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The Effect of Water Shortage on Households Well-being in Kigali City: A Case Study of Kicukiro District (2019-2022)

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Abstract

This research investigated the effect of water shortage on households' well-being in Kicukiro District, Kigali City, Rwanda. The study employed a mixed-methods approach, combining quantitative and qualitative methods. The study in Kicukiro District includes a target population of 130,112 households. Employing Slovin's formula, the sample size was 398 respondents whom were selected using both stratified and purposive which are probability sampling and purposive and non-probability sampling method respectively. Data collection utilized structured questionnaires with Likert scales, administered to 386 households and 12 WASAC staff households were given semi-structured interviews by which the qualitative data were analyzed using thematic analysis. Both descriptive (mean and standard deviation) and inferential statistics Pearson correlation and regression analysis) were used to examine the relationships between water shortage and household well-being. Therefore, the results reveal significant concerns regarding water shortage-related issues in Kicukiro, with respondents showing high agreement levels. Key concerns include regional disparities (mean = 3.780, SD = 0.795), climate variability (mean = 4.140, SD = 0.656), and urbanization (mean = 4.350, SD = 0.603). Household well-being is strongly associated with water availability, sanitation, and hygiene, with mean scores indicating critical importance (reliable water sources, mean = 4.010, SD = 0.824). Correlation analysis shows moderate to strong positive relationships between water accessibility and various well-being factors. Regression analyses highlight the significant positive impact of water availability on hygiene ($B = 0.596$, $p < 0.001$), sanitation ($B = 0.499$, $p < 0.001$), quality of life ($B = 0.278$, $p < 0.001$), and reduction of waterborne diseases ($B = 0.996$, $p < 0.001$). These findings emphasize the relationship between water scarcity and household well-being in Kicukiro District, Rwanda. Hence, urgent interventions are needed to address water infrastructure challenges, promote community engagement, and improve hygiene practices. This study recommends prioritizing water infrastructure development, fostering community participation, promoting hygiene education, and enhancing healthcare services in order to safeguard the

Stratford Peer Reviewed Journals and Book Publishing
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health and improve the overall well-being of residents of Kicukiro District, Rwanda.
Keywords: *Households' Well-Being, Hygiene and Sanitation, Water Availability, Water Shortage, Waterborne Diseases*.

1. Introduction

Kigali, the capital city of Rwanda, is undergoing rapid demographic growth, poised to double its population from 1.13 million in 2012 to an estimated 2 million by 2022 (Manirakiza et al., 2020). This surge in population, coupled with the expansion of the city's surface area, has placed immense strain on existing basic infrastructures. Sanitation and water supply, in particular, stand out as critical challenges in the face of this unprecedented growth. Currently, only 50% or less of the water needs in Kigali are met, especially during the dry season, despite the city experiencing an urbanization growth rate exceeding 9% annually (Rubogora, 2017).

Three primary factors contribute to this water scarcity challenge. Firstly, the expansion of the city lacks a coherent water supply viability plan, exacerbating inequalities in water distribution, with those residing in valleys receiving less water compared to their hill-dwelling counterparts. Secondly, the existing water network is aged and, in many instances, damaged. Thirdly, environmental degradation, including deforestation and soil erosion has led to a decline in water flow in major rivers like Nyabarongo and Nyabugogo.

The burden of this water scarcity is not evenly distributed, posing a significant socio-economic challenge. Two key aspects highlight this disparity. Firstly, the calculation of water bills has come under scrutiny for not incorporating a progressive billing system that considers the economic disparities between the affluent and economically disadvantaged households. Secondly, the scarcity itself has driven up water prices, making it economically unfeasible for poorer families to afford this essential resource.

Remarkably, despite the critical nature of this issue, empirical research addressing the nuanced dynamics and challenges faced by urban residents in response to water scarcity is lacking. This glaring research gap underscores the necessity of conducting a comprehensive study to understand the multifaceted impacts of water shortage on households in Kigali. By focusing on a case study in the Kicukiro district, this research aims to fill this gap and provide localized insights. The findings are expected to contribute significantly to the broader discourse on water scarcity in urban environments, offering evidence-based interventions and informing policy decisions to address this pressing challenge.

1.1 Research Objectives

1.1.1 General objective

The aim of the study is to assess the effect of water shortage on households' well-being in Kicukiro District, Kigali city, Rwanda.

1.1.2 Specific objectives

The specific objectives of this study are the followings:

(i) To assess the water shortage in the Kicukiro District, Rwanda.

Stratford Peer Reviewed Journals and Book Publishing
Journal of Agriculture & Environmental Sciences
Volume 8||Issue 1||Page 51-69 ||May||2024|
Email: info@stratfordjournals.org ISSN: 2616-8465

(ii) To investigate households well-being in the Kicukiro District, Rwanda.

(iii) To examine the association between water shortage and households well-being in the Kicukiro District, Rwanda.

2. Materials and methods

2.1 Profile of Kicukiro District

Kicukiro District is one of the three Districts which make up Kigali City and is situated in the South-East of the City. It is bordered by Nyarugenge in the West, Rwamagana in the East, Gasabo in the North and Bugesera in the South. Its total area is 166.7 Km2. It has 318,564 inhabitants with a gross density of 1,911 inhabitants per Km2. Administratively, Kicukiro District is composed of 10 Sectors, 41 Cells and 327 villages (Imidugudu).

Figure 3. 1: Map of the Kicukiro district with its sectors

Source: Arc GIS 2023

2.2 Research design and sampling techniques

The research employed a mixed-methods descriptive design, integrating quantitative (structured questionnaire) and qualitative (interview guide) approaches to investigate water shortage and households' well-being in Kigali's Kicukiro district. The study population comprised 12 WASAC staff households and 130,100 general households. With a sample size of 398 respondents determined using Slovin's formula, a stratified sampling technique was used to ensure representativeness, with general households selected randomly and WASAC staff households purposively.

Stratford Peer Reviewed Journals and Book Publishing
Journal of Agriculture & Environmental Sciences
Volume 8||Issue 1||Page 51-69 ||May||2024|
Email: info@stratfordjournals.org ISSN: 2616-8465

Table 3. 1: Respondents and sampling technique

Kicukiro Sectors	Households	Sample size per sector	Sampling technique
Gahanga	21,523	64	Stratified sampling
Gatenga	18,072	53	Stratified sampling
Gikondo	4,618	14	Stratified sampling
Kagarama	5,404	18	Stratified sampling
Kanombe	18,939	56	Stratified sampling
Kicukiro	4,497	13	Stratified sampling
Kigarama	16,691	49	Stratified sampling
Masaka	20,341	60	Stratified sampling
Niboye	7,579	23	Stratified sampling
Nyarugunga	12,438	36	Stratified sampling
WASAC Staff of Kicukiro District		12	Purposive sampling
Total	130,112	398	

Source: Compiled by the researcher, 2023

Table 3.2 provides information on the respondents and the sampling technique employed in the study. The population categories include households and WASAC Staff of Kicukiro District. The total population size is 130,102, with 130,100 households and 2 WASAC staff. The sample size for households is 386, selected through stratified sampling, ensuring equal chances for each household. For the WASAC Staff category, a sample size of 2 is chosen using stratified sampling. The total sample size for the study is 386, representing a subset of the broader population. This sampling approach aims to gather diverse perspectives and ensure a representative analysis of the impact of water shortage on households' well-being in Kicukiro District.

2.3 Illustration of research methodology

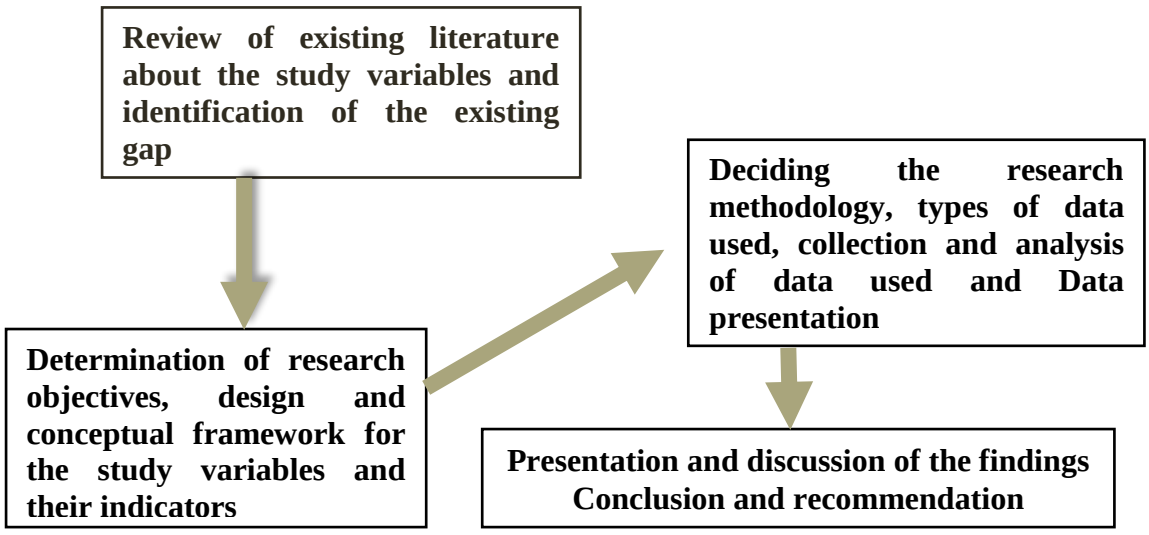

Figure 2.1: Methodology flowchart followed by the researcher

3. Results

4.2.1 Water shortage

The respondents' agreement levels regarding water shortage-related issues in Kicukiro District, Rwanda. Overall, respondents showed strong agreement with statements highlighting challenges such as regional disparities, climate variability and aging infrastructure. The data underscores the multifaceted nature of water scarcity, emphasizing the urgency of addressing interconnected socio-environmental factors to

Stratford Peer Reviewed Journals and Book Publishing
Journal of Agriculture & Environmental Sciences
Volume 8||Issue 1||Page 51-69 ||May||2024|
Email: info@stratfordjournals.org ISSN: 2616-8465

mitigate its effects in Kicukiro.

Table 4. 1: Water shortage in Kicukiro District, Rwanda

Water shortage related statements	Mean	SD
Water source accessibility profoundly affects daily life in Kicukiro.	3.690	0.919
Regional disparities heighten challenges faced by communities during water scarcity	3.780	0.795
Kigali City's water infrastructures are crucial for Kicukiro's water distribution.	4.150	0.590
Climate variability amplifies water scarcity challenges in Kicukiro District.	4.140	0.656
Unplanned city expansion worsens water distribution inequalities in Kicukiro.	4.320	0.580
Environmental degradation affects water flow in the source rivers feeding Kicukiro	4.300	0.596
Limited infrastructure coverage leads to uneven water access in Kicukiro	4.180	0.704
Rapid urbanization strains water resources, impacting Kicukiro households	4.350	0.603
Aging water networks contribute to water scarcity challenges in Kicukiro.	4.350	0.663
City expansion without addressing water scarcity strains Kicukiro's resources	4.370	0.678
Overall mean	4.163	

Source: Field Data, 2024

The Table 4.1 presents mean scores and standard deviations for statements concerning water shortage-related issues in Kicukiro. Generally, respondents rated these statements positively, indicating a high level of agreement with the challenges highlighted. Key concerns include the impact of regional disparities (mean = 3.780, SD = 0.795), climate variability (mean = 4.140, SD = 0.656), urbanization (mean = 4.350, SD = 0.603), and aging infrastructure (mean = 4.350, SD = 0.663) on water scarcity. Particularly alarming are issues like unplanned city expansion (mean = 4.320, SD = 0.580) and environmental degradation (mean = 4.300, SD = 0.596), which exacerbate inequalities in water access. The significantly high mean score for the importance of Kigali City's water infrastructures (mean = 4.150, SD = 0.590) emphasizes the interconnectedness of water distribution systems. These findings highlight the complex socio-environmental factors contributing to water scarcity in Kicukiro, emphasizing the need for comprehensive solutions addressing infrastructure, climate resilience, and equitable resource management in Kicukiro District, Rwanda.

4.2.2 Households well-being

The respondents' agreement levels regarding statements related to household well-being in Kicukiro District, Rwanda. The statistics reflect a strong consensus on the significant role of water access, sanitation, and community resilience in enhancing household quality of life. Key findings highlight the critical importance of reliable water sources, sanitation practices, and community resilience in mitigating the adverse impacts of water scarcity on households' economic stability and health satisfaction.

Stratford Peer Reviewed Journals and Book Publishing
Journal of Agriculture & Environmental Sciences
Volume 8||Issue 1||Page 51-69 ||May||2024|
Email: info@stratfordjournals.org ISSN: 2616-8465

Table 4. 2: Households wellbeing in Kicukiro District, Rwanda

Households wellbeing related statements	Mean	SD
Wellbeing tied to water source reliability for Kicukiro households.	4.010	0.824
Quality of life linked to clean water access and proper sanitation.	4.290	0.696
Water scarcity directly affects economic stability and health satisfaction.	4.260	0.628
Basic service availability crucial for determining household quality of life.	4.000	0.901
Economic disparities influence vulnerability to water scarcity impacts in Kicukiro.	4.100	0.778
Community resilience shapes household coping with water scarcity challenges.	3.960	0.881
Limited clean water access may impact physical and emotional wellbeing.	4.240	0.726
Water scarcity disrupts hygiene practices, introducing health hazards.	4.380	0.618
Water infrastructure state directly impacts households' resilience to scarcity.	4.200	0.812
Sanitation practices contribute to health and dignity in Kicukiro households	4.380	0.634
Overall mean	4.182	

Source: Field Data, 2024

The Table 4.2 shows mean scores and standard deviations for statements concerning household wellbeing in relation to water access and sanitation in Kicukiro District. Overall, respondents rated these statements positively, indicating a strong association between water availability, sanitation, and household wellbeing. Key statements include the critical importance of reliable water sources (mean = 4.010, SD = 0.824) and access to clean water and proper sanitation (mean = 4.290, SD = 0.696) for enhancing quality of life. The significant impact of water scarcity on economic stability and health satisfaction (mean = 4.260, SD = 0.628) underscores its multifaceted repercussions. Additionally, the data highlights the role of community resilience (mean = 3.960, SD = 0.881) and sanitation practices (mean = 4.380, SD = 0.634) in mitigating the adverse effects of water scarcity on household wellbeing. These findings emphasize the need for holistic approaches addressing both water infrastructure and community resilience to enhance household quality of life in Kicukiro District, Rwanda.

4.2.3 Water shortage and households wellbeing

The respondents' agreement levels regarding statements on the relationship between water shortage and household well-being in Kicukiro District, Rwanda. Overall, respondents strongly agreed with the statements, indicating significant concern over the impacts of water scarcity on family finances, health, and overall quality of life. The findings emphasize the urgent need for interventions addressing unequal water access and improving water infrastructure to enhance household well-being in Kicukiro District, Rwanda.

Stratford Peer Reviewed Journals and Book Publishing
Journal of Agriculture & Environmental Sciences
Volume 8||Issue 1||Page 51-69 ||May||2024|
Email: info@stratfordjournals.org ISSN: 2616-8465

Table 4. 3: water shortage and households wellbeing in Kicukiro District, Rwanda

statements	Mean	SD
Lack of water affects family finances and happiness.	4.34	.630
Unequal water access affects health and happiness.	4.30	.689
Waterborne illnesses show the health impact of shortages.	4.45	.584
Good hygiene habits help to cope with water scarcity.	4.53	.607
Insufficient water worsens overall quality of life.	4.44	.718
Community cooperation aids in water shortage challenges.	4.20	.953
Poor water infrastructure hampers coping with scarcity.	4.19	.861
Unequal water access creates hardships for families.	4.29	.749
Clean water and sanitation enhance family well-being.	4.15	.900
Addressing water shortage requires considering its broad impacts on families	4.47	.594
Overall mean	4.336	

Source: Field Data, 2024

The Table 4.3 offered mean scores and standard deviations for statements regarding the impacts of water shortages on household's wellbeing. Generally, respondents highly agreed with these statements, indicating significant concern over the effects of water scarcity. Key statements include different effects on family finances, happiness, health, and overall quality of life. Particularly the strong associations between waterborne illnesses and health impacts (mean = 4.45, SD = 0.584), as well as the importance of good hygiene habits in coping with water scarcity (mean = 4.53, SD = 0.607). The results also emphasize the role of community cooperation (mean = 4.20, SD = 0.953) and the need for improved water infrastructure (mean = 4.19, SD = 0.861) in addressing these challenges. These findings emphasize the broad and profound impacts of water shortages on household's wellbeing, highlighting the urgency of implementing effective measures to ensure access to clean water and sanitation for overall household's well-being in Kicukiro District, Rwanda.

4.3 Correlation and regression analysis

The inferential statistics conducted in Kicukiro District, Rwanda, shed light on the profound impact of water shortage on various aspects of household well-being. Through correlation and regression analyses had significant associations between water availability, distribution, infrastructure, and multiple socio-economic factors including hygiene, sanitation, nutrition, and food security. Specifically, water availability emerged as a strong positive predictor, significantly influencing these indicators of households' well-being. Conversely, factors like uneven distribution and poor infrastructure often showed negative impacts, highlighting the urgent need for equitable water access and improved infrastructure to enhance overall household well-being and mitigate health risks within the district. These findings emphasize the critical role of water-related interventions in promoting sustainable development and improving livelihoods in Kicukiro District, Rwanda.

4.3.1 Correlation analysis

The correlation analysis between water shortage and household well-being in Kicukiro District, Rwanda, reveals significant associations. Factors like water accessibility, distribution, and infrastructure exhibit positive correlations with hygiene, sanitation, and quality of life, albeit to varying degrees. Particularly, water availability demonstrates strong positive correlations with multiple indicators of well-being, emphasizing its crucial role in promoting household health and socio-economic conditions. These findings

Stratford Peer Reviewed Journals and Book Publishing
Journal of Agriculture & Environmental Sciences
Volume 8||Issue 1||Page 51-69 ||May||2024|
Email: info@stratfordjournals.org ISSN: 2616-8465

underscore the importance of addressing water availability to improve overall household well-being within Kicukiro District, Rwanda.

Table 4. 4: Correlation analysis between water shortage and households wellbeing in Kicukiro District, Rwanda

		Hygiene	Sanitation	Quality of life	Waterborne diseases	Nutrition	Food security
Water accessibility	P. Correlation	.171**	.136**	.101*	.225**	.167**	.127*
	Sig. (2-tailed)	.001	.007	.047	.000	.001	.012
	N	386	386	386	386	386	386
Water distribution	P. Correlation	.135**	.082	.104*	.227**	.130*	.071
	Sig. (2-tailed)	.008	.109	.041	.000	.011	.161
	N	386	386	386	386	386	386
Water infrastructure	P. Correlation	.170**	.136**	.101*	.224**	.166**	.127*
	Sig. (2-tailed)	.001	.007	.046	.000	.001	.012
	N	386	386	386	386	386	386
Water availability	P. Correlation	.669**	.620**	.336**	.822**	.705**	.599**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
	N	386	386	386	386	386	386

***. Correlation is significant at the 0.01 level (2-tailed).*

**. Correlation is significant at the 0.05 level (2-tailed).*

Source: Field Data, 2024

The Table 4.3 about the correlation analysis between water shortage and household well-being revealed significant relationships across various factors. Water accessibility shows moderate positive relationships with hygiene ($r = 0.171$, $p = 0.001$), sanitation ($r = 0.136$, $p = 0.007$), and overall quality of life ($r = 0.101$, $p = 0.047$). Similarly, water distribution shows weak to moderate positive relationships with hygiene ($r = 0.135$, $p = 0.008$), quality of life ($r = 0.104$, $p = 0.041$), and waterborne diseases ($r = 0.227$, $p = 0.000$). Water infrastructure also demonstrates similar associations with hygiene, sanitation, and quality of life (all $p < 0.05$). Notably, water availability shows strong positive relationships with hygiene ($r = 0.669$), sanitation ($r = 0.620$), quality of life ($r = 0.336$), waterborne diseases ($r = 0.822$), nutrition ($r = 0.705$), and food security ($r = 0.599$), all highly significant ($p < 0.01$). These findings highlight the critical role of water availability in influencing various aspects of household well-being in Kicukiro District, Rwanda. Hence the null hypothesis stating that there is no significant relationship between water shortage and households' well-being in the Kicukiro District, Rwanda is rejected.

4.3.2 Regression analysis

The regression analysis for water shortage and various socio-economic factors in Kicukiro District, Rwanda, reveals profound insights. Water availability emerges as a significant positive predictor across multiple domains such as hygiene, sanitation,

Stratford Peer Reviewed Journals and Book Publishing
Journal of Agriculture & Environmental Sciences
Volume 8||Issue 1||Page 51-69 ||May||2024|
Email: info@stratfordjournals.org ISSN: 2616-8465

nutrition, and food security. Conversely, factors like water distribution and infrastructure often exhibit negative impacts, indicating the critical need for equitable water access and improved infrastructure to enhance overall well-being and mitigate health risks within Kicukiro District, Rwanda.

Table 4. 5: Model summary of water shortage and hygiene in Kicukiro District, Rwanda

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.686[a]	.470	.465	.73141

a. Predictors: (Constant), Water availability, Water infrastructure , Water distribution , Water accessibility

The Table 4.4 of model summary indicates a significant relationship (R = 0.686) between water shortage variables and hygiene in Kicukiro District, Rwanda. Approximately 47% of the variance in hygiene can be explained by the combined effects of water availability, infrastructure, distribution, and accessibility. The adjusted R square of 0.465 suggests that these predictors collectively contribute to understanding hygiene, with a standard error of 0.73141.

Table 4. 6: Analysis of variance (ANOVA) of water shortage and hygiene in Kicukiro District, Rwanda

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	182.045	4	45.511	85.074	.000[b]
Residual	204.890	383	.535		
Total	386.936	387			

a. Dependent Variable: Hygiene

b. Predictors: (Constant), Water availability, Water infrastructure , Water distribution , Water accessibility

Source: Field Data, 2024

The Table 4.5 of analysis of variance (ANOVA) for water shortage and hygiene in Kicukiro District, Rwanda shows a highly significant result ($p < 0.001$). The regression model, including water availability, infrastructure, distribution, and accessibility as predictors, significantly explains the variance in hygiene. With an F-statistic of 85.074, the model demonstrates a strong ability to predict hygiene outcomes, underlining the crucial impact of water-related factors on maintaining hygienic conditions within the district.

Table 4. 7: Regression coefficients of water shortage and hygiene in Kicukiro District, Rwanda

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.340	.299		1.137	.256
Water accessibility	.985	.790	.591	1.247	.213
Water distribution	-.976	.244	-.600	-3.993	.000
Water infrastructure	.018	.740	.011	.024	.981
Water availability	.596	.034	.670	17.552	.000

a. Dependent Variable: Hygiene

Source: Field Data, 2024

Stratford Peer Reviewed Journals and Book Publishing
Journal of Agriculture & Environmental Sciences
Volume 8||Issue 1||Page 51-69 ||May||2024|
Email: info@stratfordjournals.org ISSN: 2616-8465

The Table 4.6 of regression coefficients for water shortage and hygiene in Kicukiro District, Rwanda reveal valuable insights. Among the predictors, water availability demonstrates the strongest positive impact (B = 0.596, p < 0.001), indicating that increased water availability positively influences hygiene practices. Conversely, water distribution shows a negative impact (B = -0.976, p < 0.001), suggesting that uneven distribution negatively affects hygiene. Water accessibility also exhibits a positive but non-significant impact (B = 0.985, p = 0.213), while water infrastructure has no significant effect (B = 0.018, p = 0.981). These findings underscore the critical importance of equitable water distribution and availability in promoting hygiene practices within the district.

Table 4. 8: Model summary of water shortage and sanitation in Kicukiro District, Rwanda

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.660[a]	.436	.430	.67265

a. Predictors: (Constant), Water availability, Water infrastructure , Water distribution , Water accessibility

Source: Field Data, 2024

The Table 4.7 of model summary for water shortage and sanitation in Kicukiro District, Rwanda shows a significant relationship (R = 0.660). Approximately 43.6% of the variance in sanitation can be explained by the combined effects of water availability, infrastructure, distribution, and accessibility. The adjusted R square of 0.430 suggests that these predictors collectively contribute to understanding sanitation, with a standard error of 0.67265.

Table 4. 9: Analysis of variance (ANOVA) of water shortage and sanitation in Kicukiro District, Rwanda

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	134.014	4	33.503	74.047	.000[b]
Residual	173.293	383	.452		
Total	307.307	387			

a. Dependent Variable: Sanitation

b. Predictors: (Constant), Water availability, Water infrastructure , Water distribution , Water accessibility

Source: Field Data, 2024

The Table 4.8 of analysis of variance (ANOVA) for water shortage and sanitation in Kicukiro District, Rwanda indicates a highly significant result (p < 0.001). The regression model, which includes water availability, infrastructure, distribution, and accessibility as predictors, significantly explains the variance in sanitation. With an F-statistic of 74.047, the model demonstrates a strong ability to predict sanitation outcomes, highlighting the critical influence of water-related factors on sanitation conditions within the district.

Stratford Peer Reviewed Journals and Book Publishing
Journal of Agriculture & Environmental Sciences
Volume 8||Issue 1||Page 51-69 ||May||2024|
Email: info@stratfordjournals.org ISSN: 2616-8465

Table 4. 10: Regression coefficients of water shortage and sanitation in Kicukiro District, Rwanda

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.602	.275		2.187	.029
Water accessibility	1.260	.727	.848	1.734	.084
Water distribution	-1.328	.225	-.916	-5.908	.000
Water infrastructure	.051	.681	.035	.074	.941
Water availability	.499	.031	.630	15.981	.000

a. Dependent Variable: Sanitation

Source: Field Data, 2024

The Table 4.9 of regression coefficients for water shortage and sanitation in Kicukiro District, Rwanda provide important insights. Among the predictors, water availability demonstrates the strongest positive impact (B = 0.499, p < 0.001), indicating that increased water availability positively influences sanitation. Conversely, water distribution shows a negative impact (B = -1.328, p < 0.001), suggesting that uneven distribution negatively affects sanitation. Water accessibility also exhibits a positive but non-significant impact (B = 1.260, p = 0.084), while water infrastructure has no significant effect (B = 0.051, p = 0.941). These findings emphasize the critical role of equitable water distribution and availability in promoting sanitation practices within Kicukiro District, Rwanda.

Table 4. 11: Model summary of water shortage and quality of life in Kicukiro District, Rwanda

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.338[a]	.114	.105	.89758

a. Predictors: (Constant), Water availability, Water infrastructure , Water distribution , Water accessibility

Source: Field Data, 2024

The Table 4.10 of model summary for water shortage and quality of life in Kicukiro District, Rwanda indicates a moderate relationship (R = 0.338). Around 11.4% of the variance in quality of life can be explained by water availability, infrastructure, distribution, and accessibility. The adjusted R square of 0.105 suggests that these predictors collectively contribute to understanding quality of life, with a standard error of 0.89758.

Table 4. 12: Analysis of variance (ANOVA) of water shortage and quality of life in Kicukiro District, Rwanda

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	39.673	4	9.918	12.311	.000[b]
	Residual	308.561	383	.806		
	Total	348.235	387			

a. Dependent Variable: Quality of life

b. Predictors: (Constant), Water availability, Water infrastructure , Water distribution , Water accessibility

Source: Field Data, 2024

Stratford Peer Reviewed Journals and Book Publishing
Journal of Agriculture & Environmental Sciences
Volume 8||Issue 1||Page 51-69 ||May||2024|
Email: info@stratfordjournals.org ISSN: 2616-8465

The Table 4.11 of analysis of variance (ANOVA) for water shortage and quality of life in Kicukiro District, Rwanda reveals a highly significant result ($p < 0.001$). The regression model, including water availability, infrastructure, distribution, and accessibility as predictors, significantly explains the variance in quality of life. With an F-statistic of 12.311, the model demonstrates a strong ability to predict quality of life outcomes, underscoring the crucial influence of water-related factors on overall well-being within the district.

Table 4. 13: Regression coefficients of water shortage and quality of life in Kicukiro District, Rwanda

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.723	.367		1.969	.050
Water accessibility	-.153	.970	-.097	-.158	.875
Water distribution	.069	.300	.045	.231	.817
Water infrastructure	.125	.909	.080	.138	.891
Water availability	.278	.042	.330	6.676	.000

a. Dependent Variable: Quality of life

Source: Field Data, 2024

The Table 4.12 of regression coefficients for water shortage and quality of life in Kicukiro District, Rwanda reveal key insights. Among the predictors, water availability shows the strongest positive impact ($B = 0.278$, $p < 0.001$), indicating that increased water availability positively influences quality of life. Conversely, other factors such as water accessibility, distribution, and infrastructure demonstrate non-significant impacts ($p > 0.05$). These findings underscore the critical role of adequate water availability in enhancing overall quality of life within the district. It suggests that ensuring sufficient water resources is crucial for improving various aspects of well-being and livelihoods among residents.

Table 4. 14: Model summary of water shortage and waterborne diseases in Kicukiro District, Rwanda

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.998[a]	.997	.997	.06621

a. Predictors: (Constant), Water availability, Water distribution , Water infrastructure , Water accessibility

Source: Field Data, 2024

The Table 4.13 of model summary for water shortage and waterborne diseases in Kicukiro District, Rwanda indicates an extremely strong relationship ($R = 0.998$). Approximately 99.7% of the variance in waterborne diseases can be explained by water availability, distribution, infrastructure, and accessibility. The adjusted R square of 0.997 highlights that these predictors collectively contribute significantly to understanding waterborne diseases, with a small standard error of 0.06621.

Stratford Peer Reviewed Journals and Book Publishing
Journal of Agriculture & Environmental Sciences
Volume 8||Issue 1||Page 51-69 ||May||2024|
Email: info@stratfordjournals.org ISSN: 2616-8465

Table 4. 15: Analysis of variance (ANOVA) of water shortage and waterborne diseases in Kicukiro District, Rwanda

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	488.434	4	122.109	27854.185	.000[b]
	Residual	1.679	383	.004		
	Total	490.113	387			

a. Dependent Variable: Water borne diseases
b. Predictors: (Constant), Water availability, Water distribution , Water infrastructure , Water accessibility
Source: Field Data, 2024

The Table 4.14 of analysis of variance (ANOVA) for water shortage and waterborne diseases in Kicukiro District, Rwanda reveals an extremely significant result ($p < 0.001$). The regression model, incorporating water availability, distribution, infrastructure, and accessibility as predictors, significantly explains the variance in waterborne diseases. With an F-statistic of 27854.185, the model strongly predicts the occurrence of waterborne diseases, emphasizing the critical role of water-related factors in determining health outcomes within Kicukiro District, Rwanda.

Table 4. 16: Regression coefficients of water shortage and waterborne diseases in Kicukiro District, Rwanda

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-.108	.027		-4.081	.000
Water accessibility	1.121	.043	.602	26.145	.000
Water distribution	.064	.022	.036	2.923	.004
Water infrastructure	-1.161	.031	-.627	-37.248	.000
Water availability	.996	.003	1.001	324.918	.000

a. Dependent Variable: Water borne diseases
Source: Field Data, 2024

The Table 4.15 of regression coefficients for water shortage and waterborne diseases in Kicukiro District, Rwanda provide crucial insights. Among the predictors, water availability demonstrates the strongest positive impact ($B = 0.996$, $p < 0.001$), indicating that increased water availability significantly reduces the incidence of waterborne diseases. Conversely, water infrastructure shows a strong negative impact ($B = -1.161$, $p < 0.001$), suggesting that poor infrastructure contributes significantly to the prevalence of waterborne diseases. Additionally, water accessibility and distribution also exhibit positive impacts ($B = 1.121$ and $B = 0.064$ respectively, both $p < 0.001$), emphasizing the importance of equitable access and distribution in mitigating waterborne diseases within Kicukiro District, Rwanda.

Stratford Peer Reviewed Journals and Book Publishing
Journal of Agriculture & Environmental Sciences
Volume 8||Issue 1||Page 51-69 ||May||2024|
Email: info@stratfordjournals.org ISSN: 2616-8465

Table 4. 17: Model summary of water shortage and nutrition in Kicukiro District, Rwanda

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.993[a]	.986	.986	.13221

a. Predictors: (Constant), Water availability, Water distribution , Water infrastructure , Water accessibility

Source: Field Data, 2024

The Table 4.16 of model summary indicates an extremely strong relationship (R = 0.993) between water shortage predictors and the outcome variable. Approximately 98.6% of the variance in the outcome variable can be explained by water availability, distribution, infrastructure, and accessibility. The adjusted R square of 0.986 signifies that the predictors collectively provide a highly accurate understanding of the outcome variable, with a small standard error of 0.13221.

Table 4. 18: Analysis of variance (ANOVA) of water shortage and nutrition in Kicukiro District, Rwanda

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	481.396	4	120.349	6885.131	.000[b]
	Residual	6.695	383	.017		
	Total	488.090	387			

a. Dependent Variable: Nutrition

b. Predictors: (Constant), Water availability, Water distribution , Water infrastructure , Water accessibility

Source: Field Data, 2024

The Table 4.17 of analysis of variance (ANOVA) for water shortage and nutrition in Kicukiro District, Rwanda shows an extremely significant result ($p < 0.001$). The regression model, including water availability, distribution, infrastructure, and accessibility as predictors, significantly explains the variance in nutrition. With an F-statistic of 6885.131, the model demonstrates a strong ability to predict nutrition outcomes, indicating that these water-related factors play a crucial role in determining nutritional status within Kicukiro District, Rwanda.

Table 4. 19: Regression coefficients of water shortage and nutrition in Kicukiro District, Rwanda

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.025	.053		.477	.634
Water accessibility	1.094	.086	.589	12.778	.000
Water distribution	.070	.044	.039	1.613	.107
Water infrastructure	-1.165	.062	-.631	-18.711	.000
Water availability	.992	.006	.998	161.993	.000

a. Dependent Variable: Nutrition

Source: Field Data, 2024

The Table 4.18 of regression coefficients for water shortage and nutrition in Kicukiro District, Rwanda provide valuable insights. Among the predictors, water availability demonstrates the strongest positive impact (B = 0.992, $p < 0.001$), indicating that

Stratford Peer Reviewed Journals and Book Publishing
Journal of Agriculture & Environmental Sciences
Volume 8||Issue 1||Page 51-69 ||May||2024|
Email: info@stratfordjournals.org ISSN: 2616-8465

increased water availability significantly improves nutrition outcomes. Conversely, water infrastructure shows a strong negative impact (B = -1.165, $p < 0.001$), suggesting that poor infrastructure significantly hampers nutrition. Additionally, water accessibility also exhibits a positive impact (B = 1.094, $p < 0.001$), emphasizing the importance of accessible water sources in promoting better nutrition. However, water distribution does not show a significant effect ($p > 0.05$). These findings underscore the critical role of water-related factors in determining nutritional status within Kicukiro District, Rwanda.

Table 4. 20: Model summary of water shortage and food security in Kicukiro District, Rwanda

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	.638[a]	.408	.401	.67313

a. Predictors: (Constant), Water availability, Water distribution , Water infrastructure , Water accessibility

Source: Field Data, 2024

The Table 4.19 of model summary for water shortage and food security in Kicukiro District, Rwanda shows a significant relationship (R = 0.638). Approximately 40.8% of the variance in food security can be explained by water availability, distribution, infrastructure, and accessibility. The adjusted R square of 0.401 suggests that these predictors collectively contribute to understanding food security, with a standard error of 0.67313.

Table 4. 21: Analysis of variance (ANOVA) of water shortage and food security in Kicukiro District, Rwanda

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	119.381	4	29.845	65.870	.000[b]
Residual	173.536	383	.453		
Total	292.918	387			

a. Dependent Variable: Food security

b. Predictors: (Constant), Water availability, Water distribution , Water infrastructure , Water accessibility

Source: Field Data, 2024

The Table 4.20 of analysis of variance (ANOVA) for water shortage and food security in Kicukiro District, Rwanda indicates a highly significant result ($p < 0.001$). The regression model, which includes water availability, distribution, infrastructure, and accessibility as predictors, significantly explains the variance in food security. The F-statistic of 65.870 suggests that the model is highly significant in predicting food security outcomes, reinforcing the importance of water-related factors in determining food security in Kicukiro District, Rwanda.

Stratford Peer Reviewed Journals and Book Publishing
Journal of Agriculture & Environmental Sciences
Volume 8||Issue 1||Page 51-69 ||May||2024|
Email: info@stratfordjournals.org ISSN: 2616-8465

Table 4. 22: Regression coefficients of water shortage and food security in Kicukiro District, Rwanda

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.550	.270		2.036	.042
Water accessibility	2.338	.436	1.625	5.366	.000
Water distribution	-1.267	.222	-.917	-5.698	.000
Water infrastructure	-1.071	.317	-.749	-3.380	.001
Water availability	.467	.031	.608	15.001	.000

a. Dependent Variable: Food security

Source: Field Data, 2024

The Table 4.21 showed the regression coefficients for water shortage and food security in Kicukiro District, Rwanda provide crucial insights. Among the predictors, water availability demonstrates a strong positive impact ($B = 0.467$, $p < 0.001$), indicating that increased water availability significantly enhances food security. Conversely, both water distribution ($B = -1.267$, $p < 0.001$) and water infrastructure ($B = -1.071$, $p = 0.001$) show strong negative impacts, suggesting that uneven distribution and poor infrastructure significantly hinder food security. In addition, water accessibility also exhibits a strong positive impact ($B = 2.338$, $p < 0.001$), highlighting the importance of accessible water sources in promoting food security within the district. These findings emphasize the critical role of water-related factors in ensuring food security among residents in Kicukiro District, Rwanda.

4.4 Qualitative results

Based on the insights provided by the twelve WASAC staff members interviewed, several key themes emerged regarding the impact of water shortage on daily life, household quality of life, and overall well-being in Kicukiro District.

4.4.1 Accessibility of Water Sources and Daily Challenges

The staff members highlighted the significant challenges faced by the community during water scarcity, emphasizing the critical importance of accessible water sources for daily life. They described how inadequate access to water sources exacerbates existing challenges, making it difficult for households to meet their basic needs. Factors such as climate variability and irregular rainfall patterns were noted as contributing to the exacerbation of water scarcity challenges, making it increasingly difficult for communities to access sufficient water for their daily needs.

4.4.2 Link between Quality of Life and Clean Water Access

The interviewees discussed the direct link between household quality of life and access to clean water and sanitation facilities in Kicukiro. They elaborated on how water scarcity directly affects economic stability and satisfaction within households, particularly for those already facing economic disparities. Community resilience was highlighted as playing a crucial role in how households cope with challenges related to water scarcity, emphasizing the importance of community support networks in mitigating the adverse

effects on quality of life.

4.4.3 Perception of Water Shortage and Household Well-being

The staff members shared personal experiences that underscored the profound impact of unequal water access on the happiness and health of households. They emphasized the role of sanitation practices in promoting health and dignity during water scarcity, highlighting the need for effective strategies to address these challenges comprehensively. The interviewees expressed concerns about the effectiveness of current strategies in addressing water shortage, emphasizing the need for more holistic approaches that consider the broad impacts on households beyond just water availability.

Therefore, the qualitative insights provided by the WASAC staff members offer valuable perspectives on the multifaceted challenges posed by water scarcity in Kicukiro District. Their experiences shed light on the interconnectedness of water access, household well-being, and community resilience, underscoring the importance of addressing these issues through collaborative and comprehensive strategies.

4.5 Discussion of results

The study of Adetayo et al. (2019) investigated the effect of water scarcity on households' livelihoods in a rural area of Nigeria. Their findings highlighted similar concerns regarding water scarcity, including insufficient rainfall, pollution of water sources, and increased population pressure. This aligns with the current study's emphasis on regional disparities, climate variability, and environmental degradation as key factors contributing to water shortage in Kicukiro District. Moreover, both studies emphasize the adverse effects of water scarcity on livelihoods and household well-being. Adetayo et al. (2019) found that approximately 60% of respondents perceived water scarcity to have a negative impact on their livelihoods, while the current study illustrates respondents' concerns over the impacts of water scarcity on economic stability, health satisfaction, and overall quality of life.

Rhue et al. (2023) explored the effects of household water insecurity on child health and well-being, extending the scope beyond microbiological pathogens to encompass various health impacts. This broader perspective aligns with the current study's focus on the multifaceted repercussions of water scarcity on household well-being, including economic, social, and health-related aspects. Similarly, Mbana & Sinthumule (2024) investigated on water injustice in South Africa. Their findings emphasized the deprivation of social justice and a good standard of living due to water shortages, reflecting the concerns rose in the current study regarding the critical importance of reliable water sources and proper sanitation for enhancing quality of life. Finally, Rubogora (2017) examined persistent water shortages in Kigali City, Rwanda. Their findings revealed that poorer families were most affected by water scarcity due to limited financial means and inadequate water infrastructure. This aligns with the current study's emphasis on the impact of aging infrastructure and unplanned city expansion on water access inequalities in Kicukiro District.

4. Conclusion

In conclusion, the study conducted in Kicukiro District, Rwanda, brought to light the relationship between water scarcity and household well-being, emphasizing the

complexity of the challenges faced and the potential solutions needed. The findings highlight significant apprehension regarding regional disparities, climate variability, urbanization, and aging infrastructure. The impact of unplanned city expansion and environmental degradation further worsens inequalities in water access, emphasizing the urgency for strategic interventions to address these issues. In the importance of reliable water sources and proper sanitation for enhancing quality of life is emphasized through respondents' perceptions. The study highlights how water scarcity not only affects economic stability and health satisfaction but also emphasizes the critical role of community resilience and sanitation practices in mitigating adverse effects. The results also showed that waterborne illnesses and the importance of good hygiene habits are particularly emphasized, emphasizing the need for community cooperation and improved water infrastructure.

The correlation analysis results revealed significant relationships between water shortage and household well-being factors, highlighting the crucial role of water availability in promoting overall well-being. Regression analyses further elaborate on the relationships between water shortage variables and indicators of household well-being, showcasing the significant impact of water availability on hygiene outcomes and the negative influence of water distribution and infrastructure. Therefore, Insights from two WASAC staff members supports the emphasis on challenges of water scarcity in Kicukiro District. They emphasized the critical need for accessible water sources, linking clean water access to household quality of life. Concerns were raised about the unequal impact of water shortage on well-being, highlighting the necessity for holistic strategies addressing both water access and community resilience.

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