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Sanitary Inspection of Drinking Water Sources Status in Blue Nile State, Sudan, 2023

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ABSTRACT

Background: Freshwater is the basic substance of life on earth and is increasingly in short supply.

Objectives: This study aimed to identify the sanitary inspection of drinking water sources status in Blue Nile State, Sudan, 2023.

Materials and methods: The survey conducted in all functional water sources in the five selected localities. Sanitary inspections were conducted using an adapted version of the WHO sanitary inspection form for collection information about water sources. Data was analyzed using SPSS.

Results: Out of a number of 263 water sources type were surveyed in the five selected localities in Blue Nile State, 90 (34.4) % were hafeer ponds (H.P), 85 (32.4%) were storage tanks, 28 (10.7%) were water taps, 26 (9.9%) were surface water, 19 (7.3%) were stations 6 (2.3%) were (OH DW) open holes domestic wells, and 8 (3.1%) were others. There was significance difference of sample tested for microbial in the studied localities (p=.000). The majority of water sample was acceptable from microbial view 77.2%. According to sanitary

inspection the water sources samples identified, 58.9%identfied as low priority action is required, 15.2% as high priority action is required while 25.9% identified as no action is required.Based on risk analysis of water samples microbial test, most of samples 144 (54.8%) identified as low risk, 44 (16.7%) as high risk and 75 (28.5%) as no risk. No significant association found between sanitary inspection and presence or absence of E.coli (P> 0.05).

Conclusion: Based on sanitary inspection and microbial test the study concludes that most of water sources samples identified as low priority action is required and low risk.

Keywords: *Drinking water source, status, Blue Nile state, 2023*

INTRODUCTION:

Freshwater is the simple substance of life on earth and is an increasing number of in brief supply. According to Sampat, P. [1], seventy five% of the European and 33% of the global populace use groundwater as their number one supply of drinking water. Yet, in many countries, both the quantity and first-rate of this aid have been compromised by human activities. Nowadays, water shortage influences 88 growing international locations which are domestic to 1/2 of the arena's population [2]. Surface water is any supply of water that is open to the atmosphere and is concern to run off from the land. Hence, it's miles very likely to incorporate microorganisms that can cause illness and in a few instances more severe, even fatal, ailments. In a few regions, a substantial portion of the surface consuming water is derived from bank filtration that carries a diverse chemical compounds' and pathogens' load [3] and calls for purification. On the opposite hand, groundwater is blanketed by way of soils and sediments and is considered to be much less vulnerable than floor water. Its abstraction although requires drilling and pumping device that isn't always to be had or sustainable especially in developing international locations. As the populace will increase, the groundwater abstraction is predicted to rise within the coming century, even as available web sites for surface reservoirs become limited. The most crucial step in supplying an area with secure drinking water is the choice of the high-quality available source water. The more covered supply waters are the easier and the cheaper to be transformed into secure drinking water [4]. The availability of freshwater varies each spatially and temporarily. The renewable fraction of the earth freshwater is normally determined within the shape of floor water and shows an choppy distribution. Groundwater is extra frivolously dispensed, even though plenty of it's far nonrenewable, fossil water. The water use in a specific location is decided not simplest by way of the herbal groundwater availability but also through the

population and the land use of an area, in addition to most economical factors. In the developed international locations, the municipality is obliged via law to deliver the consumers with high-quality water, while in the growing countries, this isn't always constantly legitimate. Hence, the economy of a network defines attitudes and funding in the direction of water improvement and remedy. The nearby climate also performs a huge role due to influences on evaporation costs and practices along with lawn watering and cooling necessities. Additionally, cultural values, moves, regulations, and legal guidelines of national governments also have an impact on water use. Finally, the difficulty of ownership of the resource which is connected to authorities impacts can be an important thing. Municipal water deliver structures consist of facilities for garage, transmission, remedy, and distribution. The design of these centers depends on the satisfactory of the water, the precise desires of the consumer or client, and the portions of water that need to be processed. In certain instances, seawater can also be used as a ingesting water supply via the system of desalination [5]. The simplest obviously renewable source of freshwater globally is precipitation (about a hundred and ten,000 km3 /year). Out of the precipitation going on over land, a large fraction (70,000 km3 /year) action returned to the environment thru evaporation and transpiration from plants [6]. Infiltration rates vary relying on land use, the man or woman, and the moisture content material of the soil, in addition to the depth and duration of precipitation. The purpose of this study was to identify the sanitary inspection of drinking water sources status in Blue Nile State, Sudan, 2023.

. **MATERIALS AND METHODS:**

Study design:

Descriptive cross sectional survey-water sources based.

Study area:

Blue Nile State lied in southern part of the country bordering from southeast Ethiopia, southwest of South Sudan and north is Sinner state. The State is divided into 6 administrative units “Mahaliat”, namely: Ed Damazin, Al Roseries, Baw, Geissan, El Tatamoon and El Kurmuk. Ed Damazin Town, the capital of Blue Nile State, is about 650 km south of Khartoum. The Blue Nile State is populated by 886350 persons of who 27%, 61% and 12% are urban, rural and nomadic, respectively, with an annual population growth rate of 3.01%. The majority of the population is agro-pastoralists, nevertheless a small proportion of employee and seasonal labor are present. The State is ethnically diverse, with eleven major tribes comprising a group

collectively known as the Funj. The internal displacement and refugee population has been estimated of about 165000 persons representing 18.6% of the total population [7].

Study population: Water sources in Blue Nile state.

Inclusion criteria:

All functional water sources in Blue Nile state in the selected locality.

Exclusion criteria:

- Water sources out of the selected localities.
- Non functional water sources.

Sample size:

All functional water sources in the five selected localities were sampled (262 water source).

Data collection:

Water sources survey was conducted using WHO validated water quality monitoring (WHO checklist). Data in terms of sanitary inspection for the water sources was conducted using WHO standard form. Samples for bacteriological testing using the rapid test (H2S) and multiple tube method were taken for detection of microorganisms.

Sanitary inspections were conducted using an adapted version of the WHO sanitary inspection form for tube wells (boreholes) with hand pumps [10]. Each water source is evaluated using the form and receives a sanitary risk score ranging from zero to ten, where zero indicates that none of the evaluated sanitary risk factors are present at the water source and a ten indicates that all are present. Water sources were categorized into sanitary risk classes similar to those used in other studies [11, 12]: low risk (0–3), high risk (4–6), and no risk (0).

Ethical considerations:

Permission was taken from the selected localities prior to conduct the water source survey.

Data analysis:

Data was analyzed using SPSS version 27.0. Descriptive statistics and inferential statistics were

used. Chi-square test was used to find association between variables. P-value considered significant at less than 0.05 levels.

RESULTS:

Out of a number of 263 water sources type were surveyed in the five selected localities in Blue Nile State, 90 (34.4) % were hafeer ponds (H.P), 85 (32.4%) were storage tanks, 28 (10.7%) were water taps, 26 (9.9%) were surface water, 19 (7.3%) were stations 6 (2.3%) were (OH DW) open holes domestic wells, and 8 (3.1%) were others, table 1 and figure 1.

Most of water sources found in Eldamazin locality 39.5% with most water taps 15.5% followed by Gessan locality 21.3% with most storage tanks 30.4%. There was significance difference between water sources type in the studied localities (p=.000). Table 2 illustrates the classification of presence of E.Coli/100 ml in water sources samples by localities in Blue Nile State. Group A (0 cells) represent most of water samples 140 (53.2%), Group B (1 and less than 10 cells) was 24% and Group C (10 and less than 100 cells) was 9.1%, Group D (100 and less than 1000 cells) was 0.4% and Group E (Uncountable cells) was 13.3%. Wad almahi locality was the most locality with E.coli/100 ml uncountable 15 (42.9%) followed by Elrusseris 9 (25.7%) and Eldamazin locality 5 (14.3%). There was significance difference of sample tested for microbial in the studied localities (p=.000).

Table 3 shows that the majority of samples tested for microbial test 203 (77.2%) was acceptable.

Table 4 indicates based on water samples microbial sanitary inspection score, 155 (58.9%) as low priority action is required and 40 (15.2%) as high priority action is required while 68 (25.9%) of water samples as no action is required.

Table 5 indicates based on risk analysis of water samples microbial test, most of samples 144 (54.8%) identified as low risk, 44 (16.7%) as high risk and 75 (28.5%) as no risk.

Table 6 indicates no significant relationship between sanitary inspection and E. coli/100 ml.

Table 1. Distribution of water sources by localities in Blue Nile State, 2023

Type of water source		Locality ELdamazin	ELrusseris	Wad Al mahi	Gessan	Altadamon	Total
Water Tap	n	16	7	5	0	0	**28**
	%	15.5%	12.7%	10.6%	.0%	.0%	**10.7%**

Storage Tank	n	46	5	18	17	0	**85**
	%	44.2%	9.1%	38.3%	30.4%	.0%	**32.4%**
Station	n	6	5	4	4	0	**19**
	%	5.8%	9.1%	8.5%	7.1%	.0%	**7.3%**
OHDW	n	2	0	2	2	0	**6**
	%	1.9%	.0%	4.3%	3.6%	.0%	**2.3%**
H.P	n	29	36	0	24	1	**90**
	%	28.2%	65.5%	.0%	42.9%	100.0%	**34.4%**
Surface water	n	0	2	15	9	0	**26**
	%	.0%	3.6%	31.9%	16.1%	.0%	**9.9%**
Others	n	5	0	3	0	0	**8**
	%	4.9%	.0%	6.4%	.0%	.0%	**3.1%**
Total	n	**104**	**55**	**47**	**56**	**1**	**263**
	%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0 %**
Overall (%)		**39.5**	**20.9**	**17.9**	**21.3**	**0.4**	

$\chi 2$=104.9; df=24; P-value =.000 (Significant)

Note: OHDW; Open Hole Domestic Well; H.P; Hafeer Pond

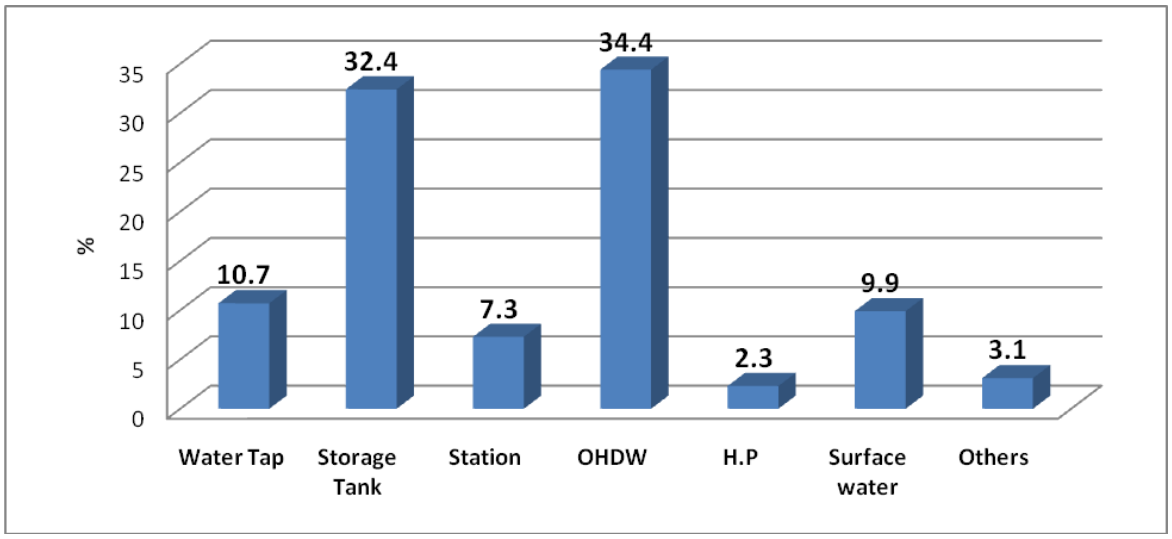

Fig. 1. Distribution of water sources by localities in Blue Nile State, 2023 (n=263)

Table 2. Classification of presence of E.Coli/100 ml in water sources samples by localities in Blue Nile State, 2023

Locality	E.Coli/100 ml	Total

		Group A (0 Cells)	Group B (1- <10 Cells)	Group C (10-<100 Cells)	Group D (100<1000 Cells)	Group E (Uncountable cells)	
ELdamazin	n	76	18	4	0	5	103
	%	54.3%	28.6%	16.7%	.0%	14.3%	39.2%
ELrussuris	n	28	12	7	0	9	56
	%	20.0%	19.0%	29.2%	.0%	25.7%	21.3%
Wad Al mahi	n	13	13	5	1	15	47
	%	9.3%	20.6%	20.8%	100.0%	42.9%	17.9%
Gessan	n	23	20	7	0	6	56
	%	16.4%	31.7%	29.2%	.0%	17.1%	21.3%
Altadamon	n	0	0	1	0	0	1
	%	.0%	.0%	4.2%	.0%	.0%	.4%
Total	n	140	63	24	1	35	263
	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Overall (%)		**53.2**	**24.0**	**9.1**	**0.4**	**13.3**	

$\chi 2$=58.6; df=16; P-value =.000 (Significant)

Table 3. Acceptability of water sources samples from microbial view by localities in Blue Nile State, 2023

Locality		Water status		Total
		Acceptable	Not acceptable	
ELdamazin	n	94	9	102
	%	46.3%	15.0%	38.9%
ELrussuris	n	40	16	56
	%	19.8%	26.7%	21.4%
Wad Al mahi	n	26	21	47
	%	12.9%	35.0%	17.9%
Gessan	n	43	13	56
	%	21.3%	21.7%	21.4%
Altadamon	n	0	1	1
	%	.0%	1.7%	.4%
Total	n	203	60	263
	%	100.0%	100.0%	100.0%
Overall (%)		**77.2**	**22.8**	

Table 4. Water sources sanitary inspection score by localities in Blue Nile State, 2023

Locality	Sanitary Inspection Score	Total

		Low priority action is required (1-3)	High priority action is required (4-6)	No action is required (0)	
ELdamazin	N	56	6	41	103
	%	36.1%	15.0%	60.3%	39.2%
ELrussuris	N	38	9	9	56
	%	24.5%	22.5%	13.2%	21.3%
Wad Al mahi	N	25	19	3	47
	%	16.1%	47.5%	4.4%	17.9%
Gessan	N	35	6	15	56
	%	22.6%	15.0%	22.1%	21.3%
Altadamon	N	1	0	0	1
	%	.6%	.0%	.0%	.4%
Total	N	155	40	68	263
	%	100.0%	100.0%	100.0%	100.0%
Overall (%)		**58.9**	**15.2**	**25.9**	

$\chi 2$=45.3; df=8; P-value =.000 (Significant)

Table 5. Water sources distribution according to risk analysis by localities in Blue Nile State, 2023

Locality		Risk analysis			Total
		Low	High	No risk	
ELdamazin	n	52	9	42	103
	%	36.1%	20.5%	56.0%	39.2%
ELrussuris	n	36	9	11	56
	%	25.0%	20.5%	14.7%	21.3%
Wad Al mahi	n	23	19	5	47
	%	16.0%	43.2%	6.7%	17.9%
Gessan	n	32	7	17	56
	%	22.2%	15.9%	22.7%	21.3%
Altadamon	n	1	0	0	1
	%	.7%	.0%	.0%	.4%
Total	n	144	44	75	263
	%	100.0%	100.0%	100.0%	100.0%

Overall (%)	**54.8**	**16.7**	**28.5**

Table 6. Regression model of sanitary inspection score and presence or absence of E coli/100 ml

Model		Sum of Squares	df	Mean Square	F	Sig.	R	R Square
1	Regression	1.191	1	1.191	1.610	.206(a)	.078(a)	.006
	Residual	193.029	261	.740				
	Total	194.221	262					

a Predictors: (Constant), E.Coli/100 ml
b Dependent Variable: Sanitary Inspection Score

DISCUSSION:

In sub-Saharan Africa (SSA) 42% of humans lack get entry to to a basic water supply, defined as a stepped forward water source on hand inside a 30 min fetching time [8]. However, even people the use of a basic water deliver may also nevertheless be ingesting contaminated water, as water quality isn't always considered without delay. While stepped forward water assets typically generally tend to supply water with higher microbial high-quality than unimproved materials, a scientific evaluation shows that many progressed sources are infected [9].

In this study some of 263 water resources kind were surveyed inside the five decided on localities in Blue Nile State, 90 (34.Four) % had been hafeer ponds (H.P), 85 (32.4%) have been storage tanks, 28 (10.7%) had been water faucets, 26 (9.9%) had been surface water, 19 (7.3%) had been stations 6 (2.3%) have been (OH DW) open holes domestic wells, and 8 (three.1%) were others. Similar findings within the same nation lately discovered that almost all of water assets type in Blue Nile State turned into significantly H.P (sixty nine.6%), storage tanks (18.4%), 2.4% O.H.D.W, surface water 4.2%, water tap 0.2%, water stations 3.1% and Jamam 2% [13].

Also the have a look at depicted the classification of presence and absence of E.Coli/one hundred ml in water assets samples by using localities in Blue Nile State. Group A (0 cells) constitute most of water samples one hundred forty (fifty three.2%), Group B (1 and less than 10 cells) was 24% and Group C (10 and less than a hundred cells) was 9.1%, Group D (a hundred and less than a thousand cells) become 0.4% and Group E (Uncountable cells) was 13.3%. Wad almahi locality changed into the most locality with E.Coli/100 ml uncountable 15 (42.9%)

observed by means of Elrusseris 9 (25.7%) and Eldamazin locality five (14.3%). There was significance distinction of sample examined for microbial in the studied localities (p=.000). Hence, the have a look at showed that the majority of samples examined for microbial test 203 (77.2%) became suitable. In addition the have a look at Indicated based totally on water samples microbial sanitary inspection rating, a hundred and fifty five (fifty eight.9%) with low priority movement is needed and 40 (15.2%) with high precedence action is needed at the same time as sixty eight (25.9%) of water samples and not using a motion is needed. The chance analysis of water samples microbial take a look at, maximum of samples one hundred forty four (fifty four.8%) with low threat, 44 (sixteen.7%) with high danger and 75 (28.5%) without a danger. In accordance look at additionally showed that level of E.Coli/100 ml substantially in Group (zero) was 64.1% and in group B become 28.4%, group C 6.1%, institution D 0.6% and organization E was 0.9%. However the acceptability of water assets amongst 543 samples taken the proper degree of E.Coli/one hundred ml in 501 (92.3%) samples. The water assets category consistent with sanitary inspection rankings suggests that forty 5.3% of the samples have been Low precedence action is required, excessive priority movement is needed (38.Five%), pressing priority movement is required (7.2%), and no motion is required (9%). In addition the water assets classification in line with risk analysis suggests 38.Three% of water resources were institution as H.P.A (High Action Priority, L.A.P (Low Action Priority) forty four.2%, N.A.R (No Action Required) nine.2%, UA (Urgent Action) eight.1% and zero.2% Not Applicable (NA) [13]. This look at confirmed no full-size relationship between sanitary inspection and E. Coli/one hundred ml. Sanitary inspection is a visual survey of chance elements which could make contributions to the likelihood of fecal contamination in water systems, and is taken into consideration an powerful and occasional-price device for risk evaluation [18]. In small network-controlled water structures, sanitary inspections are generally carried out the usage of bureaucracy advanced via the WHO, or variations of these [10]. The forms are era-type precise, and each accommodates [14] sure/no questions representing the presence/absence of sanitary risk factors. The general quantity of sanitary chance elements is summed to an typical sanitary hazard rating, which is often used to compare the level of chance among structures. Several studies have explored the relationship between sanitary inspection and water first-rate. Although sanitary inspection and water first-rate are conceptually connected [14], a few studies located no huge affiliation among the 2[15,16]. Water deliver professionals have puzzled the effectiveness of

sanitary inspection due to this apparent contradiction [17]. However, preceding checks of the relationship have not unusual weaknesses [17]. Literature comparing sanitary inspection and water first-rate evaluation has relied on the untested assumption that sanitary risk rating and E. Coli attention of a water source are positively and linearly related in all cases. This has been assessed by way of applying famous statistical checks to evaluate E. Coli awareness (as a non-stop, ordinal, or presence/absence degree) to sanitary risk rankings. Sanitary risk rating, but, isn't a complete representation of device hazard at a given factor in time but is a simplified output of a tool designed to perceive observable chance factors and manual corrective action [17].

CONCLUSION:

Based on sanitary inspection and microbial test the study concludes that most of water sources samples identified as low priority action is required and low risk. It is suggested adoption of sanitary inspection as a visual survey of risk factors in water systems because it is effective and low-cost tool for risk assessment.

DECLARATION OF COMPETING INTEREST:

The authors declared that there is no conflict of interest.

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