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Physico- chemical Assessment of Drinking Water in Northern and Southern Darfur

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Abstract

Twenty three samples of water were collected randomly from dams: ND1, ND2 (fenced), ND14 (open) and ND13 hafir in Northern Darfur (ND). Southern Darfur (SD) samples included Wadi Nyala SD3 and Rahads SD6, SD7 and SD8 Hafir for physico –chemical analysis: pH, conductivity, TDS, hardness and N – NH3. pH analysis showed a range of 6.2 – 7.8 for all samples which was similar to 6.5 -8.7 of WHO. Low conductivity less than 250µs/cm of WHO 90 µs/cm was reported for Wadi Nyala SD3, 157 µs/cm for Rahad SD7, 195 µs/cm for SD8 hafir and 220 µs/cm for ND1dam, 290 µs/cm for SD6 Rahad, 300 µs/cm for ND2 dam. Higher values compared to WHO (350 µs/cm) were recorded for ND14 and ND1 (370 µs/cm). Analysis showed a low TDS of 9 mg /L for Wadi Nyala SD3. Higher values of TDS were recorded for other samples (3700 mg/L – 4000 mg/L) compared to WHO (150 mg/L- 500 mg/L). The lowest hardness was reported 20 mg/L of CaCO3 for SD7 while the highest 180 mg/L for ND14 compared with WHO 500 mg/L. N – NH3 was nil in ND1 and ND2, while N- NH3 1.6 mg/L for ND14 and SD3 similar to WHO values 1.5 mg/L. other sample showed higher values ranging 2.3 mg/L to 3.01 mg/L.

Keywords*:* Physico- chemical; Drinking water; Northern and Sothern Darfur.

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1. Introduction

The importance of water for humans, animals and agriculture had been recognized by local, regional and international organizations. Misuse of management of water resources lead to pollution or contamination of streams, lakes, surface- water sources: since there is a constant interchange between underground and surface-water [1].

The lack of good quality water leads to water- borne diseases. Up to six million deaths per year is due to contaminated water [2]. The author in reference [3] reported that the death of most African children less than five year of age was due to inadequate and unsafe water supply. The authors in reference [4] stated that monitoring the quality of water and applying corrective measures before usage is very important. The authors in reference [5, 6, 7] established guide-lines for physico- chemical parameters for drinking water. The authors in reference [8] found that there was an inverse relationship between TDS in drinking water and incidence of cancer. The author [14] reported that total mortality of cardio-vascular rate was inversely correlated with TDS levels in drinking water. Similar results were reported by the authors in reference [9].

The author in reference [10] evaluating physico- chemical parameters of harvested stored drinking water Hafir in North West Kordufan. He reported pH 7.2- 7.9, conductivity 29.3 µs/cm- 244.3 µs/cm, TDS 25mg/L -373 mg/L and hardness 3mg/L- 150 mg/L. Also he noted that pH values are similar to WHO values, while conductivity, TDS and hardness values were lower than WHO. No seasonal differences in TDS were observed between summer and autumn. The authors in reference [11] cited by the author in reference [10] classified water as: ground water, springs, running water and standing water (lakes, lagoons, ponds, swamps and temporary waters). In nature water is constantly change from form to another. In the Sudan the main sources of water are: the Nile and its tributaries streams (Wadies) ground water, wells, deep-bores, harvested rain water catchment (natural or man-made) hafirs. Man-made dams closed or open.

Information of physico- chemical properties of hafirs, dams and Wadi waters in Northern and Southern Darfur states is lacking.

The objectives of this study are:

- Assessment of physico- chemical properties of drinking water of dams, Rahads, hafirs and wadies of Northern and Southern Darfur states.
- Preparation of base-line data for planners of water resources development and management.
- Suggestion of ways and means of improvement of water production, quantity and quality.

2. Materials and Methods

2.1 study area

1. Northern Darfur State (ND).
2. Southern Darfur State (SD)

2.2 Drinking water sources

2.2.1 Dam

It is a man- made barrier to obstruct flow of water across a flowing water source. It is dig to increase its holding capacity. Dams in Darfur region are either fenced or open.

2.2.2 *Hafir*

It is a man-made reservoir for harvesting rain water. Its capacity varies according to location. It may be open or closed.

2.2.3 Khor or Wadi

It is a seasonal running stream with gravel, sand or mud bed. It is used as drinking water. Surface shallow wells are usually hand- bored for obtaining drinking water.

2.2.4 Rahad

Rahad is a large natural and permanent source of water for drinking and live- stock. It is open.

2.3 Sampling

Twenty three samples were collected at random from eight sights of dams, wadies and hafirs s shown in table (1) and table (2).

Table 1: Northern Darfur state Sampling Location sites

Sample No	Location	Source of Supply
ND1	Golo twined Dam (Raw water) Fenced	Rain water
ND2	Golo Dam Fenced	Rain water
ND13	Hafir Jadeed Alsail open	Rain water
ND14	Maleet Dam (Raw water) open	Rain water

Table 2: Southern Darfur state Sampling Location sites

Sample No	Location	Source of Supply
SD3	Wadi Nyala surface well (1)	Rain water
SD6	Rahad Manwashi open	Rain water
SD7	Rahad Goz Badeen open	Rain water
SD8	Yau – Yau kashalango Hafir open	Rain water

Analyses

Physical and chemical analyses were carried out at site using portable Hach instruments. The physical parameters included: pH, conductivity, TDS and turbidity. They are shown in table (3).

Table 3: physical parameters

Parameter	Feature	Instrument	Method	Regulatory reporting
PH	Physical.	Hach Method No-8156	Electrode Method	EPA approved
Conductivity	physical	Hach conductivity TDS meter	Direct measurement Hach Method 8160	EPA approved
TDS	physical	Do	Direct measurement	EPA approved
Turbidity (NTU)	physical Hach UV-vis DR/ 4000 Spectro- photometer 860Hach programs 357		Hach method No 10047 (Direct reading)	USEPA approved

Chemical parameters: hardness as CaCo3, Nitrogen (N) as Ammonia (NH3) as shown in table (4)

Table 4: chemical parameters

Parameter	Feature	Instrument	Method	Regulatory report
Total Hardness as Ca Co3 mg/L	Chemical	Hach digital Titrator + Man Ver 2 hardness indicator powder	Titration method Hach method No 8213	USEPA approved
Nitrogen as Ammonia (NH3)	Chemical	Hach DR/700 colorimeter method No 803	Nesseler method, Hach (Nesseler Reagent) (2mL/test)	USEPA approved

3. Results

Northern Darfur (ND). The results of physico-chemical analysis of (ND) are presented in table (5).

Table 5: physico-chemical analysis of (ND)

WHO (1993)	pH	Conductivity	TDS	Hardness	(N-NH3) mg/L
	6.5-8.5	350µs/cm	150-500 mg/L	500 mg/L	1.5mg/L

Source	Sample No	PH	Conductivity µs/cm	TDS mg/L	Total Hardness as CaCO3	(N-NH3) mg/L
Golo Dam	ND1	7.8	220	2000	130	Nil
Golo	ND2	7.4	300	2400	100	Nil
Maleet Dam	ND14	6.7	370	3200	180	1.6
Jadeed Alsail Hafir	ND13	6.9	370	3700	110	2.6

The results of physico-chemical analysis of Southern Darfur are represented in table (6)

Table 6: physico-chemical analysis of (SD)

WHO (1993)	pH	Conductivity	TDS	Hardness	(N-NH3) mg/L
	6.5-8.5	350µs/cm	150-500 mg/L	500 mg/L	1.5mg/L

Source	Sample No	PH	Conductivity µs/cm	TDS mg/L	Total Hardness as CaCO3	(N-NH3) mg/L
Khor Nyala (wadi)	SD3	7.1	90	9	31	1.6
Manwashi Rahad	SD6	6.2	290	4000	35	2.8
Goz Badeen Rahd	SD7	6.5	175	2400	20	3.0
Yau- Yau Kashalango Hafir	SD8	6.3	195	2700	28	2.3

Physical analysis

1. pH

Results of pH are presented in tables 5 and 6. High pH values 7.8, 7.4, 6.7and 6.9 are observed in Northern

Darfur: ND1, ND2, ND14 and ND13 respectively.

Results indicated lower values of pH in Southern Darfur: SD3 (7.1), SD6 (6.2), SD7 (6.5) and SD8 (6.3). All of the pH values were between the range reported by WHO (6.5-8.3). The author in reference [10] studying physico- chemical parameters of Hafir in Western Kordufan range 7.4- 7.8 in summer and 7.2- 7.9 in autumn. No significant difference was observed between seasons.

2. Conductivity

Conductivity (EC) in drinking water in micro simens per cm (µs/cm) of samples are shown in table 5 and 6.

Results showed highest conductivity recorded in Maleet dam (ND14) and Jadeed Alsail Hafir (ND13) 370µs/cm and 300µs/cm for Golo Dam (ND2). While the lowest conductivity found in SD3 (90 µs/cm), SD7 (175 µs/cm), SD8 (195 µs/cm), ND1 (220 µs/cm) and SD6 (290 µs/cm) compared with WHO (350 µs/cm).

The author in reference [10] reported conductivity range of 160- 244.3 µs/cm in Hafir in summer and 159.3–184.9 µs/cm in autumn in west northern Kordufan area. The lowest conductivity 90 µs/cm was observed for Khor Nyala may be due to its gravel bed which acted as a natural filter or the presence of total concentration of ions, mobility and valence in water.

i. ***Total Dissolved Solids (TDS)***

Results of TDS were presented in tables 5 and 6, and fig. 1. The highest TDS (4000 mg/L) compared to WHO value 500mg/L was reported in Rahad Manwashi SD6, 3700mg/L in Hafir ND13 Jadeed Alsail, 3200 mg/L Maleet Dam Nd14, 2700 mg/L in Yau- Yau Kashalango Hafir SD8, 2400 mg/L in ND2 Golo Dam and Goz Badeen Rahad SD7, 2000 mg/L in ND1 Golo. The lowest TDS less than 500mg/L reported 9 mg/L in Khor Nyala SD3. It is noticed that Khor Nyala has low TDS (9mg/L), low conductivity (90µs/cm) and low ammonia (1.6mg/L). Hussein 2008 reported TDS 25mg/L- 320 mg/L for Hafirs in west Kordufan. Both lowest values are within the WHO values limits (500mg/L).

The author in reference [12] stated that water low in TDS is defined as water containing 1- 1oomg/L. it is the quality of water obtained from distillation, reverse osmosis and deionization. The author in reference [13] did not put low limit for TDS for drinking water. Also declared that the concentration from natural sources have been found to vary from less than 30mg/L to as much as 6000mg/L, depending on the solubilities of minerals in different geological regions. They showed also that the palatability of drinking water has been rated by panels of tasters in relation to its TDS level as follows: excellent, less than300 mg/L; good, between 300 and 600 mg/L; fair, between 600 and 900 mg/L; poor, between 900 and 1200 mg/L; and unacceptable, greater than 1200 mg/L. Water with extremely low concentrations of TDS may also be unacceptable because of its flat, insipid taste.

The authors in reference [2] found that there was an inverse relationship between TDS in drinking water and incidence of cancer. The author in reference [14] reported that total mortality of cardio-vascular rate was inversely correlated with TDS levels in drinking water. Similar results were reported by authors in reference [9, 3] that the death of most African children under five year of age was due to inadequate and unsafe water supply. Up to six million deaths per year is due to contaminated water [2].

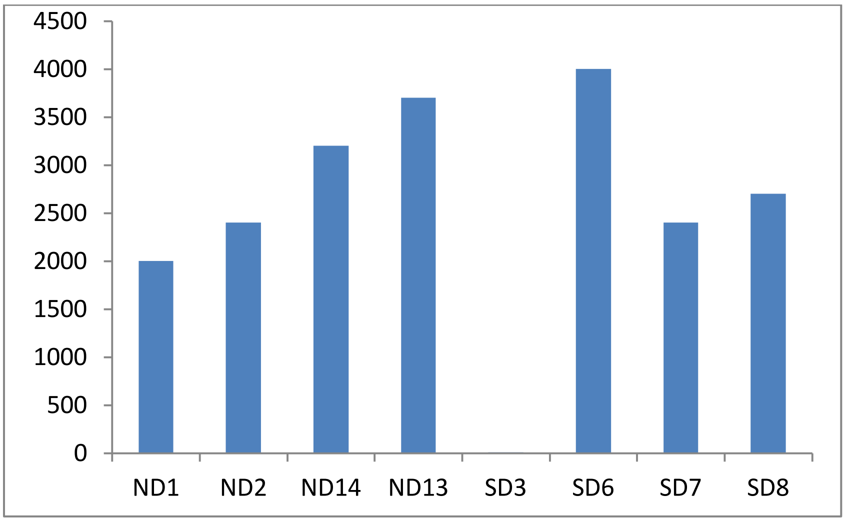

Figure 1: Northern and Southern Darfur TDS of Dams, Rahads, Wadies and Hafirs

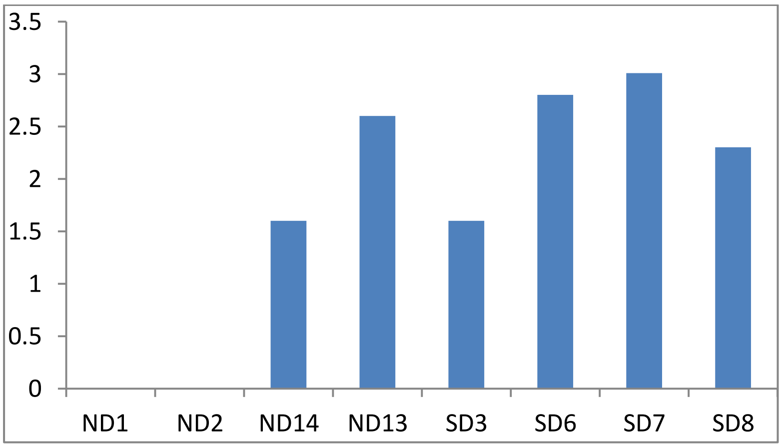

Figure 2: Northern and Southern Darfur NH3 of Dams, Rahads, Wadies and Hafirs

Chemical analysis

1. Hardness

The results of chemical analysis of hardness as $CaCO_3$ mg/L were presented in table 5 and 6. All Dams, Hafirs and Rahads, and Khor Nyala showed values lower than WHO (500mg/L). Southern Darfur values of hardness range between 20- 35 mg/L; while Northern Darfur values range 100- 180mg/L. The author in reference [10] reported that 20- 150mg/L was for Hafirs in west Kordufan.

2. Nitrogen as ammonia

The results of chemical analysis of ammonia were presented in table 5 and 6 and figure 2.

Values of ammonia for GOLO dams: ND1 and ND2 were nil due to the facts that the dams were fenced and no live- stock were allowed to enter. Values similar to WHO 1.5 mg/L were observed in Maleet Dam ND14 and Khor Nyala SD3 (1.6mg/L). Also higher values were reported in Rahad SD7 (3.0 mg/L), Rahad SD6 (2.8 mg/L), Hafir ND13 (2.6 mg/L) and Hafir Yau- Yau Kashalango SD8 (2.3 mg/L). The higher values may be due to the access of live- stock to these Rahads and Hafirs.

4. Conclusion

1. It is observed that TDS values are very high specially in Rahad in Southern Darfur and open Hafirs due to human and live-stock contamination. Periodical monitoring of drinking water quality should be adopted using Hach portable instrument. Individual TDS components had to be detected.
2. Fencing of Dams and keeping live- stock away from open Dams and Khor Nyala contributed substantially in prevention of contamination by live- stock.
3. The low physico- chemical parameters of Khor Nyala needs further studies.
4. The relationship between TDS and diseases like cancer, cardio-vascular and other water- borne diseases should be investigated.

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