Kazwenga Masawula Pascal, Ngonzo Luwesi Cush, Ibebeke Bomangwa Yvonne, Seham Dawoud Zaky Dawoud, Kayembe Kayembe Fiston, Kianawa Kinakina Danny, Lukuke Aseke Yves, Kalume Shikayi Jean and Bisimwa Byamungu Désiré
Factors affecting households'choice of REGIDESO public drinking water in Mbanza-Ngungu Health Zone, Kongo Central, DRC
International Journal Water Sciences and Environment Technologies
Vol. (x), Issue. 1, March 2025, pp. 17-35
ISSN Online: 1737-9350; ISSN Print: 1737-6688, Open Access
www.jiste.org
Scientific Press International Limited
Received: January 2025 / Revised: February 2025 / Accepted: March 2025 / Published: March 2025

Factors affecting households'choice of REGIDESO public drinking water in Mbanza-Ngungu Health Zone, Kongo Central, DRC

Kazwenga Masawula Pascal[1], Ngonzo Luwesi Cush[2], Ibebeke Bomangwa Yvonne[3], Seham Dawoud Zaky Dawoud[4,5], Kayembe Kayembe Fiston[1], Kianawa Kinakina Danny[1], Lukuke Aseke Yves[1], Kalume Shikayi Jean[1,6], Bisimwa Byamungu Désiré[6]

,

1Masters'Student, Regional Water School, University of Kinshasa, DR Congo
2Full Professor, African University of Management and Technologies (AUMT-Brazza), Congo
3Full Professor, Chemistry Department, Faculty of Sciences, National University for Education (UPN), DR Congo
4Associate Professor, Department of Agribusiness and Consumer Sciences, College of Agricultural and Food Sciences, King Faisal University, Saudi Arabia
5Professor, Department of Agricultural Economics, Damietta University, Egypt.
6Assistant Lecturer, Faculty of Agricultural Sciences, University of Kinshasa, DR Congo

Abstract

Households had to face severe hardships to acquire their drinking water in Mbanza-Ngungu health zone, prior to the establishment of the national water facility, known as REGIDESO. But as this new water supply source was availed to them, new issues arose, making it difficult for some to afford REGIDESO tap water. This study used a household survey based on a questionnaire to collect data from 817 units, in addition to quantitative and qualitative data retrieved from the literature. The analysis used statistical techniques for data analysis and an econometric modelling based on logistic regression. Results show that the proportion of households that chose REGIDESO tap water for drinking was as low as 26%, while 74% of the households used alternative sources. Among the many reasons explaining the rejection of REGIDESO tap, most of the households emphasized the facts that there were lack of continuous distribution network, frequent interruptions of water supply, and REGIDESO water was salty. These factors explain the disparity in access to the public water service. Hence, there is a need for REGIDESO to extend its distribution network to the marginal areas of the health zone, and improve its quality. These results are also relevant for creating awareness on the challenges and factor limiting current approaches for monitoring water quality and national water policies. Local water committees can thus be leveraged to identify priority areas, fill the gaps on data, negotiate water price and educate the people on how to improve its quality. The study recommends the application of the principles of Integrated water resources management (IWRM) to ensure the sustainability of drinking water supplies in Mbanza-Ngungu.

Keywords: Alternative water, Drinking water supply, Mbanza-Ngungu, public water Utility, REGIDESO

[1] Corresponding author leankalume@unikin.ac.cd

1. Introduction

1.1 State of the Art

The United Nations (UN) has credited access to drinking water as a 'human right', including it among the Sustainable Development Goal (SDG) number 6.1. The latter aims to achieve a 'universal and equitable access to safe and affordable drinking water for all' by 2030 (Beyene and Luwesi, 2018). However, it is difficult to achieve the SDG water target without paying greater attention to inequalities between regions and populations, such as rural and urban, poor and rich, women and men, disadvantaged and less educated communities, marginal ethnic groups and people living in big cities (Hutton and Chase, 2016).

According to the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) Joint Monitoring Programme (JMP) for Water Supply, Sanitation and Hygiene, water safety issues affect more than 40% of the world's population, and this proportion is likely to increase. In fact, about 2.3 billion and 844 million people lacked basic sanitation and drinking water services in 2015, respectively, due to the slow pace of infrastructure development compared to population growth, and to the inequitable allocation of resources among different users. These people did simply not have a tap located in the household's premises or water from a public standpipe, tube well, dug well or protected spring, or else any rainfall storing device (UNICEF/WHO, 2017).

Despite having one of the highest surface water endowments in the world, the Democratic Republic of Congo (DRC) faces serious challenges for availing safe drinking water to its population. The DRC has one of the lowest access rates to basic services in the world for water (35%) and sanitation (16%). A majority of the Congolese people depends on groundwater and springs for their drinking water. In many cases, these springs are simply managed sources that are widely used in isolated villages and in rapidly growing peri-urban areas (Zeufack and Jha, 2024; UNEP, 2011). This situation stems from the under-investment of the country's national water utility (REGIDESO), the constant growing demand for water with a higher population and the recurrence of conflicts exacerbating the country's governance, thus leading to a continuous mismanagement of public resources (Mushagalusa, Byumanine et al., 2018).

The World Bank, USAID and other development partners are therefore actively involved in improving water and sanitation in the DRC in response to the country's challenges. The World Bank funded Water Supply and Sanitation Access Program (PASEA) aims to provide basic water access to an additional 12 million people and basic sanitation access to at least 8 million people across the country, while enhancing good governance and REGIDESO performance as well other reforms to improve local private sector capacity and community livelihoods. These interventions also include digitalizing service provision and improving regulatory capacity of water authorities (Jha et al., 2024).

As it emerges from these discussions, most of the interventions in the water sector focus on technological innovation and investment for safe drinking water supply. Yet, socio-economic factors underlying inequalities to drinking water allocation and access are globally, regionally, and nationally overshadowed, while localized and ethnic-based factors have been acknowledged as the key determinants of access to safe drinking water in poor and middle-income countries. This paper fills this research gap by exploring the socio-economic factors that influence households' choice of public drinking water supplied by REGIDESO in the Mbanza-Ngungu Health Zone of Kongo Central province, in the Democratic Republic of Congo (DRC).

1.2 Literature Review

Access to safe drinking water is a human right, but the availability of safe drinking water is far from being universal. Providing drinking water on a permanent basis is increasingly a stringent challenge for authorities, development agencies and organizations of the civil society dealing with water supply and management. This is particularly severe in poor countries of Sub-Saharan Africa, who experience rapidly growing populations (Abubakar and Dano, 2018). Greenwood et al. (2024) found that only one in three people in low- and middle-income countries have access to safe drinking water, most water supplies being contaminated by fecal matter, mainly by Escherichia coli. As a matter of fact, more than 4.4 billion people from poor countries, representing about half of the populations in these regions in 2020, did not have access to clean water. It is estimated that

about 866 million of Africa's population have no access to safely managed sanitation and basic hygiene services, as their sewage finally drains into water resources (Leumeni, 2022; Mulenga et al., 2017).

Investment in water and sanitation is very important for health care and human well-being, since most waterborne diseases, including hepatitis A, dysentery, cholera, diarrhea and typhoid, are strongly associated with the consumption of unsafe water (Abubakar, 2016).The lack of sufficient financial resources and the absence of the required technology for tapping water in low-income countries impede sustainable planning for resource development, and its equitable allocation and access (Shifa, 2024; van den Berg and Danilenko, 2017). This lack of access to safe drinking water also threatens people's livelihoods and sustainable socio-economic development. Thence, safe drinking water has been recognized by the international community, regional agencies and national officials as of high importance for boosting public policy. It is also being acknowledged as promoting human capital accumulation, fostering private businesses and improving human well-being in a sustainable development pathway (Lee et al., 2024; Luwesi and Beyene, 2023).

While "access" refers to 'water sufficiency for meeting domestic needs and its reliable availability, close to home', safe drinking water shall be 'free from pathogens and high levels of toxic chemicals at all times' (Greenwood et al., 2024; UNICEF and WHO, 2017). Formal drinking water is usually provided by urban, provincial or national water utilities, and is both a technical and socio-economic system that involves infrastructure construction, system operation, maintenance and monitoring, billing and governance (Gazzeh and Abubakar, 2018). Although public monopolies provide water services in around 90% of the world's urban areas, public utilities in many low-income countries cannot provide sufficient and safely managed drinking water to their rapidly growing populations (Abubakar, 2019). In 2015, the percentage of urban populations with access to piped water in homes in sub-Saharan Africa was just 33% (down from 43% in 1990), while 88%, 92% and 94% of the populations in East Asia, in North Africa and Latin America and the Caribbean, respectively, had access to safe drinking water (UNICEF / WHO, 2017).

While reviewing 50 water supply and sanitation case studies in urban poor settlements, Murungi and Blokland (2016) found that strategies, processes and practices targeting systems that are tailored to developed economies generally fail because they are not well suited to services provision to the poor in less developed economies. Therefore, community participation and ownership are among the most driving factors subtending a successful provision of water services to the poor ones (Irianti et al., 2016; Yang et al., 2013).

On their side, Sinharoy et al. (2019) conclude that the search for factors shaping household drinking water supply dynamics shall be the first step in designing and implementing more appropriate water policies and interventions so as to reduce inequalities around water and sanitation access across the sectors. The authors highlight two key drivers that included donor prioritization and collective action, as well as six key barriers, namely social exclusion, lack of land and dwelling tenure status, the political economy of decision-making, and insufficient data. Hence, ensuring responsive water and sanitation policies for informal settlements requires diverse and inter-disciplinary collaborations, using both top-down and bottom-up approaches.

2. Materials and Methods

2.1 Presentation of the Study Area

Mbanza-Ngungu is one of the 31 health zones of Kongo Central province since 1983, located within the former District of Cataractes of the DRC, the territory of Mbanza-Ngungu. It is 155 km away from Kinshasa and 200 km away from the port city of Matadi. It is geographically delineated by longitude 14° 55' 03"and latitude 5° 18' 10", at 735 m above sea level. The health zone covers an area of 711 km² and has a population of 165,167 people, with a density of 232 inhabitants per km² (Figure 1).

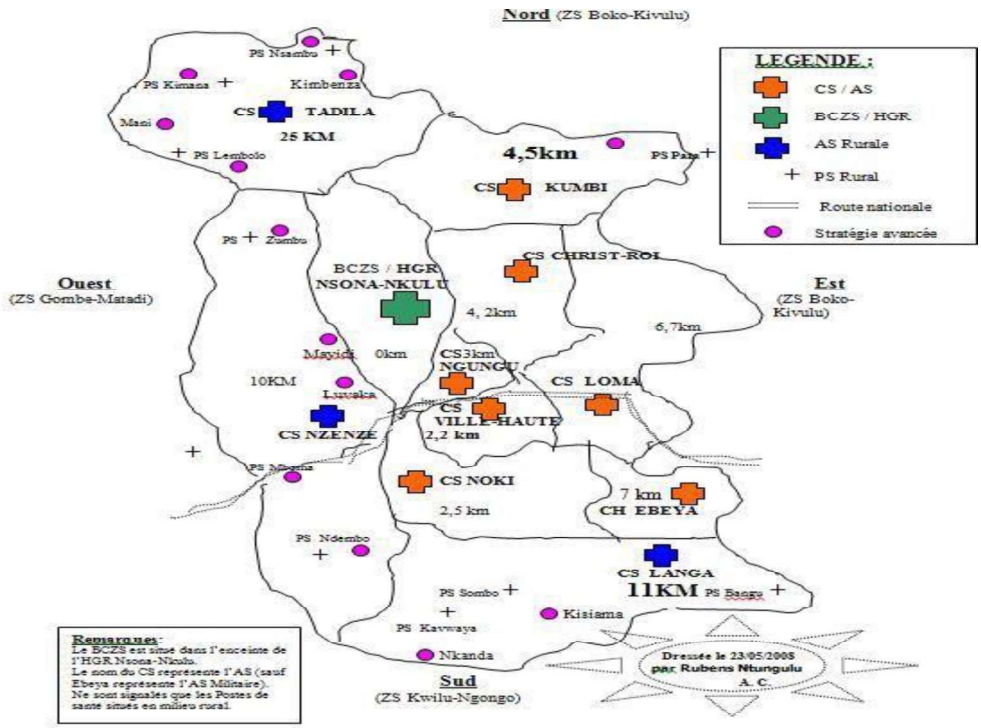

Figure 1. Map of Mbanza-Ngungu health zone (Zone de santé de Mbanza-Ngungu, 2024)

2.2 Data Collection

This research used a household survey and interviews to collect primary data, in addition to available secondary data from the literature. This field survey took place in 12 health areas of the Mbanza-Ngungu health zone between 15 July and 20 August 2023, using a questionnaire. No specific criteria were used to identify respondents, to give a chance to both urban and rural people. Field observation enabled assessing the state of the environment in which these people were living. Data collected enabled us to determine the proportion of people in the health zone, who had access to safe drinking water and why they choose REGIDESO tap water.

The questionnaire was administered to a total of 817 heads of household in the various neighbourhoods of the study area. This sample size was calculated based on Fisher's equation:

$$n = \frac{t^2 x P(1-P)}{y^2} \qquad \text{(Equation 1)}$$

Where,

t_p is the student's t test at 95 confidence interval (t_p = 1.96)

y is the sample margin of error (y= 0.05)

N is the population size (N= 1,220 households)

P is the proportion of population served (P= 0.67; 1-P = 0.33)

n is the sample size (n=817 households)

2.3. Data Analysis

2.3.1 Descriptive Statistics

A thematic content analysis was used to provide a meaningful account of the respondents' discourse as objectively and reliably as possible. It consisted of three consecutive stages: data pre-processing and classification using a Likert scale. The final processing comprised a tabulation (and graphing), which allowed a descriptive statistical analysis of the sample distribution's characteristics, in terms of frequency and, central tendency and

deviation measurements. This finally enabled the interpretation of the results in terms of descriptive inferences (Krief and Zardet, 2012).

2.3.2 Econometric Modelling

The choice of a safe drinking water source depends on both socio-economic and technological conditions that determine the quality and quantity of water, distance to source and prices of water that are affordable. Water developers have to make some trade-offs between infrastructure development and socio-economic factors that influence market competitiveness and households' choice so as to achieve water services efficacy, as much as possible.

The study used a logistic regression to estimate k + 1 unknown β_k (or α_k) parameters (see Equation 2), which directly determined the probability of occurrence of Y, a dichotomous dependent variable. These logistic fit parameters indicated the degree of association between each independent variable and the final outcome (Y). A maximum likelihood (maxL) ratio was estimated to fit the model. It determined a set of parameters for which the probability of the observed data was maximum. To this end, the logistic regression calculated the probability of success versus the probability of failure. Hence, a sensitivity analysis was undertaken to improve the efficiency of reduced model estimates. It accounted for the changes of the output in response to the variations of some omitted variables, which were thought to be statistically insignificant (Wang and Abdel-Aty, 2008; Lee and Mannering, 2002).

Key socio-economic variables of the study were derived from the literature to determine household's choice of REGIDESO tap water in the Mbanza-Ngungu Health Zone as the most relevant source of drinking water supply. The analysis targeted factors like the gender and occupation of the head of household, his/her level of education, and the quality and price of water distributed by REGIDESO in some selected areas of the study zone. Hence, the choice of REGIDESO as the source of safe drinking water for households was held as the dependent variable. Table 1 shows the most important independent variables selected in this study for the purpose of analysis.

The primary power multiplicative function of this drinking water demand was set as follows:

$$Q=\beta GER\alpha_1 NIV\alpha_2 PRO\alpha_3 PRE\alpha_4 QER\alpha_5 \square \quad \text{(Equation 2)}$$

Where,
β and α_i are the logistic fit parameters, β being a constant (intercept), and α_i (i=1, 2, 3, 4, ...) the elasticities (slope); and
$\square$ is the error term

For the convenience of estimation, the analysis introduced a logarithmic factor to linearize the equation (2) and obtained the following equation (3):

$$Log(Q)=\alpha_0+\alpha_1 Log(PRE)+\alpha_2 Log(QRE)+\alpha_3 Log(GER)+\alpha_4 Log(NIV)+\alpha_5 Log(PRO)+\square. \quad \text{(Equation 3)}$$

Where,
$Log(\beta) = \alpha_0$

Modeling the natural logarithm (ln) odds ratio allowed estimating the probability of households' choice of REGIDESO tap water as a source for safe drinking water for living in the Mbanza-Ngungu Health Zone using a linear relationship, similar to linear regression, as follows:

$$\frac{P(Y)}{1-P(Y)} = \exp(\beta_0+\beta_1 X_1+\beta_2 X_2+\ldots+\beta k X_k) \quad \text{(Equation 4)}$$

Table I. Key variables of the study

N°	variable	Expected sign	Comments
1	REGIDESO water prices (PRE)	-	In estimating a demand function, the focus is on the relationship between price and quantities, and in our specific context, this is the relationship between price and the choice of water supply source. We are assessing a customer's appreciation of the price, whether it is affordable or not.
2	Quality of REGIDESO water (QRE)	+	Considered to be good or poor, the quality of alternative waters guides the choice of water supply sources. This variable was selected. It is also a determining factor in households' choice of water supply sources.
3	Level of education of head of household (NIV)	+	The level of education of the head of household was used to explain the choice of household water supply sources.
4	Gender of head of household (GER)	-	Whether male or female, the gender of the head of household is a factor in the choice of supply sources.
5	Profession of head of household (PRO)	-	The professional activity of the head of household was also taken into account to explain or not the choice of household water supply sources.

Source: Authors (2024)

Hence, the log odds ratio model helped predicting the following probability:

$$P(Y) = \frac{e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k}}{1 + e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k}} \quad \text{(Equation 5)}$$

Where,

$\ln \frac{P(Y)}{1-P(Y)}$ are log odds

P(Y) is the statistical probability of households' choice of REGIDESO tap water

X_n (=X_1, X_2, ... , X_k) are independent variables described in Table I

β_n (= β_0, β_1, β_2, ... , β_k) are regression parameters similar to α_n in Equation 2

exp (X) is the exponential function

This functional log odds ratio helped estimating each logistic fit parameter, to explain the behaviour of the dichotomous dependent variable (Y), which was taking two values: 0 and 1 (1 meaning 'Yes' and 0, 'No'). To transform back the log odds, the analysis used the following probability function :

$$P(q) = \frac{1}{1 + \exp(-q)} \quad \text{(Equation 6)}$$

Where,

$q = \beta 0 + \beta 1 X_1 + \beta 2 X_2 + \ldots + \beta k X_k$

q is a sigmoid (S-shaped curve)

This q function's steepness was controlled by $\beta_n X$ matrix that mapped the linear function back to probabilities lying within the interval [0, 1] (Lever et al. 2016).

3. Results of the Study and Discussion

3.1 Results of the Descriptive Analysis of the Study Sample

The study results comprise a descriptive analysis of the sample to unveil a set of socio-economic characteristics of the respondents, including their gender, age, level of education, the main activity of the head of household, the size of the household, ... as well as their perception on water supplied by the REGIDESO public network and that of alternative water sources; lastly, a logistic regression is conducted to disclose the determinants of REGIDESO and alternative water choice par households.

3.1.1. Description of Key Socio-economic Characteristics of the Survey Respondents

Table II. Socio-economic characteristics of households surveyed

N°	Households' characteristics	Value	Frequency (%)(N=817)
1	Gender	Male	71.1
		Female	28.9
2	Age group	≤ 25 years old	03.4
		26-40 years old	40.3
		41-55 years old	33.0
		≥ 56 years old	23.3
3	Occupation	Public service	35.0
		Formal private sector	04.9
		Informal private sector	60.1
4	Educational level	Postgraduate studies' degree	00.6
		University degree	23.6
		Secondary leaving certificate	57.3
		Primary studies' certificate	14.7
		None	03.8
5	Marital status	Single	16.5
		Married	71.4
		Widow	06.1
		Divorcee	06.0
6	Household size	≤ 5	28.5
		6-9	54.0
		≥ 10	17.5

Source: Authors (2024)

A socio-demographic analysis of the households' characteristics shows that 71.1% of the households surveyed in the Mbanza-Ngungu health zone are headed by men, and 28.9% by female heads. Most of these householders are employed by informal private investors (60.1%) or by the national civil service (35%); Less than 5% are employed by formal private investors. (4.9%). Regarding their marital status, a majority among the respondents are married (71.4%), heading about 8 people (6 to 9 people) (54%); but a few are single householders (16.5%), widows (6.1%) or divorcees (6%). Detailed information is provided in Table 2.

3.1.2. Perception on household water supply

(a) Source of drinking water supply

According to the householders surveyed, their main source of drinking water was water packed in sachets (26.3%), followed by well-managed spring water (20.4%) and REGIDESO tap water (18.4%). (Figure 2).

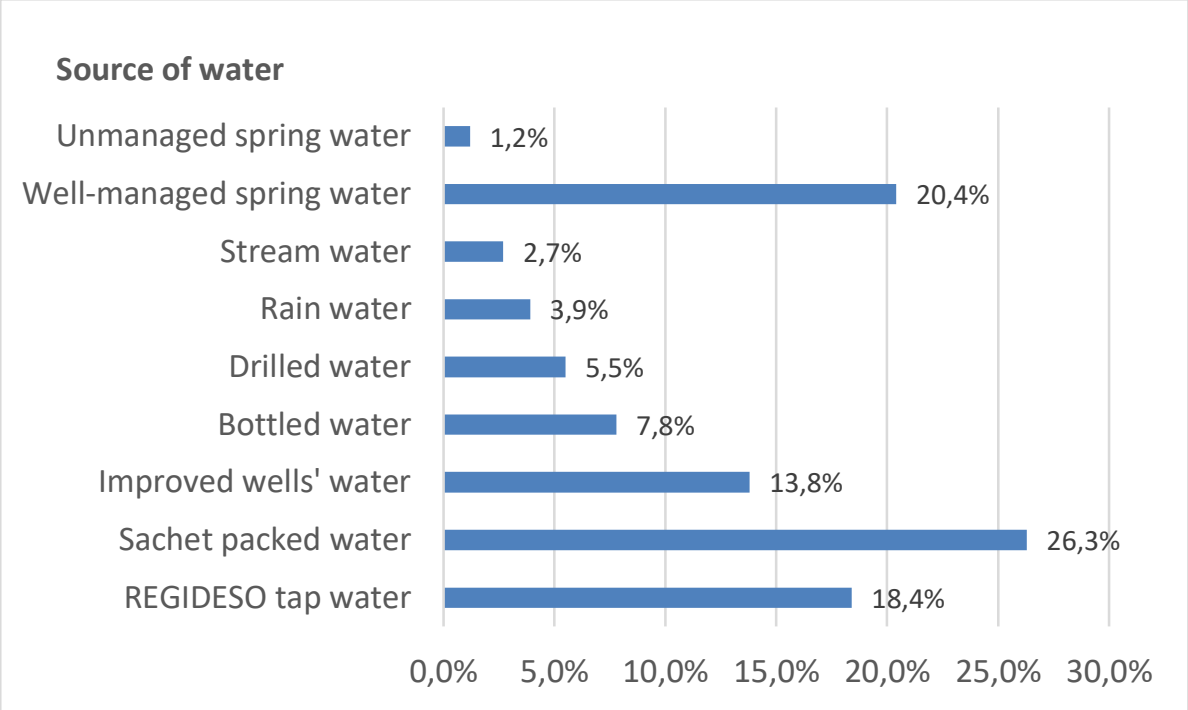

Figure 2. Sources of drinking water supply (Authors, 2024)

(b) Source of water supply for non-drinking usager

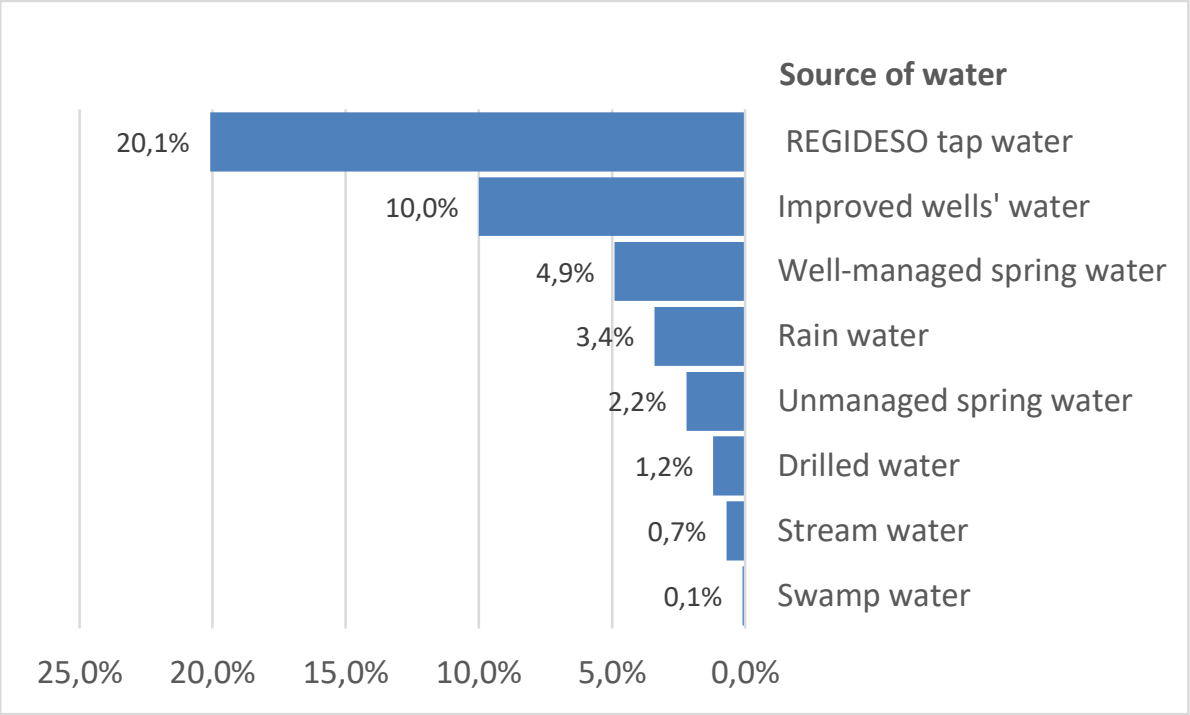

Figure 3. Sources of non-drinking water supply (Authors, 2024)

With regard to the source of water supply for uses other than drinking, Figure 3 reveals that tap water from REGIDESO is the first source of non-drinking water supply (20.1%), followed by water from improved wells (10%) and well-managed spring (4.9%).

(c) Choice of REGIDESO tap water

The Mbanza-Ngungu health zone has both urban and rural settings. The entire rural part is not served at all by REGIDESO. It includes the health areas of Langa, Nzenze, Kumbi and Tadila. In the urban side of the health zone, the fast extension of the town (urbanisation) did allow REGIDESO to extend its network accordingly; only 26% of the people surveyed did have a tap at home but a majority did not (78%). These include households from 8 health areas, including Noki, Nsona-Nkulu, Ngungu, Christ-Roi, Athénée, Loma, Militaire and Ville haute (Figure 4).

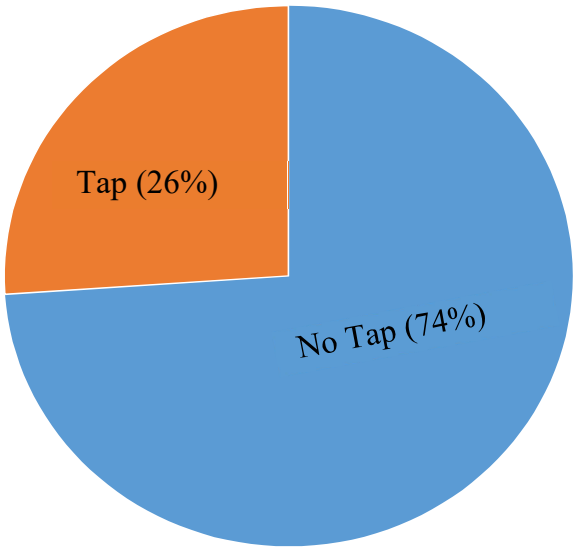

Figure 4. Connection to REGIDESO tap water network (Authors, 2024)

(d) Reasons for using water sources other than REGIDESO water

The reasons why most of the households surveyed do not use REGIDESO tap water for alternative water sources are shown in Figure 5. More than a third did inform of the missing tap network in their neighborhoods or village (38.5%) while more than a quarter evoked frequent breakage (27.1%). Other respondents thought that REGIDESO's water supply was unfit for consumption (11.2%), salty (8.9%), damaging clothes (8.4%), and had a bad taste (3.1%) or an unaffordable price (2.8%)(Figure 5).

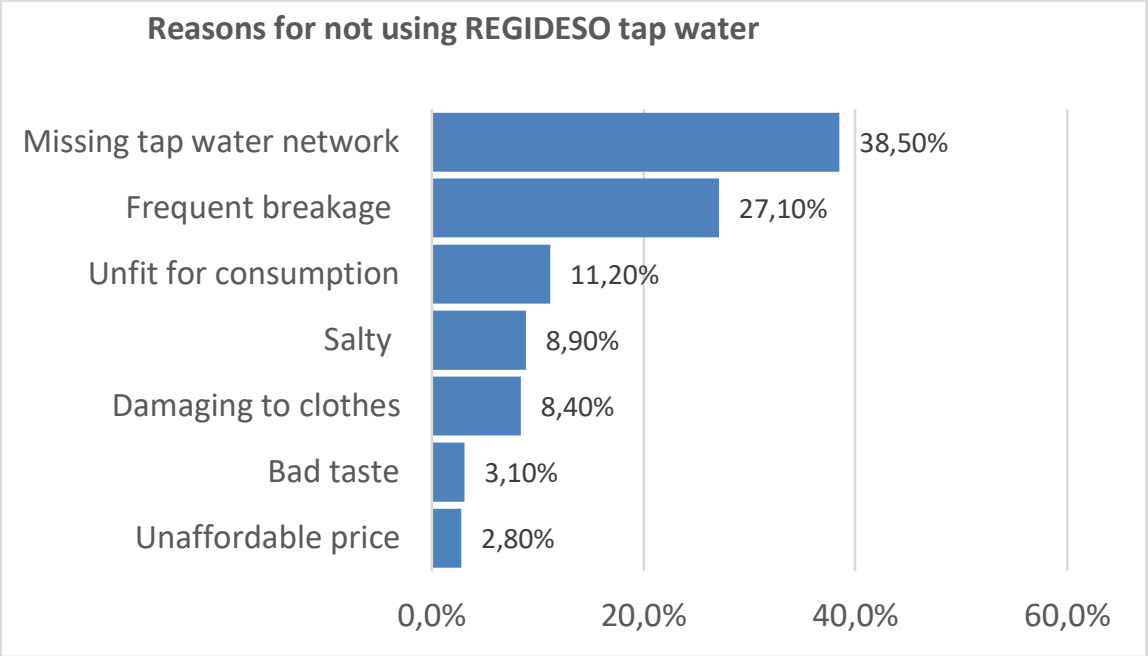

Figure 5. Reasons for using water sources other than REGIDESO (Authors, 2024)

(e) Advantages of using REGIDESO water

Results of the study show that more than a third of the respondents recognized that REGIDESO water has the advantage of being treated (38%), while 25% recognized no advantage at all. Moreover, than 15% among the respondents acknowledged that REGIDESO water is affordable and 10% recognized that the water is accessible even close to home. But 18% had no idea about the benefits of using tap water, possibly because there has never been tap water in their neighborhoods (Figure 6).

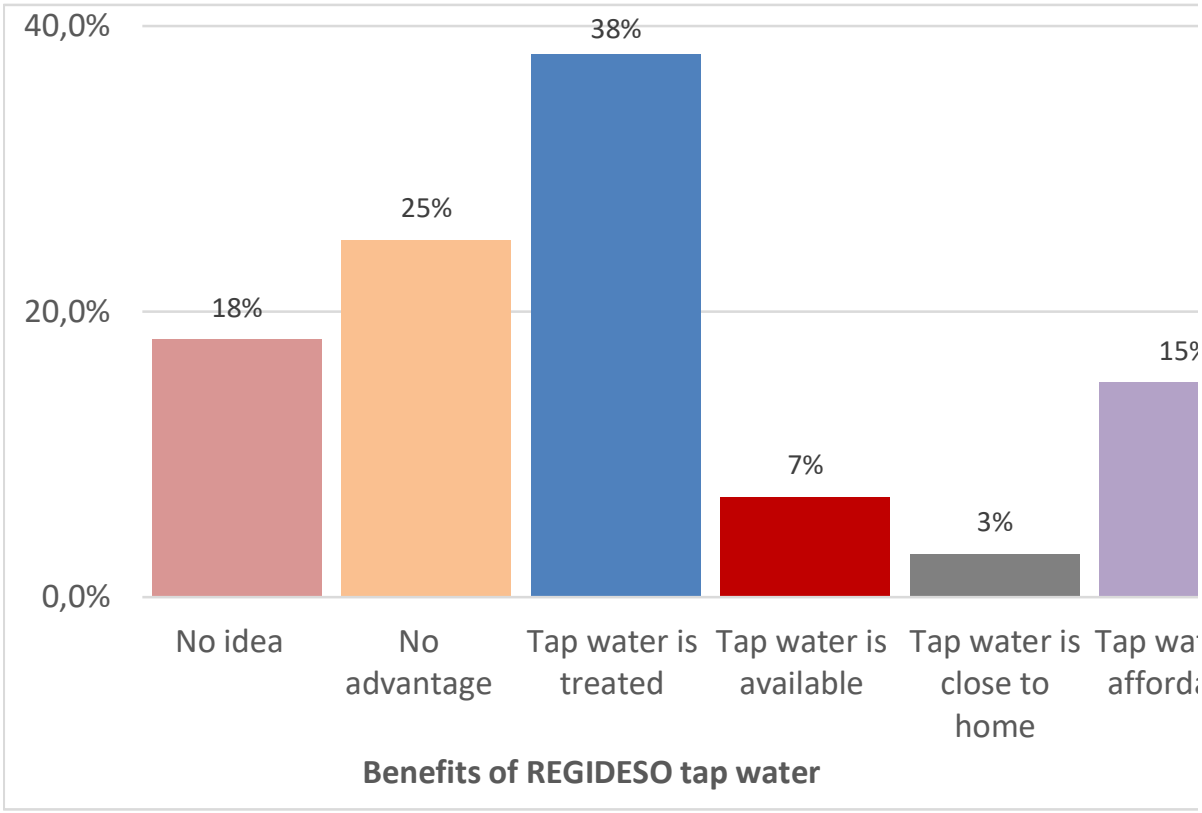

Figure 6. Advantage of using REGIDESO tap water (Authors, 2024)

(f) Risks of using alternative water sources

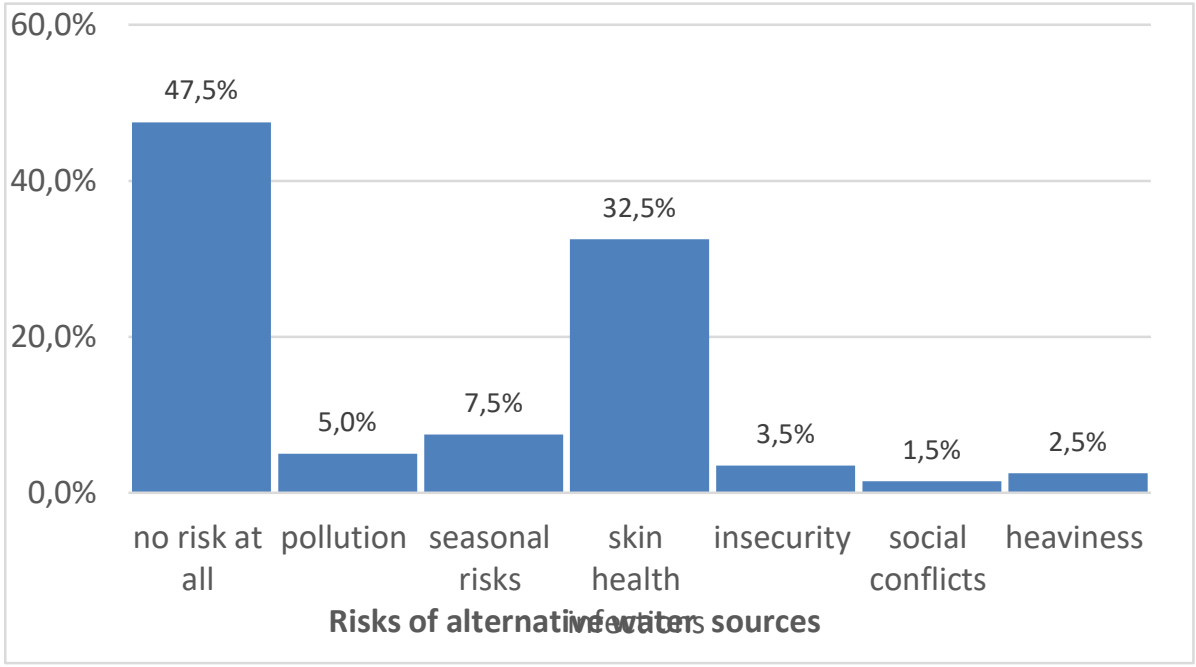

Figure 7. Risks of using sources of water other than REGIDESO tap water (Authors, 2024)

With regard to the risks of consuming alternative water sources than REGIDESO tap water, a majority among the respondents believed that there was no risk at all (47.5%), but more than 45% acknowledged that these

water sources carry waterborne diseases due to pollution (5%), seasonal risks (5%), and skin health infections' agents (32.5%). However, others mentioned social risks, including insecurity (3.5%), social conflicts (1.5%) and heaviness (2.5%) (Figure 7).

(g) Ways of avoiding risks of alternative drinking water sources

Figure 8 shows how householders avoid the risks related to alternative drinking water sources. The most recurrent drinking water treatment techniques encompassed boiling drinking water (36%), water filtration (19.9%), salting (15.6%) and treating water using Aquatabs tablets (12.2%) or granulated chlorine (calcium hypochlorite) (7%). Other techniques included taking pills after the use of water, including Paracetamol (4.4%), Tanzol (3.7%), Vermox (1.5%), Decaris (1.9%) and Amoxicillin (0.7%).

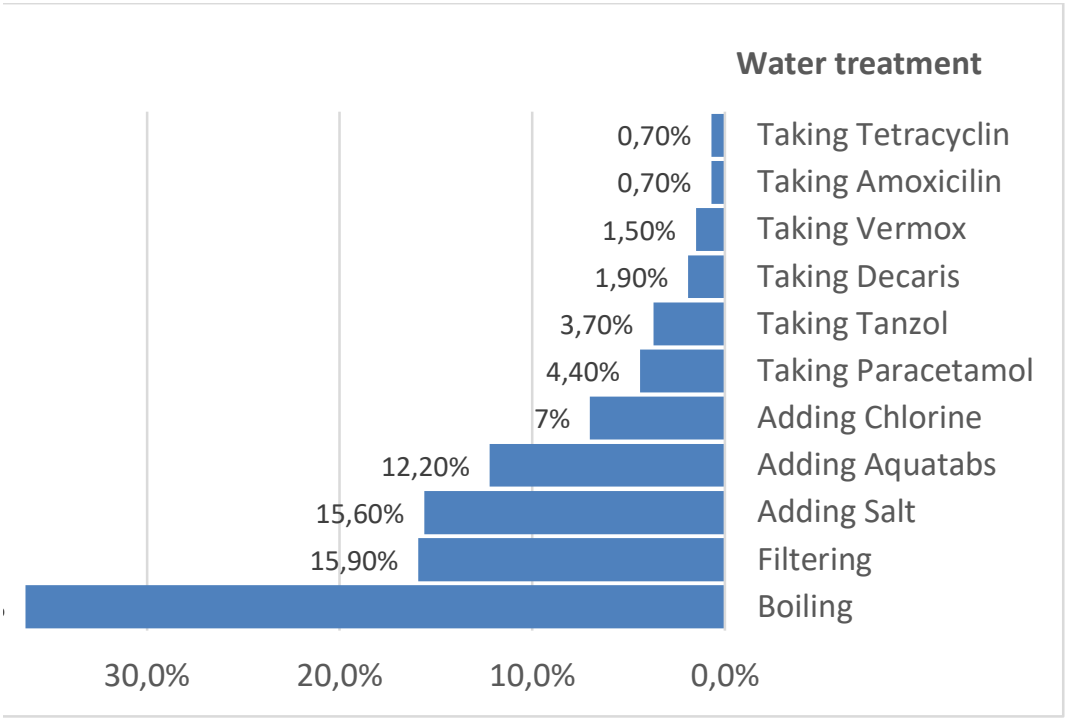

Figure 8. Drinking water treatment techniques (Authors, 2024)

3.2. Results of the Probit Logistic Regression

A multiple regression was carried out on a sample of 817 households, among which 212 were connected to the REGIDESO tap water network in the survey area, using a Probit logistic model. The results of this Probit regression model are presented in Tables 3, 4 and 5. Overall results show a robust prediction with Khi-square statistics significant at 1% significance interval (Tableau 3), and McFadden's R^2 that is above the threshold of 25% for Probit models (with a value of 32.1%)(Table 4). This meant that 32.1% of the variability of households' choice of REGIDESO as a source of drinking water supply in Mbanza-Ngungu health zone was explained by the most significant variables of the model. Thus, the model established a strong association between these independent variables and the dependent one (Briand and Loyal, 2017).

Table III. Model fitting through log likelihood ratio test

Model	Criteria for Model fit	Likelihood ratio test		
	Reduced model 2-log-likelihoods	Khi-square	df	sig
Constant	614.754			
Final	313.977	300.777	18	0.000

Source : Authors (2024)

Table IV. Pseudo R-square values

Cox et Snell	0.308
Nagelkerke	0.451
McFadden	0.321

Source : Authors (2024)

Table 5 reveals that almost all the independent variables influenced households' choice for REGIDESO tap water as a source of drinking water in the Mbanza-Ngungu health zone at 5% significance interval. This meant that these variables had an impact on the attitude of households to selecting public drinking water supplied by REGIDESO as their main source of water in their health zone at 95% confidence interval.

This variability of REGIDESO tap water choice as a source of drinking water supply in Mbanza-Ngungu health zone (32.1%) was explained by the following five independent variables: the gender of the household's head, his/her educational level, occupation, appreciation of REGIDESO water price, and of REGIDESO water quality.

Table V. Maximum likelihood ratio tests

Variables	Criteria for Model fit	Likelihood ratio test		
	Reduced model-2 log-likelihoods	Khi-square	df	Sig.
Constant	313.977	0.000	0	
Gender of the household head	319.970**	5.993	1	0.014
Educational level of the Head	324.361**	10.383	4	0.034
Profession of the household head	326.080***	12.103	3	0.007
REGIDESO water Price	402.719***	88.742	5	0.000
REGIDESO water quality	333.794***	19.817	5	0.001

Source : Authors (2024)
Note: *** 1% significance interval ; ** 5% significance interval

The following 2-log-likelihood reduced model was derived from the above table:

LogQ = 0,904 - 0,544*GER + 3,171*NIV - 0,766*PRO - 3,133*PRE + 1,661*QER + □
(0.000) (0.014) (0.034) (0.007) (0.000) (0.001)

The educational level and gender of the household's heads were determinant for increasing the likelihood of selecting REGIDESO as a source of drinking water at 95% confidence interval. However, the household's head profession, and the price and quality of REGIDESO tap water increased that likelihood at 99% confidence

interval in Mbanza-Ngungu health zone. The lower the educational level of the household's head, the lower the probability of choosing REGIDESO as a source of drinking water. Also, the more the households are headed by women or by civil servants, the lower the probability of selecting REGIDESO tap water. However, the lower the price and the quality of REGIDESO tap water, the lower the probability of choosing it as a source of drinking water.

3.3 Discussion of the Results

3.3.1. Discussion on Descriptive Statistics Results

The study revealed that 26% of households are connected to the REGIDESO distribution network. This rate is close to the one put forward by ANAPI (2021), but lower to that of Van den Berg Caroline and Alexander Danilenko, (2017) and Byumanine et al. (2018). This low rate is seemingly justified by the increasing urban population in Mbanza-Ngungu health zone, mainly due to the rural exodus, the cost of connection and financial challenges facing REGIDESO, which prevent its network extension to the peri-urban health areas (Lubera, 2022; Linangelo et al., 2018; Kazadi, 2012).
Regarding households' attitude towards water supplied by REGIDESO, water sold in sachets (plastics) was their main source of drinking water (26.3%), followed by well-managed springs (20.4%) and REGIDESO tap water (18.4%). However, the latter was being used for other purposes than drinking (20.1%), followed by water from managed wells (10%) and well-managed springs (4.9%). Moreover, the people interviewed in Mbanza-Ngungu do not prefer using REGIDESO water as their source of drinking water, because they consider it as salty, tasteless and unfit for consumption. These results are in line with Byumanine et al. (2018), Ilundu (2020) and Bousquet (2004). These studies asserted that some of the households supplied by REGIDESO do not use its water for drinking purpose. Their attitude is explained by the fact that it does not have good organoleptic qualities and is said to be the cause of certain illnesses such as typhoid fever, stomachache and amoebiasis, as well as women's urogenital infections, skin irritation, etc. Hence, households prefer using it for washing vehicles, cleaning houses and toilets, watering gardens, washing clothes and dishes for some households, and other uses. From the point of view of socio-demographic characteristics, the level of education of the household head is an essential factor explaining that choice.

3.3.2. Discussion on the Results of the Probit Logistic Model Regression

The analysis of factors explaining households' choice of drinking water supply was adequately persuasive. The estimated correlation coefficients (Rhô) and maximum likelihood ratio were significant at 5% significance interval. This indicated a good fit of the model (Tables 3, 4 and 5). According to these results, the household head's gender, level of education, occupation, appreciation of the REGIDESO water price and of its water quality were the most determinant factors influencing households' choice of water supply sources. Studies by Tibi (2021) and Ismaïla (2019) and Yao et al (2002) confirm these factors, especially water price, which explains water demand significantly at 95% confidence interval. The cost of access to water is thus a relevant determinant of households' choice of water supply.

However, the price represented in the Probit logistic model had a positive-sign coefficient, which is not consistent with the literature. Yet, the study expected a negative sign in consistence with the law of diminishing demand with the price. This meant that the lower probability of selecting REGIDESO as a source of drinking water was also explained by its low prices. This kind of snobbism may be explained by the fact that most of the households that select REGIDESO as their source of drinking water were more likely headed by highly educated male heads. Hence, the male gender, private profession and educational level of the household's head, as well as the price and the quality of drinking water were positively influencing the choice of REGIDESO as a source of drinking water in Mbanza-Ngungu health zone with a price elasticity of 3.133. This meant that, all other things being equal, the volume of water consumed increased by 313.3% when the price rose up to 1%. The elasticity of water demand can be explained by the presence of substitutes to REGIDESO drinking water, including water from wells and springs, sachet water and expensive bottled water brands and other alternative water sources (Quora, 2024; Stein, 2007).

Water from wells, boreholes, rainwater, springs and streams was treated by male respondents and small businessmen as "indigenous" water sources compared to the REGIDESO public drinking water network, which was viewed as an "industrial" innovative productive, making it a luxuary for these categories, in the case of Mbanza-Ngungu. However, Etienne et al. (1998) argued that drinking water demand (DWD) by low-income populations in sub-Saharan Africa increase by 2.5 litres/pers/day with reduced price of 100 CFA Francs per m^3 (Rainelli, 1994). That is the reason why most of the households outside Mbanza-Ngungu city buy water from their neighborhoods or from a single tap, and/or mostly use alternative water sources. This has an effect on increasing the consumption with the price of a cubic meter. Therefore, the average unit price of water is far above the subsidized level.

Besides, the occupation and gender of the household head are also factors that explain the high probability of choosing REGIDESO as a source of drinking water. The respective elasticities of the gender and occupation of the head of household are 0.544 and 0.766. This implies that the more households are headed by male and private businessmen (or employees other than civil servants), the higher the probability of choosing REGIDESO as a source of water supply. This is justified by the fact that household heads with a fairly low levels of income coupled with high family burdens may not easily afford REGIDESO water cost. These burdens are enormous if they are divorced or widowed with dependent children. From a professional point of view, Mbanza-Ngungu is basically an administrative town and the private sector is not well developed. Most employees are public servants of the Congolese State, including the army, public administration, education, health… This sector is featured by low and irregular incomes. The vast majority of the population work in the informal sector or in agriculture, where incomes are uncertain. Thence, as ascertained by Ake-Awomon (2022) and Coutard (1999), there is a direct link between the profession and the gender of the household heads and their choice of water supply source.

With regards to the perception of household heads of their water quality, it was found that if the household perceives the quality of REGIDESO water as a good, this has no effect on the likelihood of using alternative water sources. But this factor has a positive and very significant effect on the decision to use alternative water. Similarly, if households believe that alternative water sources are of good quality, their use of REGIDESO water may be reduced. From these results, it follows that the perception of water quality has an explanatory power on the household's decision even if this perception remains subjective and linked to cultural variables (Zoungrana, 2021; Boudjemaa and Cherrad, 2011; Montginoul and Waechter, 2007). Some households have a strong preference for water drawn from wells and springs because they believe it is tasty while others simply perpetuate their cultural habits from generation to generations (Omarova et al., 2019). In this context, the use of alternative water sources is often high due to errors of assessment, leading to significant health issues. This cultural fact is directly linked to the level of education of the of household head.

If at the household head is highly educated, this increases the likelihood of using REGIDESO tap water. The literature has shown that the probability of being connected to a public water distribution network increases with the level of education, for several reasons. In some cases, income can increase with the level of education, while in others, education may enhance or limit opportunities for accessing information. A low level of education limits understanding of the issues involved in drinking water supply, including health benefits, ease of collection, constant availability and time saving, while a high level of education is generally associated with a strong appreciation of the many benefits of drinking water (Johri et al., 2019; Briand and Loyal, 2017). This household propensity towards public drinking water sources is in line with other authors' findings. Ismaïla, (2019) and Morakinyo et al. (2015) indicate a positive relationship between the level of education of the household head and the probability of choosing public drinking water sources. Indeed, a household whose head is highly educated has a better understanding of the benefits associated to water quality and often adopts appropriate health and hygiene behaviors (Sehreen et al., 2019; Sintondji et al., 2017). Education therefore plays a decisive and positive role in household choice of water sources. However, due to water scarcity, households may use all water supply sources, regardless of their consequences.

7. Conclusion

This study highlights how the supply of drinking water from different sources by households in the Mbanza-Ngungu health zone is influenced by socio-economic factors like education, occupation, gender, price and quality of water. These factors explain the disparity in access to public drinking water sources. The results show that only 26% of the household heads interviewed chose REGIDESO as their main source of water supply while 74% did not. Among their reasons of not selecting REGIDESO as the source of drinking water they cited the absence of a REGIDESO distribution network in their neighborhoods, frequent breakages of REGIDESO water network, and other considered this water as salty and unfit for consumption.

This low rate of access to REGIDESO tap water contributes to the development of alternative water sources. The level of education of the household head, his/ her occupation and gender, and the price and quality of REGIDESO water are among the most significant factors associated with the choice of REGIDESO as their source of drinking water in the Mbanza-Ngungu health zone. These factors increase the probability for households' choice of REGIDESO as a source of their drinking water supply. However, an increase of water consumption with the level of price was termed as a kind of "snobbism". It increased the probability for households to select REGIDESO tap water rather than alternative water sources as their main source for drinking water supply, based on their level of education and of income. 'Public drinking water' was seen as a luxury or industrial product, while 'alternative water sources' were being perceived as indigenous goods. These Disparities in both sources of drinking water supply can be explained by social inequalities and households' burdens.

However, the research needs a very comprehensive classification of water substitutes, beyond the simple classification of 'public water' and 'alternative water' sources to recommend appropriate and accurate water supply policies and programs, focusing on households' burdens, and regional variations in order to reduce social inequalities and accelerate access to improved water supplies. Other recommendations include focusing on public standpipes and community boreholes as interim measures while making greater efforts to develop long-term piped water supply among poor communities and marginalized areas. These measures could contribute to greater social and ecological inclusiveness in water supply. Hence, there is a need for REGIDESO to extend its distribution network to marginal areas of the health zone.

Finally, considering the fact that a majority of households are largely unaware of health and economic repercussions of alternative drinking water sources, health authorities need to raise awareness and educate the population to set up local water management committees to provide quality water at a negotiated price. This application of IWRM principles may help ensuring the sustainability of drinking water supplies in Mbanza-Ngungu health zone.

Acknowledgements

This research was carried out as part of the training for the International Master's Program in Water Resources organized at the Regional School of Water (ERE) of the University of Kinshasa. The authors would like to thank the management of the ERE school and the political, administrative and health authorities of Mbanza-Ngungu.

Compliance with ethical rules

The authors declare no conflict of interest. Field research did not involve any threat to any community or protected species. No informal or legal organization played a key role in the design of the study, the collection and analysis of data so as to decide on the final outcome of the study. The decision to prepare the manuscript and publish it was solely taken by the authors.

List of References

[1] Abubakar I. R. (2019). Factors influencing the access of the households to drinking water to Nigeria. Elsevier, Utilities Policy, vol. 58 (C): 40-51.
[2] Abubakar I. R. & Dano U. L. (2018). Socio-economic challenges and opportunities of urbanisation in Nigeria. In: Urbanisation and its impacts on socio-economic growth in developing regions. IGI Global, Pennsylvania, 130-154 pp.
[3] Abubakar I. R. (2016). Dimensions of the quality of public water services in Abuja, Nigeria. Utilities Policy 38, 43-51.
[4] Ake-Awomon (2022). Etudes des facteurs influençant l'accès à l'eau potable dans la commune d'Abobo (Abidjan-Cote d'Ivoire), Editions Francophones Universitaires d'Afrique (EFUA), pp. 11-31.
[5] ANAPI. (2021). Investir dans le sous-secteur de l'eau. Cahier Sectoriel, MédiasPaul, Kinshasa.
[6] Beyene, A. & Luwesi C.N. (eds).(2018). Innovative Water Finance in Africa – A Guide for Water Managers – Volume 1: Context. Current African Issues, Nordiska Afrikainstitutet, Uppsala, 166 P. (ISBN: 9789171068156, 9171068155)
[7] Boudjemaa S. & Cherrad S. E. (2011). Les ressources en eau dans la wilaya de Mila : mobilisation, consommation et comportement de ménages, Sciences & Technologie, N°34, 19-25 pp.
[8] Bousquet A. (2004). Desserte collective des quartiers pauvres en Zambie, un long apprentissage. Flux (2004/2), Nn° 56-57, pp. 71-86 (ISSN 1154-2721 ; DOI 10.3917/flux.056.0071)
[9] Briand A. & Loyal A. (2017). La demande pour des services urbains d'eau potable : une analyse du consentement à payer des ménages bamakois et de quartiers précaires de Ouagadougou. Revue d'économie régionale & urbaine, n°1, janvier, pp. 33-66.
[10] Coutard O. (1999). L'accès des ménages à faible revenu aux services d'eau et d'énergie en France et en Grande-Bretagne. Flux, N° 36-37, pp. 7-15 (DOI : https://doi.org/10.3406/flux.1999.1271).
[11] Etienne J., Maïga A. & Morel à l'huissier A. (1998). Aspects socio-économiques de la demande en eau domestique en Afrique subsaharienne : quelles leçons pour la gestion de l'eau ? Communication UNESCO, juin 1998.
[12] Gazzeh K. & Abubakar, I. R. (2018). Regional disparity in access to basic public services in Saudi Arabia: A sustainability challenge. Utilities Policy 52, 70-80.
[13] Greenwood E. E., Lauber T., van den Hoogen J., Donmez A., Bain R. E. S., Johnston R., Crowther T. W., and Julian T. R. (2024). Mapping safe drinking water use in low- and middle-income countries, Science, 15 Aug 2024, Vol 385, Issue 6710, pp. 784-790 (DOI: 10.1126/science.adh9578)
[14] Hutton G. & Chase, C. (2016). The knowledge base for achieving the sustainable development goal targets on water supply, sanitation and hygiene. Int. J. Environ. Res. Public Health 13 (DOI: 10.3390/ijerph13060536).
[15] Ilundu J. L. (2020). Social and health impact of the lack of water of Regideso in the municipality of Kadutu. International Journal of Innovation and Scientific Research (Sep. 2020), Vol. 50 (2): 166-179.
[16] Irianti S., Prasetyoputra P. & Sasimartoyo, T. P. (2016). Determinants of the drinking water source household in Indonesia: An analysis of the 2007 Indonesian Family Life Survey. Cogent Medicine 3(1), 1151143 (DOI: https://doi.org/10.1080/2331205X.2016. 1151143).
[17] Jha, K. S., Eslick J. N. & Mutombo D. T. (2024). Bridging the Water Access Gap: New Partnership Brings Hope to the Democratic Republic of Congo. World Bank Blogs (August 28, 2024) (URL: https://blogs.worldbank.org/en/water/bridging-the-water-gap--new-partnership-brings-hope-to-drc-)
[18] Johri M., Sylvestre M.-P., Kone G. K., Chandra D. & Subramanian S. V. (2019). Effects of improved drinking water quality on early childhood growth in rural Uttar Pradesh, India: A propensity score analysis. Plos One, vol.14 (1), N° e0209054 (URL : https://doi.org/10.1371/journal.pone.0209054, consulté le 05/05/2023).
[19] Kaiyatsa S., Mapemba L. & Tembo G. (2016). Households' Choice of Drinking Water Sources in Malawi. Conference presentation, 12th Meeting of the International Water Resource Economics Consortium, The World Bank, Washington, DC September 11-13, 1-15 pp.

[20] Kazadi M. A. Z. (2012). Contribution à l'étude de la qualité et de la gestion de l'eau de boisson dans la région de Kisangani, Thèse de doctorat, Faculté des Sciences, UNIKIS, Kisangani, pp. 243.
[21] Krief N. & Zardet V. (2012). Analyse de données qualitatives et recherche-intervention Revue de Recherches en Sciences de Gestion-Management Sciences-Ciencias de Gestión, N°95, 211-237 pp.
[22] Lee J. & Mannering F. (2002). Impact of Roadside Features on the Frequency and Severity of Run-Off-Roadway Accidents: An Empirical Analysis. Accident Analysis & Prevention, 34, 149-161. (DOI: https://doi.org/10.1016/S0001-4575(01)00009-4)
[23] Lee J., Nemati M., Allaire M. & Dinar A. (2024). The impact of pricing structure change on residential water consumption: A long-term analysis of water utilities in California. Water resources and economics 46 (2024) 100240 (DOI: https://doi.org/10.1016/j.wre.2024.100240)
[24] Leumeni, P. (2022). Progress on Water, Sanitation and Hygiene in Africa, 2nd Regional Consultation UN-WAD, UNECA, Addis Ababa
[25] Lever J., Krzywinski M. & Altman N. (2016). Logistic regression: Regression can be used on categorical responses to estimate probabilities and to classify. Nature Methods vol. 13, pp. 541–542 (DOI: https://doi.org/10.1038/nmeth.3904)
[26] Linangelo S. B., Kamango J. B., Mokili J. K. E., Monama T. O., Ulyel J. A. P. & Kazadi Z.-A. (2018). Problématique d'accès a l'eau potable en milieu rural en RDC : cas de la ville urbano-rurale de Bumba. International Journal of Innovation and Scientific Research (Jul. 2018), Vol. 37 (2): 130-138.
[27] Luwesi, C.N. & Beyene, A. (eds).(2023). Innovative Water Finance in Africa –Economics and Principles of Financial Innovations for Water Managers. Cham: Palgrave MacMillan, Springer Nature Switzerland AG, 209 P. (ISBN :9783031382345, 303138234X)
[28] Montginoul M. & Waechter V. (2007). Les ménages et l'eau du robinet : perceptions et pratiques dans une communauté urbaine. Ingénieries eau-agriculture-territoires, Vol. 51, pp. 33-46.
[29] Morakinyo O. M., Adebowale S. A. & Oloruntoba E. O. (2015). Wealth status and sex differential of household head: implication for source of drinking water in Nigeria. Archives of Public Health, vol. 73 (1): p. 58.
[30] Mulenga J. N., Bwalya B. B. & Kaliba-Chishimba K. (2017). Determinants and inequalities of access to improved water sources and sanitation among Zambian households. International Journal of development and sustainability, 6(8) : 746-762.
[31] Murungi, C. & Blokland, M.W. (2016). Benchmarking for the provision of water supply and sanitation services to the urban poor: an assessment framework. International Journal of Water 10, No 2/3 : 155–174.
[32] Mushagalusa B., Mudherwa B., Emina A., Kalialia B., Mushagalusa B.E. & Macumu H. P. (2018). Evaluation of the acceptability of water produced by REGIDESO Nguba pumping. International Journal of Innovation and Scientific Research (Dec. 2018), Vol. 40 (1) : 202-218 (ISSN 2351-8014, URL : http://www.ijisr.issr-journals.org/)
[33] Omarova A., Tussupova K., Hjorth P., Kalishev M. & Dosmagambetova R. (2019) Water Supply Challenges in Rural Areas: A Case Study from Central Kazakhstan. International Journal of Environmental Research and Public Health, vol. 16 (66): 1-14 pp.
[34] Quora (2024). Are expensive bottled water brands really worth the money, or is most of the price just a marketing thing? (Available at URL: www.quora.com).
[35] Rainelli P. (1994). Brigitte Desaigues, Patrick Point, Economie du patrimoine naturel ; la valorisation des actifs du patrimoine naturel, Paris, Economica, 1993 (Compte-rendu). Revue d'études en Agriculture et environnement (Année 1994), 32 : pp. 135-137.
[36] Sehreen F., Masud M. M., Akhtar K., Masum M. R. A. (2019). A contingent valuation approach to evaluating willingness to pay for an improved water pollution management system in Dhaka City, Bangladesh, Environmental Monitoring and Assessment, vol. 191, n° 457, pp. 1-15.
[37] Shifa M. (2024). Inequality in access to basic services is a major problem in sub-Saharan Africa—but progress is happening. Phys.org (30 Jan. 2023) (URL: https://phys.org/news/2023-01-inequality-access-basic-major-problem.html)

[38] Sinharoy S. S., Pittluck R. & Clasen T. (2019). Review of drivers and barriers of water and sanitation policies for urban informal settlements in low-income and middle-income countries. Utilities Policy (October 2019), Vol. 60, 100957 (URL: https://doi.org/10.1016/j.jup.2019.100957)

[39] Sintondji L. O., Vissin E., Dan O. F., Dossou-Yovo E. R. & Amouzouvi D. (2017). Sociodemographic characteristics of households as determinants of access to water, hygiene and sanitation in Soava, Benin. Journal of Environmental Science and Public Health, vol. 1, n° 4, pp. 253-267.

[40] Stein, J. (2007). Entertainment: The making of a water snob. 5 Minute Read (June 7, 2007), TIME (Available at URL: www.time.com).

[41] UNEP. (2011). Water Issues in the Democratic Republic of Congo: Challenges and Opportunities - Technical Report, Nairobi, Kenya, p. 98 (URL: https://wedocs.unep.org/20.500.11822/22067)

[42] UNICEF & WHO. (2017). Progress on drinking-water, sanitation and hygiene: 2017 update and SDG baselines (ISBN:978-92-4-151289-3; URL: https://www.who.int/publications/i/item/9789241512893)

[43] van den Berg C., & Danilenko A., (2017). Performance of Water Utilities in Africa. Water Global Practice report, World Bank, Washington DC, pp.172.

[44] Wang X. & Abdel-Aty M. (2008). Analysis of Left-Turn Crash Injury Severity by Conflicting Pattern Using Partial Proportional Odds Models. Accident Analysis & Prevention, 40, 1674-1682. (DOI : https://doi.org/10.1016/j.aap.2008.06.001).

[45] Wanlin (2007). L'analyse de contenu comme méthode d'analyse qualitative d'entretiens : une comparaison entre les traitements manuels et l'utilisation de logiciels dans Recherches qualitatives. Hors-série, N°3, 242-272 pp.

[46] Yang H., Bain R.., Bartram J., Gundry S., Pedley S. & Wright J. (2013). Water safety and inequality in access to drinking-water between rich and poor households. Environmental Science & Technology, Vol. 47 (3): 1222-1230.

[47] Yao S. Y. (2002). Détermination de la demande d'eau potable par la création d'un marché fictif base sur le consentement à payer : cas de la ville de Cotonou au Benin, Rapport, 22 pages, Inédit.

[48] Zeufack A. & Jha S. K. (2024). Democratic Republic of Congo: In the water sector, taking stock of challenges leads to new solutions. World Bank Blogs (June 10, 2024) (URL: https://blogs.worldbank.org/en/africacan/drc-water-sector-taking-stock-challenges-leads-to-new-solutions-afe-0624)

[49] Zoungrana, T.D. (2021). Les déterminants du choix d'approvisionnement en eau potable des ménages ruraux de la commune de Koudougou au Burkina Faso, Économie rurale [On line], 377 (URL : http:// journals.openedition.org/économie rurale/9135)