

Seasonal Switching of Drinking-Water Sources from the Rainy to the Dry Season among Households in Somalia: Evidence from the 2022 Somalia Integrated Household Budget Survey

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Abstract

Household drinking-water access is often assessed using a single main source, which may overlook changes between seasons. Evidence on seasonal drinking-water source switching in Somalia remains limited. This study examined the prevalence and geographic and residence-type patterning of seasonal switching among households in Somalia. Data were analyzed from the 2022 Somalia Integrated Household Budget Survey, covering 7,212 households across 17 regions and rural, urban, and nomadic settings. Seasonal switching was defined as reporting a different main drinking-water source in the dry season than in the rainy season. Survey-weighted descriptive analyses and multivariable logistic regression examined associations with residence type, region, household size, internally displaced person status, and log-transformed real per-capita expenditure. Overall, 17.25% of households switched their main drinking-water source seasonally (95% CI: 16.21–18.34%). Switching was highest among nomadic households (34.27%), followed by rural (21.85%) and urban households (11.70%) ($p < 0.001$). In adjusted analysis, urban households had lower odds of switching than rural households (OR=0.49, 95% CI: 0.41–0.59), whereas nomadic households had higher odds (OR=1.82, 95% CI: 1.43–2.32). Switching also varied substantially across regions. No independent associations were found with IDP status, household size, or per-capita expenditure. Seasonal drinking-water source switching is a substantial and geographically heterogeneous feature of household water access in Somalia. Water planning and monitoring should account for seasonal source changes and differences across residence types and regions.

1. Introduction

Safe, reliable, and continuously available drinking water is fundamental to human health, household welfare, and sustainable development. Yet global progress toward universal access remains incomplete. The latest WHO/UNICEF Joint Monitoring Programme estimates indicate that 2.1 billion people still lacked safely managed drinking-water services in 2024, with persistent inequalities between rural and urban populations and across socioeconomic groups [1]. These inequalities are important because drinking-water access is not determined solely by whether a household has a nominally improved source; safely managed service also requires that water be available when needed, accessible on premises, and free from contamination [1, 2]. Inadequate water services are consequently linked to preventable infectious disease, time and financial burdens, and reduced household well-being, with children particularly vulnerable to the health consequences of unsafe water [3]. At the same time, climate variability is increasing pressure on water systems in many parts of Africa, where drought, rainfall variability, and hydrological fluctuations interact with existing infrastructure and institutional constraints to intensify water insecurity [4, 5]. Understanding household water access therefore requires attention not only to whether a source is classified as improved or unimproved, but also to whether that source remains available and usable throughout the year.

An increasingly important perspective in water research is that household water access is dynamic rather than static. The household water-insecurity literature conceptualizes water security in terms of the

reliability, adequacy, safety, and accessibility of water over time, rather than simply the physical presence of infrastructure [6, 7, 8, 24]. Similarly, research on multiple household water sources demonstrates that households may combine or alternate between sources according to availability, reliability, distance, cost, water quality, and seasonal conditions [9]. Seasonality can therefore alter not only the quantity of water available but also the type of source households depend upon. Evidence from pastoral and semi-arid communities in Uganda and Tanzania found substantial wet-to-dry changes in primary water sources, including transitions between sources with different contamination risks [10]. Qualitative evidence from Ghana, Kenya, and Zambia likewise shows that seasonal variation affects water-source availability, use, and the operation of community-managed systems [11]. In Malawi, households reported using alternative sources when their principal source was insufficient, unavailable, or non-functional, with reliability and proximity emerging as important considerations in source selection [12]. More recent multi-country evidence strengthens this argument: analysis of 37,105 households across 14 low- and middle-income countries found that approximately 10% used a different primary drinking-water source in the rainy and dry seasons, although prevalence varied substantially between countries [13]. Importantly, these findings demonstrate that seasonal source switching is not a uniform phenomenon and that its magnitude depends strongly on local environmental, infrastructural, and socioeconomic conditions.

The importance of these dynamics is particularly evident in dryland and fragile settings, where water availability is highly sensitive to seasonal rainfall and where formal water infrastructure may coexist with wells, boreholes, surface water, rainwater harvesting, water catchments, and water-vending systems. In such settings, switching sources may represent an adaptive response to changing water availability, but it may also expose households to different levels of reliability, distance, cost, or contamination. Evidence from South Africa illustrates this complexity: seasonal changes in primary drinking-water sources were relatively uncommon in one rural setting, while interruptions in municipal water supply were widespread, suggesting that source switching and continuity of supply are related but distinct dimensions of household water access [14]. Recent work in rural Mali similarly emphasizes that seasonal patterns of water use and household water insecurity cannot be adequately understood from infrastructure availability alone because the reliability and seasonal stability of services influence households' lived experiences of water access [15]. Thus, evidence from other countries cannot simply be transferred to Somalia, where the combination of arid and semi-arid environments, recurrent droughts, pastoral and nomadic livelihoods, rapid urbanization, displacement, weak infrastructure, and fragmented water-service provision creates a distinctive setting in which households may respond differently to seasonal changes [4, 16].

Somalia represents a particularly important context for examining seasonal drinking-water source switching. The country experiences strong climatic variability, recurrent drought, and substantial spatial differences in water availability, while water systems have also been affected by prolonged conflict, institutional constraints, and limited infrastructure. During the severe drought period preceding the SIHBS 2022 survey, widespread water-source depletion and declining water availability were documented, illustrating the sensitivity of Somali livelihoods and communities to rainfall failure [17, 18]. Hydrological studies likewise demonstrate substantial pressures on Somali water resources, including

variability in river flows and drought conditions [19]. These pressures interact with major differences in household water access across rural, urban, and nomadic populations. The SIHBS 2022 documentation explicitly distinguishes these three residence types and provides nationally representative household information across all 17 regions of Somalia [20]. Existing national analyses based on Somali survey data have demonstrated pronounced geographic and socioeconomic inequalities in drinking-water access, including differences associated with region, residence type, wealth, and community characteristics [21, 22, 23]. However, these studies have predominantly examined the type or quality classification of the water source at a particular point in time rather than whether households change their principal drinking-water source between seasons.

This distinction identifies an important empirical gap. Static measures of drinking-water access can conceal seasonal instability because a household may be classified according to one primary source even though its source changes when environmental or service conditions change. The international literature has increasingly recognized seasonal switching and multiple-source use as important dimensions of household water services [9, 13], but evidence remains geographically uneven, particularly for fragile dryland countries. Within Somalia, previous research has documented disparities in improved or unimproved water-source use and spatial inequalities, but nationally representative evidence on the prevalence, geographic distribution, and correlates of actual seasonal switching between rainy- and dry-season drinking-water sources remains limited [22, 23]. Moreover, it remains unclear whether seasonal switching in Somalia is primarily associated with household socioeconomic characteristics or whether it is more strongly structured by geographic and residence-specific water-service conditions. This distinction is theoretically important because household water-insecurity frameworks emphasize household experience and coping, whereas the multiple-source literature suggests that source choice can also reflect the availability and reliability of local water infrastructure and environmental conditions [6, 9]. Consequently, household-level socioeconomic characteristics may not fully explain observed patterns when strong spatial differences in water systems exist.

The present study addresses this gap by treating seasonal drinking-water source switching as a distinct household-level outcome rather than using source type alone as a proxy for water access. Using nationally representative SIHBS 2022 household data, the study estimates the prevalence of switching between rainy- and dry-season drinking-water sources and examines how switching varies across residence type and region. It further evaluates whether household size, internally displaced person (IDP) status, and economic status are independently associated with the likelihood of seasonal source switching after accounting for geographic and residence characteristics. This approach extends existing research in two ways. First, it shifts the analytical focus from the static classification of water sources toward the temporal stability of household drinking-water access. Second, it evaluates whether seasonal switching is primarily differentiated by household characteristics or by the broader geographic and residential context in which households obtain water. The analysis of specific rainy-to-dry source transitions further identifies the pathways through which switching occurs, providing information that is not captured by a binary improved/unimproved classification. Such evidence is relevant for water-service

monitoring and for interventions designed to improve the continuity and seasonal resilience of drinking-water supplies, particularly in dryland and fragile contexts.

Accordingly, the primary objective of this study was to estimate the prevalence and distribution of seasonal drinking-water source switching among households in Somalia and to identify household and geographic characteristics associated with switching using SIHBS 2022 data. Specifically, the study addressed three questions: (1) What proportion of Somali households change their principal drinking-water source between the rainy and dry seasons? (2) How does seasonal source switching vary across residence type and region? and (3) Are household size, IDP status, and economic status independently associated with the likelihood of seasonal source switching after adjustment for residence type and region? In addition, the study characterized the most common rainy-to-dry drinking-water source transitions among households that switched sources. Given the observational cross-sectional design, the study was designed to estimate population patterns and statistical associations rather than causal effects.

2. Methodology

2.1 Study Design and Data Source

This study used a cross-sectional quantitative design based on secondary analysis of the 2022 Somalia Integrated Household Budget Survey (SIHBS 2022) conducted by the Somalia National Bureau of Statistics (SNBS). The SIHBS 2022 is a nationally representative household survey designed to collect information on household demographic and socioeconomic characteristics, living conditions, and access to basic services. The survey employed a stratified, multistage probability sampling design and covered 7,212 households selected from 601 enumeration areas across the 17 regions of Somalia [20].

The analysis used the SIHBS 2022 household-level analytical dataset. The study examined whether households changed their main source of drinking water between the rainy and dry seasons and identified household and geographic characteristics associated with seasonal source switching.

2.2 Study Population and Analytical Sample

The study population consisted of households included in the SIHBS 2022 household dataset. The initial dataset contained 7,212 households. The primary outcome variable, seasonal drinking-water source switching, was available for all households included in the analysis.

For the multivariable regression analysis, household expenditure information was required to construct the real per-capita expenditure variable. Sixty households had missing expenditure values. Consequently, the complete-case analytical sample for models including economic status was 7,152 households.

2.3 SIHBS 2022 Sampling Design

The SIHBS 2022 employed a stratified multistage probability sampling design. Enumeration areas (EAs) served as the primary sampling units, and households were selected through successive sampling stages. The survey documentation reports that 601 EAs were selected, with approximately 35 EAs allocated to each of the 17 regions, and approximately 12 households selected per EA. Sampling weights were provided to account for the unequal probabilities of household selection and to produce population-representative estimates [20].

The present study used the household sampling weight provided in the SIHBS 2022 analytical dataset. For variance estimation, strata were constructed by cross-classifying region and enumeration-area type (rural, urban, and nomadic), following the analytical specification used for this study.

2.4 Survey Weighting and Variance Estimation

All descriptive and regression analyses incorporated the household sampling weights. The survey design was specified in Stata using the household identifier as the clustering variable, the SIHBS household weight as the probability weight, and a combined region-by-enumeration-area-type variable as the stratification variable.

The survey-weighted percentage of households experiencing seasonal source switching was calculated as:

$$P = [\sum(w_i \times S_i) / \sum w_i] \times 100$$

where P is the weighted percentage of households experiencing seasonal drinking-water source switching; w_i is the survey weight for household i ; S_i is the seasonal switching indicator for household i , coded 1 when the household reported a different main drinking-water source between seasons and 0 when the source remained the same.

The Stata survey specification was:

```
svyset hid [pweight = wgt], strata(strata)
```

where hid is the household identifier, wgt is the SIHBS household sampling weight, and $strata$ represents the combined region and enumeration-area-type strata.

Because the available analytical household file did not contain the original SIHBS enumeration-area identifier required to exactly reproduce the survey's original EA-level clustering, the variance estimates should be interpreted as based on the analytical survey specification described above rather than as an exact reconstruction of the original EA-level design. The original SIHBS sampling design used enumeration areas as primary sampling units [20].

2.5 Definition of the Outcome Variable

The primary outcome was seasonal drinking-water source switching. The variable was derived from the SIHBS question asking whether the household's main drinking-water source during the dry season was the same as that used during the rainy season.

The outcome was coded as:

0 = No seasonal switching; the household used the same main drinking-water source in both seasons.

1 = Seasonal switching; the household used a different main drinking-water source in the dry season compared with the rainy season.

Thus, the outcome represented a binary measure of whether a household changed its principal drinking-water source between seasons.

2.6 Drinking-Water Source Transition Analysis

Among households classified as seasonal switchers, an additional transition analysis was conducted to identify the most common changes between rainy-season and dry-season drinking-water sources.

The rainy-season source was represented by the SIHBS variable **hh_water_type**, while the dry-season source was represented by **hh2_11**. A transition variable was constructed by combining the two source codes:

$$\text{transition} = (\text{rainy-season source} \times 100) + \text{dry-season source}$$

The transition distribution was then estimated among households with seasonal switching using the SIHBS sampling weights.

The transition percentages represent the proportion of all households that switched sources that followed each specific rainy-season-to-dry-season pathway. Therefore, the percentages reported for individual pathways should not be interpreted as percentages of all households in Somalia.

Because some individual source transitions had small numbers of observations, the analysis focused on the most common transition pathways rather than interpreting very small individual cells as substantive population-level patterns.

2.7 Explanatory Variables

The explanatory variables were selected to capture geographic, residential, demographic, displacement, and economic characteristics that could plausibly be associated with seasonal drinking-water source switching.

Residence type was classified as rural, urban, or nomadic, based on the SIHBS enumeration-area classification (**ea_type_n**). Rural residence was used as the reference category in regression models.

Region included the 17 SIHBS regions, with Awdal used as the reference category.

Household size was measured as the number of members in the household (hhsz) and entered as a continuous variable.

Internally displaced person (IDP) status was classified as IDP or non-IDP using the SIHBS household self-identification variable (hh1_18). Non-IDP households were used as the reference category.

Economic status was measured using real per-capita expenditure (pcer). Because expenditure was positively skewed, its natural logarithm was used in the regression model:

$$\ln_pcer = \ln(pcer)$$

Only positive expenditure values were included in the logarithmic transformation.

2.8 Statistical Analysis

Data analysis was conducted using Stata. Descriptive statistics were first used to summarize the distribution of seasonal drinking-water source switching across residence type, IDP status, and region.

Survey-weighted proportions with 95% confidence intervals were estimated for the outcome overall and across major categorical characteristics. Differences in the prevalence of seasonal switching across residence type, IDP status, and region were assessed using design-based survey tests.

For continuous household characteristics, survey-weighted means were estimated separately for households that switched and did not switch drinking-water sources.

Because the outcome was binary, a survey-weighted logistic regression model was used to estimate adjusted associations between household characteristics and seasonal drinking-water source switching.

The multivariable model was specified as:

$$\text{logit}[P(S_i = 1)] = \beta_0 + \beta_1 \text{Residence}_i + \beta_2 \text{Region}_i + \beta_3 \text{HouseholdSize}_i + \beta_4 \text{IDP}_i + \beta_5 \ln(\text{PCE}_i)$$

where $P(S_i = 1)$ represents the probability that household i experienced seasonal drinking-water source switching; β_0 is the intercept; and β_1 through β_5 represent the coefficients associated with residence type, region, household size, IDP status, and logged real per-capita expenditure, respectively.

The regression results were reported as adjusted odds ratios (ORs) with 95% confidence intervals and design-based p-values. An odds ratio greater than 1 indicates higher odds of seasonal source switching relative to the reference category, whereas an odds ratio below 1 indicates lower odds.

Adjusted predicted probabilities were also estimated using Stata's margins command to facilitate interpretation of residence-type and regional differences after adjustment for the other variables in the model.

2.9 Model Diagnostics

Several diagnostic procedures were conducted before interpreting the multivariable model.

Multicollinearity among explanatory variables was assessed using variance inflation factors (VIFs). The mean VIF was 1.91, with individual VIF values ranging from 1.04 to 2.61, indicating no evidence of problematic multicollinearity.

The linearity of continuous predictors on the logit scale was assessed by adding quadratic terms for household size and logged real per-capita expenditure. A joint Wald test of the quadratic terms was not statistically significant ($F(2, 7102) = 1.95, p = 0.142$), supporting retention of the continuous predictors in their linear form.

2.10 Missing Data

The primary seasonal-switching outcome was available for the households included in the analysis. The economic variable, real per-capita expenditure, contained 60 missing observations. Therefore, analyses involving per-capita expenditure, including the multivariable logistic regression model, were conducted using complete cases, resulting in an analytical sample of 7,152 households.

No imputation was performed because the proportion of missing expenditure observations was small relative to the total analytical sample.

2.11 Ethical Considerations

This study involved secondary analysis of anonymized SIHBS 2022 household survey data. The analysis did not involve direct contact with human participants or the collection of new personal information. The study used the publicly documented SIHBS 2022 microdata and followed the data-use and confidentiality principles associated with the survey dataset.

The SIHBS 2022 was implemented by the Somalia National Bureau of Statistics as an official national household survey, with standardized data collection, quality-control procedures, and confidentiality protections described in the survey documentation [20]. Clinical trial number: not applicable.

2.12 Data Availability

The study used the Somalia Integrated Household Budget Survey (SIHBS) 2022 conducted by the Somalia National Bureau of Statistics. The SIHBS documentation and microdata are available through the Somali National Data Archive (SoNADA), subject to the access conditions established by SNBS.

3. Results

3.1 Overall prevalence of seasonal drinking-water source switching

Among the 7,212 households in the household-level SIHBS 2022 dataset, 1,411 households (19.56% unweighted) were classified as seasonal switchers, while 5,801 (80.44%) reported the same main drinking-water source across the rainy and dry seasons. After application of the household sampling weights and the final survey design, the estimated national prevalence of seasonal drinking-water source switching was 17.25% (95% CI: 16.21–18.34%). The corresponding weighted population estimate was approximately 397,582 households.

Table 1. National prevalence of seasonal drinking-water source switching

Outcome	Unweighted n	Weighted %	95% CI
No seasonal switching	5,801	82.75	81.66–83.79
Seasonal switching	1,411	17.25	16.21–18.34
Total	7,212	100.00	—

3.2 Seasonal switching by residence type

Seasonal switching varied substantially by residence type. The weighted prevalence was 21.85% among rural households, 11.70% among urban households, and 34.27% among nomadic households. The survey-adjusted association was statistically significant ($F(1.95, 13,964.98) = 93.90, p < 0.001$). Thus, seasonal source switching was least common in urban households and most common among nomadic households.

Table 2. Seasonal drinking-water source switching by residence type

Residence type	Switching (%)	95% CI	Survey-adjusted test
Rural	21.85	19.69–24.18	$F(1.95, 13,964.98) = 93.90; p < 0.001$
Urban	11.70	10.64–12.84	
Nomadic	34.27	30.02–38.78	

3.3 Seasonal switching by IDP status

Seasonal switching prevalence was almost identical between IDP and non-IDP households. The weighted prevalence was 17.24% among non-IDP households and 17.27% among IDP households. The survey-adjusted test provided no evidence of an association between IDP status and seasonal switching ($F(1, 7,163) = 0.0002, p = 0.988$).

Table 3. Seasonal drinking-water source switching by IDP status

IDP status	Switching (%)	95% CI	Survey-adjusted test
Non-IDP	17.24	16.15–18.40	F(1,7,163)=0.0002; p=0.988
IDP	17.27	14.03–21.07	

3.4 Geographic variation in seasonal switching

Marked geographic heterogeneity was observed across the 17 regions. Weighted switching prevalence ranged from 4.81% in Mudug to 48.87% in Bakool. Other regions with relatively high prevalence included Sanaag (33.49%), Lower Juba (29.96%), Bari (29.59%), Sool (28.20%), and Togdheer (25.78%). The lowest prevalences were observed in Mudug (4.81%), Banadir (7.75%), Waqooyi Galbeed (8.05%), and Hiraaan (9.98%). The survey-adjusted test indicated strong regional heterogeneity ($F(13.68, 97,994.46) = 24.41, p < 0.001$).

Table 4. Seasonal switching by region

Region	Switching (%)	95% CI
Awdal	11.24	8.36–14.94
Bakool	48.87	43.45–54.32
Banadir	7.75	5.78–10.33
Bari	29.59	24.34–35.44
Bay	21.11	16.12–27.14
Galgaduud	19.85	15.08–25.67
Gedo	11.61	9.35–14.33
Hiraan	9.98	7.39–13.35
Lower Juba	29.96	24.96–35.48
Lower Shabelle	15.54	11.78–20.22
Waqooyi Galbeed	8.05	5.89–10.91
Middle Shabelle	12.46	9.31–16.49
Mudug	4.81	2.92–7.83
Nugaal	16.51	12.90–20.91
Sanaag	33.49	25.97–41.95
Sool	28.20	22.57–34.60
Togdheer	25.78	21.04–31.17

3.5 Household characteristics

Household size and logged real per-capita expenditure were similar across switching groups. Mean household size was 6.68 among non-switching households and 6.59 among switching households. Mean logged real per-capita expenditure was 6.64 among non-switchers and 6.62 among switchers. Analyses involving expenditure used 7,152 households because 60 households lacked the expenditure measure.

Table 5. Household characteristics by seasonal switching status

3.6 Adjusted associations with seasonal source switching

A survey-weighted multivariable logistic regression model was fitted using residence type, region, household size, IDP status, and logged real per-capita expenditure. The model was statistically significant overall ($F(21, 7,083) = 22.59, p < 0.001; n = 7,152$). Relative to rural households, urban households had approximately 51% lower odds of seasonal switching (aOR = 0.495, 95% CI: 0.413–0.593, $p < 0.001$), whereas nomadic households had approximately 82% higher odds (aOR = 1.819, 95% CI: 1.429–2.317, $p < 0.001$).

Substantial regional differences remained after adjustment. Compared with Awdal, the highest adjusted odds were observed in Bakool (aOR = 7.172, 95% CI: 4.714–10.910, $p < 0.001$), followed by Lower Juba (3.993), Bay (3.057), Bari (2.878), Sanaag (2.880), Togdheer (2.699), Sool (2.289), and Nugaal (1.684). Mudug had substantially lower adjusted odds (aOR = 0.323, 95% CI: 0.171–0.609, $p < 0.001$).

IDP status, household size, and logged real per-capita expenditure were not independently associated with seasonal switching in the adjusted model. The adjusted odds ratio for IDP status was 0.888 (95% CI: 0.664–1.187; $p = 0.421$), for household size was 1.021 (95% CI: 0.992–1.052; $p = 0.163$), and for logged real per-capita expenditure was 0.970 (95% CI: 0.854–1.103; $p = 0.647$). These findings indicate no evidence of an independent association within the variables included in the model; they should not be interpreted as evidence that these characteristics have no relevance to water access more broadly.

Table 6. Survey-weighted multivariable logistic regression of seasonal switching

Predictor	Adjusted OR	95% CI	p-value
Urban vs rural	0.495	0.413–0.593	<0.001
Nomadic vs rural	1.819	1.429–2.317	<0.001
Bakool vs Awdal	7.172	4.714–10.910	<0.001
Banadir vs Awdal	1.038	0.647–1.664	0.878
Bari vs Awdal	2.878	1.853–4.471	<0.001
Bay vs Awdal	3.057	1.904–4.909	<0.001
Galgaduud vs Awdal	1.546	0.960–2.489	0.073
Gedo vs Awdal	1.276	0.838–1.945	0.256
Hiraan vs Awdal	0.785	0.483–1.275	0.327
Lower Juba vs Awdal	3.993	2.574–6.194	<0.001
Lower Shabelle vs Awdal	1.445	0.901–2.317	0.127
Waqooyi Galbeed vs Awdal	0.814	0.504–1.316	0.402
Middle Shabelle vs Awdal	1.059	0.653–1.718	0.816
Mudug vs Awdal	0.323	0.171–0.609	<0.001
Nugaal vs Awdal	1.684	1.067–2.659	0.025
Sanaag vs Awdal	2.880	1.743–4.758	<0.001
Sool vs Awdal	2.289	1.433–3.658	0.001
Togdheer vs Awdal	2.699	1.738–4.191	<0.001
Household size (per unit)	1.021	0.992–1.052	0.163
IDP vs non-IDP	0.888	0.664–1.187	0.421
Log real per-capita expenditure	0.970	0.854–1.103	0.647

3.7 Adjusted predicted probabilities

Adjusted predictive probabilities reinforced the strong residence-type gradient. Holding the other model covariates at their observed/model-adjusted values, the predicted probability of switching was 21.10% for rural households, 12.13% for urban households, and 31.71% for nomadic households. These are model-based adjusted probabilities and should not be confused with the raw weighted prevalence estimates presented in Table 2.

Table 7. Adjusted predicted probability of seasonal switching by residence type

Residence type	Adjusted probability	95% CI
Rural	21.10%	18.83–23.37
Urban	12.13%	11.05–13.21
Nomadic	31.71%	27.59–35.83

3.8 Rainy-to-dry drinking-water source transition pathways

Among the 1,411 households classified as seasonal switchers, the transition analysis identified multiple rainy-to-dry source pathways. No single transition represented a majority of switching households. The most common weighted transition was from piped water into the dwelling during the rainy season to piped water to the yard or plot during the dry season (11.30%). Other prominent pathways included tubewell/borehole to tanker-truck water (5.89%), rainwater collection to an unprotected dug well (5.67%), and piped water into the dwelling to a tubewell/borehole (4.28%). Several prominent transitions originating from rainwater collection involved movement toward wells, boreholes, or tanker-truck supplies. The percentages in Table 8 are shares of all seasonal switchers and therefore do not sum to 100% because only the most prevalent pathways are displayed.

Table 8. Most prevalent rainy-to-dry drinking-water source transitions among seasonal switchers

Rainy-season source	Dry-season source	Weighted % among switchers
Piped into dwelling	Piped to yard/plot	11.30
Tubewell/borehole	Tanker-truck	5.89
Rainwater collection	Unprotected dug well	5.67
Piped into dwelling	Tubewell/borehole	4.28
Piped to yard/plot	Piped into dwelling	3.56
Rainwater collection	Protected dug well	2.95
Natural surface water	Tanker-truck	2.76
Rainwater collection	Tanker-truck	2.59
Tubewell/borehole	Public tap/standpipe	2.47
Piped into dwelling	Tanker-truck	2.41
Rainwater collection	Tubewell/borehole	2.29

3.10 Summary of principal findings

Approximately one in six households nationally changed its principal drinking-water source between the rainy and dry seasons. The strongest and most consistent differences were geographic and settlement-related: switching was substantially more common among nomadic and rural households than among urban households, and prevalence varied markedly across regions. In contrast, IDP status, household size, and logged real per-capita expenditure were not independently associated with switching in the final adjusted model. The transition analysis further showed that seasonal switching was heterogeneous rather than representing a single behavioral pathway, with prominent movements involving piped supplies, boreholes, wells, rainwater, and tanker-truck sources.

4. Discussion

4.1 Principal findings

The findings support a more precise conceptualization of seasonal source switching as a temporal dimension of household water access that is embedded in geographic and settlement contexts. This complements household water-insecurity frameworks, which emphasize reliability and continuity, and multiple-source perspectives, which emphasize flexible source use [6, 8, 9]. The study does not propose a new theory; rather, it provides national empirical evidence that temporal source stability deserves attention alongside static source classification. For monitoring and planning, seasonal continuity could be assessed alongside conventional source indicators, with interventions tailored to settlement and geographic context. Transition-specific interventions should incorporate source quality, functionality, distance and cost rather than assuming that every switch is undesirable.

4.2 Seasonal switching as a temporal dimension of water access

This study found that 17.25% of households changed their principal drinking-water source between the rainy and dry seasons. The strongest statistical differentiation was by residence type and region: switching was highest among nomadic households, intermediate among rural households, and lowest among urban households, while regional prevalence ranged from 4.81% in Mudug to 48.87% in Bakool. After adjustment, urban households had lower odds of switching than rural households and nomadic households had higher odds. IDP status, household size, and logged real per-capita expenditure were not independently associated with switching. Multiple rainy-to-dry pathways were observed, indicating that switching is heterogeneous rather than a single national behavior.

4.3 Residence and geographic context

The finding that roughly one in six households switched sources shows that a single main-source measure does not necessarily represent household water sourcing throughout the year. This complements evidence that households may use multiple sources and change sources across seasons [9, 13, 26]. The study therefore adds a temporal dimension to existing national evidence on Somali drinking-water access, which has mainly focused on whether sources are improved or unimproved [22,

23, 28]. Importantly, switching is not itself a measure of water insecurity: it may reflect adaptation, changing availability, or deterioration of a preferred source. The SIHBS data do not identify the reason, quality, cost, functionality, or consequence of individual transitions.

4.4 Transition pathways

Residence type showed a clear gradient. Nomadic households had higher adjusted odds of switching than rural households, while urban households had lower odds. This pattern is compatible with evidence from pastoral settings where water availability, mobility and livelihoods interact seasonally [10, 27]. Regional differences remained substantial after adjustment for residence and measured household characteristics. These differences complement recent Somali studies documenting strong geographic inequalities in drinking-water source access [22, 23]. The present analysis cannot determine whether rainfall, groundwater, infrastructure, markets, drought or other local conditions produce these regional patterns because those mechanisms were not measured. The results should therefore be interpreted as geographic patterning, not evidence that residence or region causes switching.

4.5 Household characteristics

The transition analysis adds information that a binary switching indicator cannot provide. The most common pathway was piped water into the dwelling to piped water to the yard or plot, followed by tubewell/borehole to tanker-truck and rainwater collection to unprotected dug well. No single pathway accounted for a majority of switchers. This heterogeneity is consistent with multiple-source research showing that households may alter sources as availability and reliability change [9, 12, 26]. The direction of a transition matters: movement between two piped arrangements differs from movement toward an unprotected source. However, the SIHBS data do not permit classification of individual pathways as adaptive or adverse.

4.6 Theoretical and policy implications

The lack of an independent association with IDP status should not be interpreted as evidence that displacement is unrelated to water insecurity. The binary IDP measure does not capture duration, camp status, humanitarian water provision, tenure, or local service conditions. Similarly, household size was close to the null in the adjusted model, while economic status measured by real per-capita expenditure was not associated with switching. Economic resources may influence which sources households can afford [25] without determining whether the source changes seasonally, while households sharing the same local water constraints may switch regardless of economic position. These interpretations are plausible but cannot be tested with the available variables.

4.7 Future research

Future research should move beyond identifying whether households switch sources to examine the mechanisms, consequences, and temporal dynamics underlying these changes. Longitudinal or repeated seasonal surveys could establish when switching occurs, how frequently households change sources, and whether transitions are associated with changes in water availability, reliability, quality,

distance, or expenditure. Linking household survey data with rainfall, drought indicators, groundwater conditions, and local water-service infrastructure would also help explain the marked regional heterogeneity observed in this study. Further work should distinguish between transitions that maintain or improve service continuity and those that move households toward less reliable or less protected sources. Such analyses would strengthen assessment of seasonal water-service resilience and help identify interventions that are appropriate to different settlement and geographic contexts.

4.8 Limitations

Several limitations should be considered when interpreting these findings. First, the cross-sectional nature of SIHBS 2022 precludes causal inference; therefore, the observed associations should not be interpreted as evidence that residence type or region causes households to switch drinking-water sources.

Second, seasonal source information was based on household reports and may be subject to recall or reporting error, particularly when respondents reported conditions across different seasons. Third, the binary switching measure does not capture the frequency or duration of switching, reasons for switching, or simultaneous use of multiple water sources.

Fourth, the available data did not provide direct measures of potentially important mechanisms, including source functionality, distance to source, water quality, water price, rainfall, groundwater availability, drought exposure, and household-specific water expenditure. Their absence may have resulted in residual confounding and limits interpretation of the pathways underlying observed source transitions.

Fifth, the economic analysis excluded 60 households with missing per-capita expenditure information. Although this represented a small proportion of the analytical sample, complete-case analysis may introduce bias if missingness was systematically associated with seasonal switching or other household characteristics.

Finally, variance estimation followed the available household analytical file and the prespecified analytical survey design. Although the original SIHBS sampling design used enumeration areas as primary sampling units, the available analytical household file did not contain the original EA identifier required to reproduce EA-level clustering exactly. Consequently, the reported confidence intervals and design-based tests should not be interpreted as a perfect reconstruction of the original survey variance. This limitation was explicitly considered when interpreting the inferential results.

5. Conclusion

This national analysis shows that seasonal drinking-water source switching is a substantive feature of household water access in Somalia. Approximately 17.25% of households changed their principal drinking-water source between the rainy and dry seasons, with substantially higher prevalence among nomadic and rural households than among urban households and pronounced heterogeneity across

regions. After adjustment, residence type and region remained strongly associated with switching, whereas IDP status, household size, and real per-capita expenditure were not independently associated with the outcome.

The findings demonstrate why assessment of drinking-water access should not rely exclusively on a single source classification or a single survey period. Seasonal source switching provides a useful complementary indicator of temporal stability, particularly in dryland and fragile settings where households may depend on different water sources as conditions change. The observed transition pathways also show that switching is heterogeneous and should not automatically be interpreted as either adaptive or adverse. For policy and monitoring, seasonal continuity should therefore be considered alongside source type, with attention to the reliability and protection of the sources used across seasons.

Overall, the study provides nationally representative evidence that the temporal dimension of household drinking-water access varies systematically by settlement and geography in Somalia. Future studies that combine repeated household observations with environmental and service-level data are needed to determine the mechanisms and consequences of these seasonal transitions and to identify interventions that improve the year-round resilience and continuity of drinking-water services.

Declarations

Author Contributions

Jamal Abdikarim Mohamed: Conceptualization, methodology, formal analysis, investigation, data curation, writing—original draft, writing—review and editing, visualization. Abdilatif Hussein Omar: Methodology, investigation, writing—review and editing, supervision.

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Data Availability

The SIHBS 2022 data used in this study are publicly available through the Somali National Data Archive with the following link <https://microdata.nbs.gov.so/index.php/catalog/59> , maintained by the Somalia National Bureau of Statistics.

Ethics Approval and Consent to Participate

This study involved secondary analysis of the publicly available SIHBS 2022 dataset. No new data were collected from human participants by the authors. The analysis used de-identified household-level

survey data and did not involve direct contact with participants.

Competing Interests

Both authors declare that they have no competing interests.

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Table

Table 5 is not available with this version.