to information and wealth. Conversely, it decreases with household size. The approach of Fairlie (2006) is further used to evaluate the contribution of the above factors to urban-rural differences in the adoption of improved water sources. Our analysis shows that the above factors explain 41% of the differences in water source choices observed between urban and rural households. The policy recommendations of the research are described in the paper.

Keywords: Adoption of improved water source, determinants of adoption, urban-rural gap.

INTRODUCTION

Access to and use of improved water sources have many health and economic outcomes. Improved sources are those that are potentially capable of delivering safe water by nature of their design and construction. These include piped water, boreholes or tube wells, protected dug wells, protected springs, and rainwater. Unimproved sources include unprotected dug wells and unprotected springs (World Health Organisation, 2017). Microbiologically contaminated drinking water can transmit diseases such as diarrhoea, cholera, dysentery, typhoid and polio and is estimated to cause 485 000 diarrhoeal deaths each year (WHO, 2023). In addition, when water comes from improved and more accessible sources, people spend less time and effort physically collecting it, meaning they can be productive in other ways. This can also result in greater personal safety and reducing musculoskeletal disorders by reducing the need to make long or risky journeys to collect and carry water. Better water sources also mean less expenditure on health, as people are less likely to fall ill and incur medical costs and are better able to remain economically productive (WHO, 2023).

However, statistics show that access to an improved water source represents a daily struggle for millions of human beings living mainly in developing countries. In 2020, while 5.8 billion people used safely managed drinking-water services – that is, they used improved water sources located on premises, available when needed, and free from contamination, at least 2 billion people use a drinking water source contaminated with faeces (WHO, 2023). In Cameroon, 78% of households use an improved water source for drinking purpose, implying that 22% of households rely on unimproved sources (INS and ICF, 2020).

Beyond the fact that many households do not collect water from improved sources, it is worth noting that such a situation particularly concerns rural households. Statistics indicate a significant difference in the adoption of improved water sources between urban and rural households. In Cameroon, 96% of urban households consume water from an improved source against 57% of rural households (INS and ICF, 2020). Therefore, rural areas constitute the greatest challenge in the efforts to provide safe water for all. In the literature, several studies such as those of Nauges & Van den Berg (2009) and Briand & Loyal (2013) show that spatial variables are significant determinants of water source choices. In a study conducted in Ghana, Adams et al. (2016) found that respondents in urban settings were 19 % more likely to have access to an improved source of water than those in rural areas. In addition, respondents in the Ashanti, Upper East, and Upper West regions demonstrated higher odds of having access to an improved source of water, with those in the Volta and Western regions reporting lower odds of having access to an improved source of water in comparison to those in the Greater Accra region. However, these existing studies fail to explore factors explaining the differences in households' choices of water sources according to the zone of residence. The identification of the factors explaining these differences and the measurement of the contribution of these factors to the differences will enlighten decision-makers on the effective interventions to promote a better access of all to improved water sources. It will indicate the key factors on which to act to promote the use of improved sources, particularly among rural households.

This study aims to enrich the literature on water source choices by analyzing the differences in improved water source adoption between urban and rural households in Cameroon. Even if the supply of water sources are not the same between rural and urban zones, meaning that households in both rural and urban zones do not face the same choice set in terms of water sources, we assume that each household, specifically rural households, have access to at least one improved source. Indeed, even if piped water is not usually available in rural areas, the government has long opted for a rural-type water supply system involving a collective water supply system. Therefore, the differences in improved water source adoption between rural and urban zones are mainly considered as a matter of demand. The failure of the first International Drinking Water and Sanitation Decade (1980-1990), showing in particular that despite enormous public investments in water infrastructure in developing countries, access to drinking water did not increase significantly (Jaglin, 2001), provides support to our assumption. This failure was due to the fact that the objective over the decade was limited and consisted only of a quantitative objective of connection to the network which sometimes led to oversized projects poorly adapted to the needs of the population (Breuil, 2004). Even when good water infrastructures are available, people might not use them if they do not meet their needs, hence the necessity to understand their water choice behaviour. Access is an intermediate output and has to be combined with favourable demand to generate desired outcomes among users (Larson et al., 2006).

In short, we found in the study that the probability of using improved water sources increases with education, access to information, wealth and when the household is headed by a woman. It decreases with household size. The differences in wealth level, education and information access between urban and rural households are the factors that have the highest explanatory power in explaining the differences in improved water source adoption between the two groups.

Our contribution to the literature is threefold. First, while most studies to date have been limited to the determinants of water source choices, this study – to the best of our knowledge – is the first one exploring factors that explain the differences in improved water source adoption between urban and rural areas. Second, the paper identifies a new determinant of water source choice, namely access to information that we captured by internet and mobile phone use. Although evidence shows that individuals or agents behave differently when information is made available to them, exploration of the effect of information disseminated through internet and mobile phone on water source choices has not yet been performed by scholars. Finally, our study is conducted in Cameroon. Only a few studies on water source choices, including those of Etia et al. (2022) and Totouom (2020) have been conducted in a similar context. However, while these studies show that the zone of residence determines water source choices, they do not explain the differences in access to water observed between households depending on their zone of residence. Our study fills this gap by exploring urban-rural differences in improved water access, as mentioned previously.

The rest of the article is organized as follows: section 2 describes the background and literature review. It is followed by the description of the methods used in section 3. The paper then turns to the presentation of the estimation results in section 4 and finally offers some concluding remarks with recommendations for water policies in section 5.

BACKGROUND AND LITERATURE REVIEW

Many households in Cameroon still rely on unimproved sources. Only 78% of households use improved water sources for drinking purposes (INS and ICF, 2020). In order to ensure adequate household access to drinking water in Cameroon, the Cameroonian authorities have long opted for a policy involving the establishment of two water supply systems (WSS) as in most developing countries: an urban-type WSS allowing households to obtain water via a private connection or a standpipe[1] and a rural-type WSS (or village hydraulics) intended for rural communities and comprising only collective water supply points.

In urban areas in particular, public drinking water supply activities were carried out by La Société Nationale des Eaux du Cameroun (SNEC). Since the reorganization of this sector in December 2005, two new entities have been created with the aim of strengthening service throughout the country. This is the Cameroon Water Utilities Corporation (CAMWATER) whose purpose is the management, on behalf of the State, of the assets and rights allocated to the public service of drinking water in urban and peri-urban areas and of the water company whose activities started in 2008 for a period of 10 years, with the mission of ensuring the public service of drinking water in Cameroon on the leased perimeter which covers a little more than 100 urban and peri-urban centers. Thanks to the end of the concession with CAMWATER in 2018 and the new Decree of 2018 reorganizing CAMWATER, the latter now also has the mission of operating the public service for the production, transport and distribution of drinking water.

However, whether they are connected to the piped network or not, domestic users have to deal with many inconveniences on a daily basis, such as untimely water cuts at the source of supply. In urban areas, among households using tap water or water from a pumped well or a borehole, nearly half (46%) reported having experienced an interruption in water supply for at least one day during the last two weeks preceding the fifth Cameroon Demographic and Health survey (CDHS-V). This proportion is 52% in Yaoundé/Douala and only 18% in rural areas (INS and ICF, 2020). Users of the national water distribution company face an average of 8.34 water cuts per month due to demand which is greater than supply and the company's infrastructure which is insufficient (Atangana Ondoua, 2021). In addition to water cuts, there is also the water offered which is not always of good quality. Faced with the approximate quality of water that can often be offered, people can resort to various water treatment techniques to make it more suitable for consumption. With regard to water treatment, just over one in ten households (12%) use an appropriate method of drinking water treatment, mainly the addition of bleach/chlorine (7%) and filtering using ceramic, sand, cloth or other filters (5%) (INS and ICF, 2020).

A fundamental step in addressing the issue of low access to drinking water is improved understanding of the root causes of the phenomenon, hence the interest of our study. Over the past decades, a number of studies have contributed to the literature on water source choices (Adams et al., 2016; Basani, et al., 2008; Boone et al., 2011; Briand & Loyal, 2013; Etia et al., 2022; Mu et al., 1990; Persson 2002; Totouom, 2020; Zoungrana, 2021). They highlighted the effect of a number of factors on household choices that we also consider in our study. Previous studies such as Adams et al. (2016), Nauges & Van Den Berg (2009) and Totouom (2020) stress the effect of the level of education on household choices regarding the source of water used. They suggest that the higher the level of education, the greater the probability of using an improved source, mainly piped water. The idea is that income may increase with the level of education. In addition, the lack of education limits the opportunities for access to information. A low level of education limits the understanding of the advantages (health benefits, ease of collection, constant availability and saving in terms of time of fetching water) of having water at home. We thus formulate the following hypothesis:

> *Hypothesis 1: Education increases the probability of improved water source adoption*

Gender is also highlighted in previous studies as determining water source choices. Although the impact of gender of the household head in previous studies is mixed, most of the studies concluded that female-headed households are more likely to have access to and use improved water sources than male-headed households. For example, Boone et al. (2011) in their study found that female-headed households in rural areas are 16% more likely to use public taps and 6% less likely to use surface water. One explanation could be that women are usually responsible for caring for sick people in a household. As a result, they feel more concerned than men about the risks associated with drinking unsafe water, since in the event of illness, the time they would have to devote to productive and remunerative employment, education children or preparing meals will be reallocated to sick people (Totouom et al., 2018). The following hypothesis is therefore formulated:

> *Hypothesis 2: Having a woman as household head increases the probability of improved water source adoption*

Household size is also a factor considered in previous studies. As suggested by numerous authors, including Nauges & Van Den Berg (2009) and Briand et al. (2010), household size is highlighted as a significant factor that can have a mixed effect on the choice of water supply source. A large household size for example can demotivate a poor household to take a private connection at home in order to rationalize water consumption, while a large number of members can encourage connection to the water supply network to facilitate collection of water, especially since the opportunity cost of collection from alternative sources would be very high (Briand & Loyal, 2013). However, following Etia et al. (2022), who show that there is a negative relationship between household size and the probabilities of using taps and standpipes for drinking water in Cameroon, the following hypothesis is formulated:

> *Hypothesis 3: Household size reduces the probability of improved water source adoption*

Wealth/income level is also an important factor in household choices. The positive effect of income/wealth on improved source adoption is justified by the fact that in general, the most safe and reliable sources (and therefore the most sought after) are in general those which involve the highest costs of access, excluding the poor. Etia et al. (2022), in their study conducted in Cameroon, highlight a positive relationship between the quintile of economic well-being (richest category) and the probabilities of access to drinking water from taps and boreholes, as well as a positive relationship between a household's electricity connection and the probability of access to drinking water from a tap. This result is confirmed in the work of Totouom (2020). The following hypothesis is thus formulated:

> *Hypothesis 4: Wealth increases the probability of improved water source adoption*

The lack of information can be a barrier to the adoption of improved water sources for many households. It is well known since the seminal works of Stigler (1961) and Arkerlof (1970) that economic agents do not always have all the necessary information when making their choices as postulated by neoclassical microeconomic analysis, which

[1] Formerly promoted in developing countries by international organizations including the World Bank to overcome the difficulties of extending the network in urban areas, standpipes have been increasingly abandoned because of poor upkeep and maintenance, but much more due to the fact that they were a source of wastage of water by users due to the fact that it is generally free. The public standpipes that still exist today have mostly been given in concession to private individuals. It was born from the water restructuring policy implemented by the Cameroonian government by decree N0 2005/493 of December 31, 2005 and intervenes in place of the defunct National Water Company of Cameroon (SNEC).

lead to non-optimal decisions and equilibriums. Besides, evidence shows that individuals or agents behave differently when information is made available to them. For instance, when information about the level of arsenic in drinking water is provided, households switch the drinking water source (Barnwal et al., 2017). Likewise, exposure to newspaper and radio increases the probability of purifying drinking water (Jalan et al., 2009). We formulate the following hypothesis:

Hypothesis 5: Access to information increases the probability of improved water source adoption

METHODS

The model explaining the adoption of improved water source

In this study, we first estimate the determinants of the probability to adopt improved water sources before estimating the contribution of each determinant to the differences observed between urban and rural households. For the first step of the analysis, a standard logit model is used. The underlying economic model is a random utility model as developed by McFadden (1974). The model assumes that each household adopts an improved source if its indirect utility $U_1(.)$ is greater than the one without adoption $U_0(.)$. Under the assumption that the indirect utility function $U_k(.)$can be written as the sum of a deterministic component $U_k(x,\beta_k)$, where x is the vector of the observable factors that drive the household decision, and ε a random term of mean 0, we have:

$$Improved^{*} = U_1 - U_0 = x'(\beta_1 - \beta_0) + \varepsilon_1 - \varepsilon_0 = x'\gamma + \mu. \qquad (1)$$

Here, $Improved^{*}$ is a latent variable related to the adoption of an improved source. It is not observed by the researcher. The observable choice of water source takes the value of 1 for households using improved sources and 0 otherwise:

$$Improved = \begin{cases} 1\ if\ Improved^{*} > 0 \\ 0\ if\ \ Improved^{*} \leq 0 \end{cases} \qquad (2)$$

Under the assumption that μ follows a logistic distribution, we obtain the following logit model:

$$\begin{cases} prob(Improved = 1) = prob(Improved^{*} > 0) = prob(\mu < x'\gamma) = F(x'\gamma) \\ prob(Improved = 0) = prob(Improved^{*} \leq 0) = prob(\mu < -x'\gamma) = 1 - F(x'\gamma) \end{cases} \qquad (3)$$

where $F(.)$ is the cumulative distribution function for μ. The maximum likelihood technique is used for the estimations. The estimated coefficients from the likelihood maximization are consistent and asymptotically normal and the asymptotic variance of the estimated parameters can be estimated directly (Wooldridge 2002). The log-likelihood function to be maximized is:

$$Log\ L = \sum_{i=1}^{n} Recycling_i log[F(x_i'\gamma)] + (1 - Recycling_i) log[1 - F(x_i'\gamma)] \quad (4)$$

The variables of the model explaining the adoption of improved sources

The explanatory factors considered in the econometric analysis are given in this subsection. We selected the relevant variables from the literature on water source choices (Adams et al., 2016; Basani, et al., 2008; Boone et al., 2011; Briand & Loyal, 2013; Etia et al., 2022; Mu et al., 1990; Persson 2002; Totouom, 2020; Zoungrana, 2021) for which the data were available in the dataset used. The explanatory variables considered in the study are:

- **Education**. This variable captures the education level of the household. It is a categorical variable classified into three dummies: **Primary education** (1 if the head of the household has no-education or has gone at most through primary education, 0 otherwise), **Secondary education** (1 if the head of the household has gone at most through secondary education, 0 otherwise), and **Higher education** (1 if the head of the household has gone through university, 0 otherwise).
- **Female**. Is a dummy variable taking the value of 1 for female-headed households and 0 for male-headed households.
- **Household size**. This variable represents the number of household members.

We also consider wealth as a determining factor of water source choice in our study. There is a wealth index variable in the CDHS-V calculated by the National Institute of Statistics. However, we used three different variables to capture wealth instead of the wealth index because this index is calculated based on housing characteristics and the possession of certain durable goods, among which, access to water and Internet and possession of a mobile phone. Using the wealth index in our study would lead to both an endogeneity problem because access to water is used as our dependent variable and a multicollinearity problem since internet access and telephone ownership are used as explanatory variables. In this case, the variables used to capture wealth are:

- **Access to electricity**. Is a binary variable taking the value 1 for households that have access to electricity and 0 otherwise;
- **Floor material**. Is a binary variable taking the value 1 for households living in a dwelling with modern floor material (parquet or waxed wood, vinyl or asphalt, tiles, cement, carpet) and 0 otherwise;
- **Wall Material**. Is a binary variable taking the value 1 for households living in a dwelling with modern wall materials (cement, stone with lime/cement, mud bricks, cement blocks, adobe and wood planks/shingles) and 0 otherwise.

By facilitating access to information about the health benefits of drinking water from improved sources and the health risks associated with the use of unsafe water, the Information and Communication Technologies (ICT) can constitute a key factor explaining the adoption of improved water sources. Two measures of ICT are used to capture access to information:

- **Internet**. Is a binary variable taking the value 1 for households having a private Internet connection and 0 otherwise.
- **Mobile phone**. This binary variable takes the value 1 if at least one household member has a mobile phone and 0 otherwise.

Evaluation of the difference in the adoption of improved water sources between urban and rural households

We use the approach of Fairlie (2006) to study urban-rural differences in the adoption of improved sources. This approach is an extension to probit and logit models of the decomposition technique developed by Oaxaca-Blinder (1973). For this purpose, we break down into two parts the difference in average probability of using improved sources between urban and rural households. The decomposition according to the approach developed by Fairlie (2006) is expressed as follows:

$$\overline{Improved}^{U} - \overline{Improved}^{R} = \left[\sum_{i=1}^{N^U} \frac{F(x_i^U \hat{\gamma}^U)}{N^U} - \sum_{i=1}^{N^R} \frac{F(x_i^R \hat{\gamma}^U)}{N^R}\right] + \left[\sum_{i=1}^{N^R} \frac{F(x_i^R \hat{\gamma}^U)}{R} - \sum_{i=1}^{N^R} \frac{F(x_i^R \hat{\gamma}^R)}{N^R}\right] \quad (5)$$

Here, $F(.)$ represents the cumulative distribution function associated with the logistic distribution. $\overline{Improved}^{j}$ is the average probability of households to use improved sources in group j ($j=R$ for rural households and $j=U$ for urban households). N^j is the size of subsample j, x^j corresponds to the distribution of observable characteristics within subsample j, γj represents the estimated coefficients of the explanatory variables of the logit models within subsample j.

The first terms in equation (5) provide an estimate of the contribution of the zone of residence difference (rural/urban) in the entire set of independent variables to the zone of residence difference in the dependent variable. Estimation of the total contribution is relatively simple as one only needs to calculate two sets of predicted probabilities and take the difference between the average values of the two. The method of Fairlie (2006) makes it possible to determine the relative contribution of each determinant to the difference in average probability of using improved water source between the two sub-samples of households. From the estimated coefficient of the logit model on the total sample $\hat{\gamma}$, the independent contribution of an observable characteristic x_1 to the difference in the adoption of improved water sources is given by:

$$\frac{1}{N^R}\sum_{i=1}^{N^R} F(x_{1i}^U\hat{\gamma}_1 + x_{2i}^U\hat{\gamma}_2) - F(x_{1i}^R\hat{\gamma}_1 + x_{2i}^U\hat{\gamma}_2) \quad (6)$$

Similarly, the contribution of x_2 can be expressed as:

$$\frac{1}{N^R}\sum_{i=1}^{N^R} F(x_{1i}^R\hat{\gamma}_1 + x_{2i}^U\hat{\gamma}_2) - F(x_{1i}^R\hat{\gamma}_1 + x_{2i}^R\hat{\gamma}_2) \quad (7)$$

The sum of the relative contribution of each variable will be equal to the total contribution of all the variables evaluated with the total sample.

Source of data

The data used in this study come from the fifth Cameroon Demographic and Health survey carried out from June 2018 to January 2019 by the National Institute of Statistics of Cameroon. The sample to be surveyed was distributed in such a way as to guarantee an adequate representation of urban and rural areas as well as the following 12 regions of study: Adamawa, Center (without Yaoundé), Douala, East, Far North, Littoral (without Douala), North, North-West, West, South, South-West and Yaoundé. A total sample of 11,710 households was surveyed. The CDHS-V is thus a nationally representative dataset of Cameroon covering 11,710 households (6,467 urban households and 5,243 rural households).

In each region (except Yaoundé and Douala which do not have rural areas), two strata were created: the urban stratum and the rural stratum. A stratified, two-stage area survey was implemented. At the first stage, 470 Enumeration Areas (AEs) or clusters were systematically drawn with a probability proportional to their household size, from the updated list of AEs from the 2005 population and housing census. Then, in the second stage, a sample of 28 households per cluster with systematic sampling with equal probability was selected. Four types of questionnaires were used to collect EDSC-V data: the Household questionnaire, the Individual Female questionnaire, the Individual Male questionnaire and the Biomarkers questionnaire. The Household questionnaire whose information is used in this study was administered to the head of the household or another adult member of the household.

The large coverage of the dataset that we use for empirical analysis guarantees a high heterogeneity in socioeconomic and demographic characteristics of the households surveyed but also in their relationship to water in general.

THE RESULTS

Descriptive statistics

The results of the CDHS-V presented in Table 1 highlight the diversity of sources of drinking water used by Cameroonian households. Following the question asked during the survey on the main source of drinking water used by the household, another subsidiary question for the sample of households having declared that they drink water from sachets or bottles (3.2% of total sample) was asked. This question was related to the main source of water used for other purposes such as cooking and washing hands. The results show that for uses other than drinking, approximately 89% of households use an improved source. For the other households not using sachet or bottled water for drinking, it was implicitly assumed that the source used for drinking also serves as a source for other needs (cooking, washing up, etc.).

Regarding the main source of drinking water used by households, the results presented in Table 1 show that more than 78% of households use an improved water source for drinking purpose. With nearly 30% of households using it, tube wells and boreholes are the most widely used source of drinking water. However, there is an important difference in households' use of improved sources between urban and rural households. Statistics show that 95% of urban households use improved sources against 57% for rural households.

Table 2 gives the result of the Chi-Square Test of Independence between sources of water and zone of residence. This test shows

Table 1. Distribution of households by water sources

	Water sources	Urban	Rural	Total sample
Improved sources	Piped into dwelling/yard/plot	25.3	2.3	15.2
	Piped to neighbour	16.6	1.2	9.8
	Public tap/standpipe	14.1	6.1	10.6
	Tube well or borehole	26.1	34.8	29.9
	Protected well	2.8	5.4	5.1
	Protected spring	4.4	6.1	3.9
	Rainwater	0.3	0.9	0.5
	Sachet water/bottled water	5.4	0.3	3.2
Total improved sources		**95**	**57.1**	**78.3**
Unimproved sources	Unprotected well	2.2	18.9	9.5
	Unprotected spring	1.6	11.7	6.0
	Tanker truck/Cart with small tank	0.7	0.2	0.5
	(River/dam/lake/ponds/stream/canal…)	0.5	12.1	5.6
	Others	0.1	0	0.1
Total unimproved sources		**5**	**42.9**	**21.7**

*Bottled/sachet water is only considered an improved water source if the household uses an improved water source for handwashing and cooking (INS et ICF, 2020).
Source: Adapted by the author from INS and ICF (2020)

Table 2. Chi-Square Test of Independence between sources of water and zone of residence

	Zone of residence		
Sources of water	**Urban**	**Rural**	**Total**
Unimproved sources	373	2,142	2,515
Improved sources	6,094	3,101	9,195
Total	6,467	5,243	11,710

Pearson chi2(1) = 2.1e+03 Pr = 0.000

that we fail to reject the null hypothesis that the two variables are independent. We have sufficient evidence to conclude that there is a statistically significant association between whether or not a household lives in an urban area and the source of water used.

Table 3 summarizes the descriptive statistics of the dependent and explanatory variables. These statistics are calculated on the sample of 11,271 households used in our analysis. Apart from household size, all the other variables are binary.

Table 3 also confirms the differences in the adoption of improved water source between urban and rural households in our sample: 94% of urban households use improved sources against 59% by rural households. With regard to internet access, the proportion is higher in urban areas (14%) compared to rural areas (1%). Conversely, there is a significant proportion of households in which mobile phones are used. In 86% of households (94% in urban areas and 75% in rural areas), at least one household member has a mobile phone. Table 3 also shows that about 53% of heads of households have gone through at most a primary education. These proportions are 37% and 10% for secondary education and higher education, respectively. Regarding the heads of households' gender, statistics show that about 27% of households are headed by women. As far as household size is concerned, Table 3 shows that the average household size is 5 members. Finally, in terms of wealth measures, statistics show that the proportions of households that have access to electricity, live in a dwelling with a modern wall, and live in a dwelling with a modern floor are respectively 64%, 63% and 63%.

Table 3. Descriptive statistics

Variables	Total sample	Urban sample	Rural sample
Improved source (%)	78	94	58.7
Internet (%)	8.6	14.4	1.4
Mobile phone (%)	85.6	94	75
Female (%)	27	29.5	24
Primary education (%)	52.8	37.5	71.4
Secondary education (%)	37	46	26
Higher Education (%)	10	16.4	2.6
Household size (Mean)	5.17	4.676	5.783
Access to electricity (%)	64.4	90.4	32.5
Wall material (%)	62.8	84.7	36
Floor material (%)	63	88	32.9

Econometric results

The logit model estimates used to identify the determinants of the adoption of improved water sources are presented in Table 4. The table reports both the coefficients and the marginal effects. The results reported in columns 1-2 were obtained on the full sample of 11,271 households. Those reported in columns 3-4 and 5-6 where obtained on the sample of urban and rural households respectively. As mentioned above, the explanatory variables considered in the study are education, household size, gender of the head of household, access to information captured by internet and mobile phone use, as well as wealth captured by access to electricity, floor and wall materials. The first column of table 4 presents the logit estimates conducted on the whole sample. They show that the dummy indicating the zone of residence (urban/rural) has a negative and statistically significant coefficient. In other words, living in rural areas significantly reduces the probability of using an improved source.

The results suggest that the use of improved water source also increases with education. Previous studies such as Adams et al. (2016),

Table 4. Adoption of improved water sources: estimates

	Total sample		Urban sample		Rural sample	
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	**Coef.**	**Marg. Eff.**	**Coef.**	**Marg. Eff.**	**Coef.**	**Marg. Eff.**
Zone of residence (Rural=1)	-1.315***	-0.162***				
	(0.075)	(0.010)				
Female	0.280***	0.031***	0.314**	0.011**	0.263***	0.062***
	(0.065)	(0.007)	(0.130)	(0.004)	(0.074)	(0.017)
Secondary education	0.343***	0.038***	0.627***	0.024***	0.239***	0.056***
	(0.063)	(0.007)	(0.128)	(0.005)	(0.073)	(0.017)
Higher Education	0.844***	0.076***	1.161***	0.033***	0.568**	0.126**
	(0.179)	(0.012)	(0.276)	(0.005)	(0.246)	(0.049)
Household size	-0.040***	-0.005***	-0.054***	-0.002***	-0.035***	-0.008***
	(0.007)	(0.001)	(0.016)	(0.001)	(0.008)	(0.002)
Access to electricity	1.025***	0.133***	0.968***	0.055***	1.018***	0.230***
	(0.068)	(0.010)	(0.150)	(0.012)	(0.076)	(0.015)
Wall material	0.270***	0.032***	0.483***	0.022***	0.214***	0.051***
	(0.069)	(0.008)	(0.141)	(0.007)	(0.077)	(0.018)
Floor material	0.331***	0.039***	0.400**	0.018**	0.312***	0.074***
	(0.074)	(0.009)	(0.160)	(0.008)	(0.082)	(0.019)
Internet	0.955***	0.082***	0.940***	0.027***	0.690*	0.150*
	(0.244)	(0.014)	(0.317)	(0.006)	(0.400)	(0.075)
Mobile phone	0.193***	0.023***	0.341**	0.015**	0.173**	0.042**
	(0.068)	(0.009)	(0.172)	(0.009)	(0.072)	(0.017)
Constant	1.099***		0.757***		-0.173**	
	(0.103)		(0.194)		(0.077)	
Observations	11,271	11,271	6,204	6,204	5,067	5,067
Pseudo R^2	0.255	0.255	0.113	0.113	0.0765	0.0765

Notes : Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0

Nauges & Van Den Berg (2009) and Totouom (2020) highlight the effect of the level of education on the choice of water source. In a study conducted in Madagascar, Boone et al. (2011) show that the number of years of education of the head of household is positively associated with the choice of a public tap, and negatively associated with the choice of a well.

Our results show that the probability of using an improved source increases when the household head is a woman. In a similar study conducted in Cameroon, Etia et al. (2022) also show that there is a positive relationship between female-headed households and their probability to access drinking water from taps and standpipes. Given that women in female-headed households are more likely to have a say in decision-making than in male-headed households, this result may reflect women's greater preference for more reliable and safer water sources. For instance, as they are usually responsible for caring for sick people in a household, women are more concerned than men about the health risks associated with drinking unsafe water.

As expected, our results show that the probability of adopting an improved source decreases with household size. In Cameroon, Etia et al. (2022) also show that there is a negative relationship between household size and the probabilities of using taps and standpipes for drinking water.

Several variables were introduced into our analysis as proxy for household wealth: wall material, floor material and access to electricity. The results suggest that compared to poor households, wealthier households are more likely to adopt improved water sources. Indeed, the results show that the coefficient of the variables access to electricity, floor and wall materials are all positive and statistically significant at 1% level. Our result is consistent with Briand and Loyal (2013) who found that the level of wealth increases the probability that a household is connected to a drinking water network operated by small private operators. Etia et al. (2022), in their study conducted in Cameroon, highlight a positive relationship between the quintile of economic well-being (richest category) and the probabilities of using taps and boreholes for drinking water. This result is confirmed in the work of Totouom (2020).

The estimation results also show that households that use internet and mobile phones are more likely to adopt an improved water source than those that do not. Whatever the specification considered, the coefficients of these variables are positive and statistically significant at 1%. By facilitating access to information concerning, among other things, the health benefits of drinking safe water from improved sources and the health risks associated with the use of unsafe water, internet and mobile phones are key determinants of improved source adoption. From different perspectives, internet access and mobile phones can also be seen as indicators of households' wealth and living conditions. Our result is contrary to that obtained by Abebaw et al. (2010) which show that information disseminated through radio has no significant effect on water source choices in Ethiopia.

As a post-estimation diagnostic, the results of the test to assess multicollinearity between the variables are reported in Table 5. The values of the variance inflation factor (VIF) estimates how much the variance of a coefficient is "inflated" because of linear dependence with other predictors. Our results do not suggest any multicollinearity issue to address. In fact, all the VIF values are lower than the 2.5 threshold widely used as the rule of thumb for high multicollinearity.

Finally, Table 6 shows the decomposition of the differences in improved water source adoption according to the zone of residence. The results indicate that in Cameroon, the difference in average probability to adopt improved water source between urban and rural households is 0.355. The difference explained by our model is 0.146, that is 41% of the total difference. This means that if households in rural areas had the same average characteristics as urban households, their rate of improved source adoption would be higher and the difference reduced by 41%.

Table 5. Multicollinearity test

Variables	VIF	1/VIF
Internet	1.25	0.800553
Mobile	1.21	0.826785
Female	1.05	0.952298
Education		
Secondary education	1.46	0. 682794
Higher education	1.27	0. 787801
Household size	1.07	0. 937733
Floor material	2.21	0. 453013
Wall material	1.87	0. 535250
Electricity access	1.96	0. 509538
Mean VIF	1.52	

Table 6. Decomposition of the differences in improved water source adoption according to the zone of residence

Variables	Coefficients
Mean adoption of improved source in urban areas	0.942
Mean adoption of improved source in rural areas	0.587
Difference	0.355
Total explained	0.146
Female	0.002
	(0.001)
Education	
Secondary education	0.013***
	(0.003)
Higher education	0.005***
	(0.001)
Household size	0.006***
	(0.002)
Access to electricity	0.061***
	(0.011)
Wall material	0.025***
	(0.008)
Roof material	0.022***
	(0.010)
Internet	0.003***
	(0.001)
Mobile phone	0.008*
	(0.005)

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0

The details on the explained adoption gap of improved water sources between urban and rural households show that this gap is mainly explained by the difference in welfare level between the two groups. Differences in wealth variables between urban and rural households contribute up to 74% to the differences in improved water source adoption explained by our model.

The second variable with strong power in explaining the difference in improved water source adoption between urban and rural households is the level of education. Differences in education between urban and rural households explain up to 12% of the differences in improved water source adoption between the two groups. This essential role of education is highlighted by Singh et al. (2020) in the explanation of the differences in LPG adoption between households according to socio-religious groups in rural India.

It is also worth noting that the difference in internet and mobile phone access between urban and rural households explained 7.5% of the difference in improved source adoption between the two groups. This highlights the role of information in shaping household behaviours.

CONCLUSION

This study aimed at analysing the differences in improved water source adoption between urban and rural areas in Cameroon. Data from the fifth Cameroon Demographic and Health survey used for the empirical analysis showed that 95% of urban households use improved sources against 57% for rural households. In the first step of our econometric analysis, we identified the determinants of the probability of using improved water sources. The results indicate that this probability increases with education, access to information, and wealth. It also increases when the head of household is a woman. Conversely, the probability of using an improved water source decreases with household size. The results of the decomposition used in the second stage of the econometric analysis indicate that the differences in improved water source adoption between urban and rural households are explained at 41% by the determinants listed above. The differences in wealth levels, education and information access between urban and rural households are the factors that have the highest explanatory power. They respectively contribute up to 74%, 12% and 7.5% of the differences explained by our model.

Based on these results, various recommendations can be formulated. In particular, the capacity of households to access improved sources should be strengthened due to the high cost which makes them inaccessible for poor households. Such policies should primarily target rural areas where households have more difficulties accessing improved sources than urban households. In rural areas, water supply systems such as public taps matching the needs of people should be subsidized and the maintenance of the infrastructure entrusted to local communities. In urban areas, subsidies for tap water connection should be put in place and they would probably represent a means of supplying water to a greater number of households, including the poorest. Individual piped household water connection allows poor households to have access to water at a lower cost and to benefit from the advantages of having drinking water at home, i.e., health benefits, ease of collection and savings in terms of time. On the other hand, when several households fetch – for example – water from a piped neighbour, as it is the case for almost 10% of households in Cameroon (INS and ICF, 2020), total consumption increases beyond the social bracket, and they ultimately pay a much higher price. Besides, measures to raise people awareness about the health risks of using unsafe water from unimproved sources should be undertaken. Such measures can be implemented through appropriate school curricula, audio and television media, internet platforms and other ICT means.

Our analysis has two main limitations due to the data used for empirical analysis. First, we limited ourselves to the main source of drinking water supply used by households. However, the reality is that in developing countries, households can use several sources of water supply at the same time (Nauges & Whittington, 2010) depending on the use considered. There is thus a relationship of complementarity between these different sources. The CDHS-V did not allow us to consider the alternative sources of water used by households. Similarly, the dataset does not provide information on several potential determinants of water source choices that we could have considered in the study. For example, the availability of an improved water source is important, but its use is also linked to accessibility (e.g., distance to the water source). The CDHS-V does not provide information on distances between homes and available sources. Second, we used cross-sectional differences across households at a point of time, whose relevance to understanding shifts over time is difficult to assess. The use of longitudinal household data over time would be a big step forward.

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