

Multivariate Statistical and Hydrochemical Analysis of Drinking Water Resources in Northern Cameroon Watersheds

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Table S1 Formula of hydrochemical data with their water resources conditions

Hydrochemical data	Formula*	Criteria	Water condition/status	references
Total dissolved solids (TDS)	$TDS \left(\frac{mg}{L} \right) = 0.64 * EC \left(\frac{\mu S}{Cm} \right) \quad (1)$	TDS < 500 TDS = 500 – 1,000 TDS > 1,000	Drinking Permissible for drinking Suits for agriculture	[48]
Total permanent Hardness (TH)	$TH \left(\frac{mg}{L} \text{ as } CaCO_3 \right) = 2.5[Ca^{2+}] + 4.1 [Mg^{2+}] \quad (2)$	$TH = 0 - 60$ $TH = 61 - 120$ $TH = 121 - 180$ $TH \geq 181$	Soft Moderately hard Hard Very hard	[49]
Total alkalinity (TAC)	$TAC \left(\frac{mg}{L} \text{ as } CaCO_3 \right) = \frac{TAC \left(\frac{mg}{L} \right)}{1.22} \quad (3)$	$TAC > 80$	Domestic and agricultural use	[50]

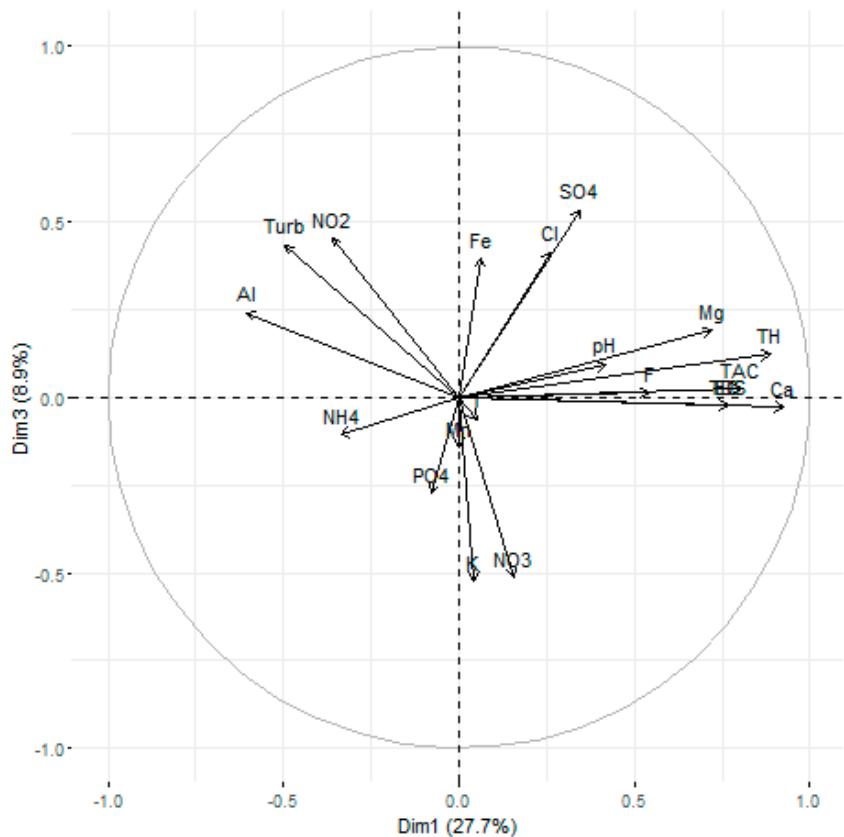
Langelier saturation index (LSI)	$LSI = pH - pH_s$ (4) $*pH_s = A \div B - \log(Ca^{2+}) - \log(\text{Alk})$ $pH \leq 9.3$ $* pH_s = (9.3 + A \div B) - (C \div D)$ $pH > 9.3$	$LSI > 0$ $LSI = 0$ $LSI < 0$	Super saturated, tend to precipitate CaCO_3 Saturated, CaCO_3 is in equilibrium Under saturated, tend to dissolve solid CaCO_3	[51- 52]
Ryznar stability index (RSI)	$RSI = 2 pH_s - pH$ (5)	$RSI < 6$ $6 < RSI < 7$	Super saturated, tend to precipitate CaCO_3 Saturated, CaCO_3 is in equilibrium	[51- 52]
% error	Balance	$\%E = 100 * \frac{\sum \text{Cations} - \sum \text{Anions}}{\sum \text{Cations} + \sum \text{Anions}}$ (6)	$\%E \leq \pm 10\%$ within acceptable range $\%E \leq \pm 5\%$ within permissible limit	[53]

* $A = (\log_{10}(TDS) - 1)/10$; $B = -13.12 \times \log_{10}(\text{°C} + 273) \div 34.55$; $C = \log_{10}(\text{Ca}^{2+} \text{as } \text{CaCO}_3) - 0.4$;
 $D = \log_{10}(\text{Alkalinity as } \text{CaCO}_3)$ [54].

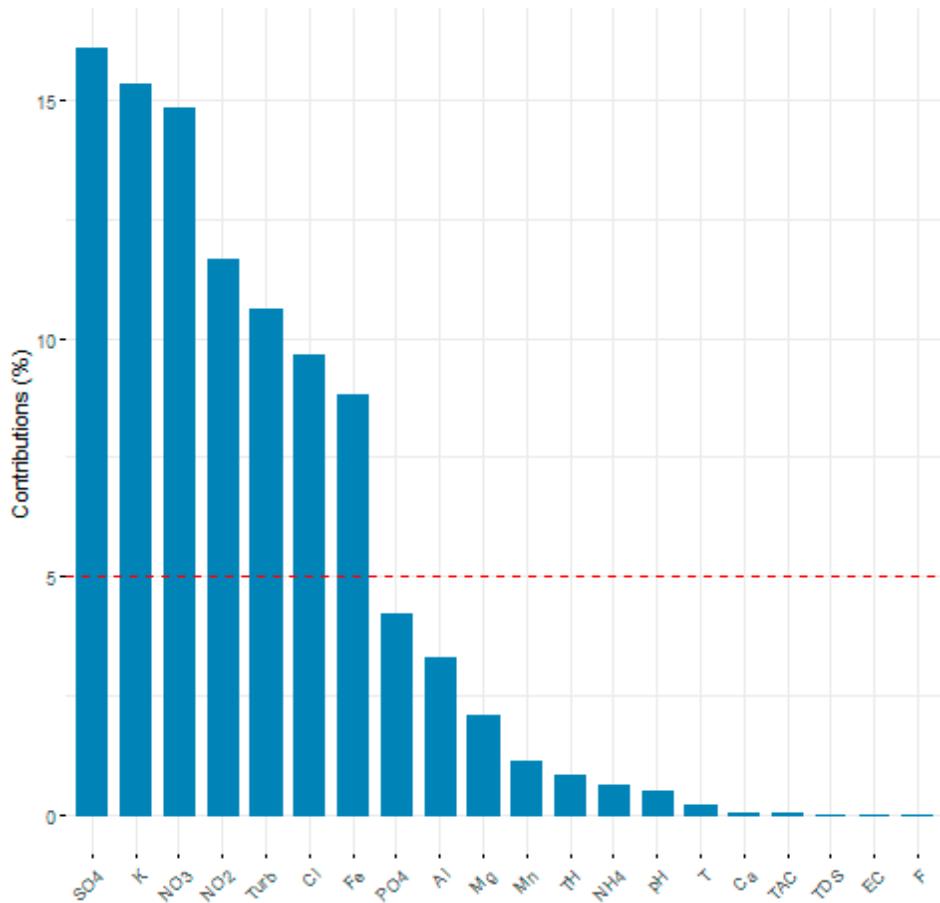
Table S2. Median and Range (Maximum–Minimum) values of physico-chemical parameters for the North Region (R-NO) and Adamawa Region (R-AD) during the rainy season. All physico-chemical parameters are given in mg/L except pH; temperature in °C; EC in µS/Cm; turbidity in NTU.

Physico-chemical Parameters	Median (Range)		CDWS (2012)	WHO (2011)
	North Region (n = 40)	Adamawa Region (n = 34)		
Temperature	29.70 (24.90–35.10)	25.96 (23.20 –30.10)	≤ 25	
EC	35.00 (10–1230)	10.00 (0–130)	1000	
Turbidity	0.76 (0.09–53.40)	0.43 (0.08–16.10)	≤ 2	5
pH	7.48 (6.99–8.09)	8.24 (6.83–8.64)	6.5-9	6.5-8.5
TDS	17.50 (5.00–615.00)	5.00 (0.00–65.00)		1000
TH	146.02 (32.45–324.50)	64.90 (32.45–227.15)		
Ca ²⁺	40.10 (10.02–120.30)	20.05 (10.02–81.12)		100-300
Mg ²⁺	87.06 (12.40–284.40)	44.85 (12.40–187.05)	≤ 50	
TAC	248.00 (93.00–837.00)	124.00 (62.00–403.00)		
K ⁺	2.35 (0.20–18.80)	3.85 (0.40–24.00)	≤ 12	
SO ₄ ²⁻	8.00 (0.00–81.00)	3.00 (0.00–10.00)	≤ 250	250
Cl ⁻	21.50 (5.00–110.00)	8.50 (0.00–66.00)	≤ 200	250
NO ₃ ⁻	2.02 (0.64–67.20)	2.70 (1.36–21.60)	≤ 50	50
NO ₂ ⁻	0.03 (0.00–0.07)	0.01 (0.00–0.08)	≤ 0.1	3
NH ₄ ⁺	0.00 (0.00–0.29)	0.02 (0.00–0.81)	≤ 0.5	35
PO ₄ ³⁻	0.10 (0.00–1.30)	0.00 (0.00–1.20)	/	
Fe ²⁺	0.75 (0.05–23.20)	0.05 (0.00–10.40)	≤ 0.2	0.3
Al ³⁺	0.01 (0.00–0.23)	0.09 (0.02–0.52)	≤ 0.2	0.2
Mn ²⁺	0.00 (0.00–0.03)	0.00 (0.00–0.01)	≤ 0.05	0.1
F ⁻	0.01 (0.00–0.76)	0.00 (0.00–0.32)	≤ 0.7/1	1.5

Variables - PCA



Contribution of variables to Dim-3



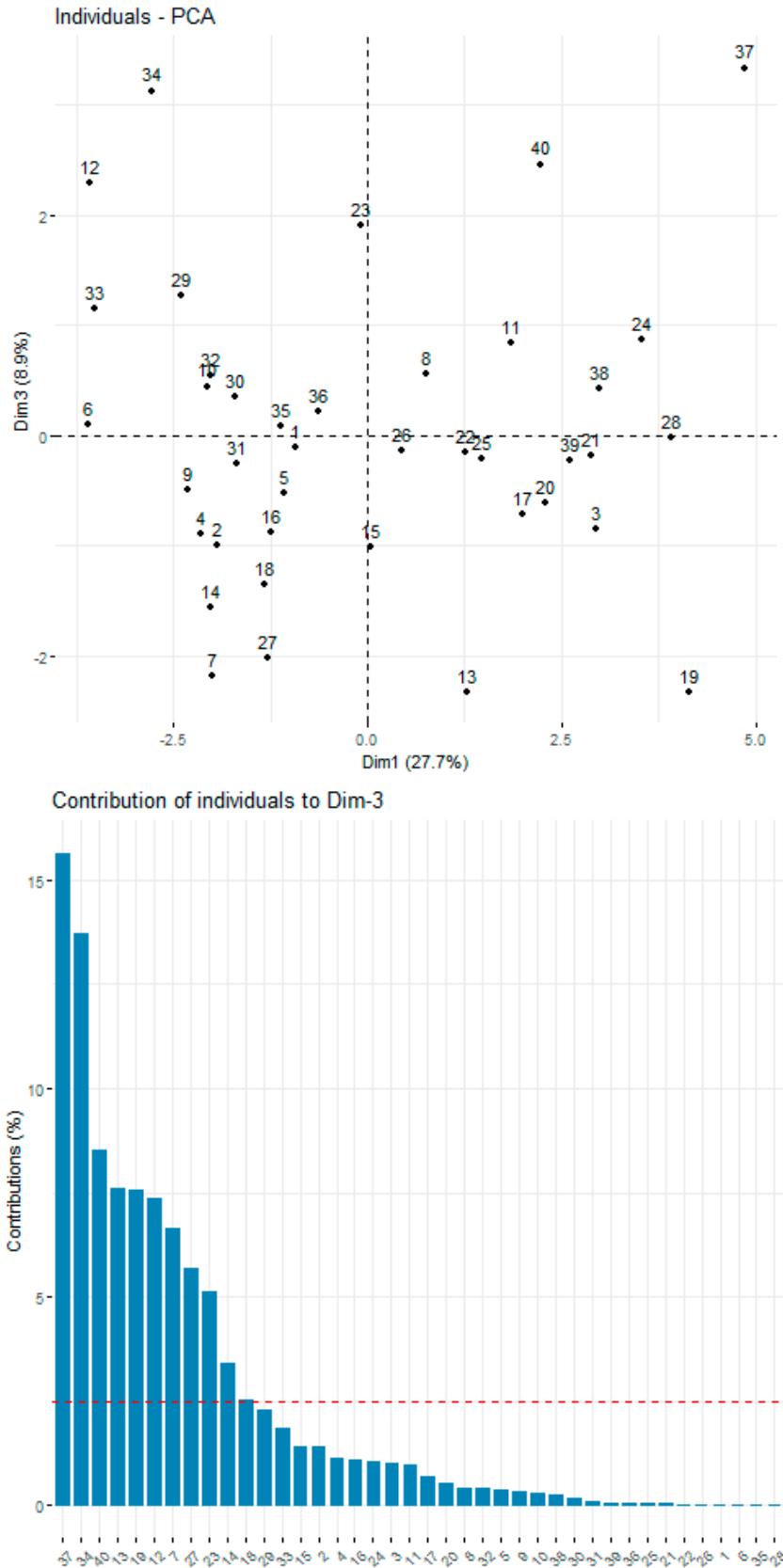
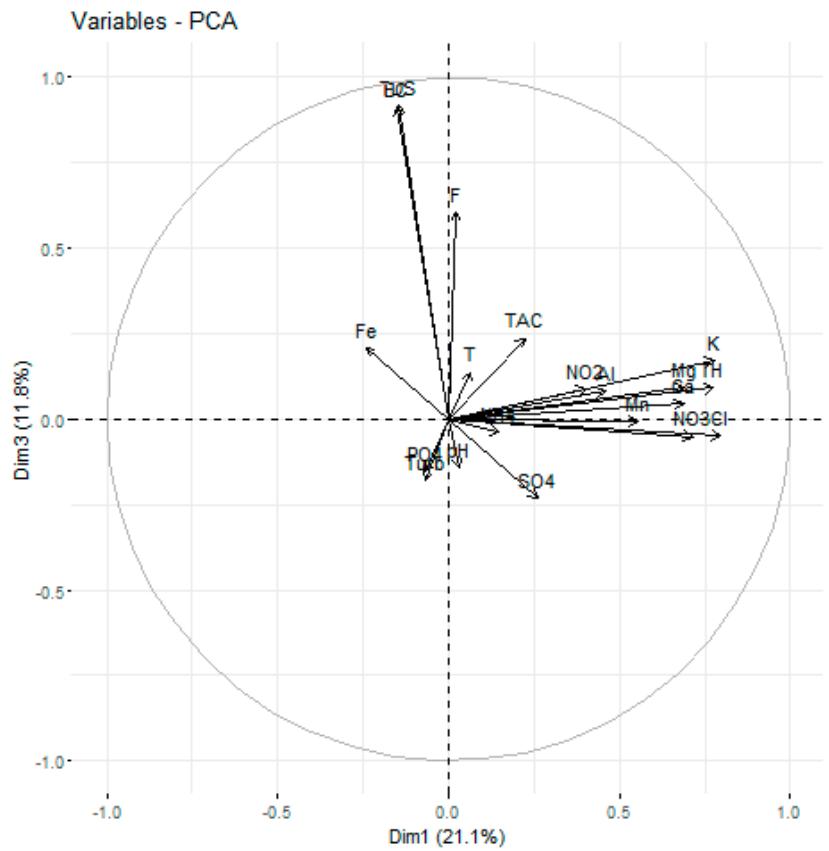
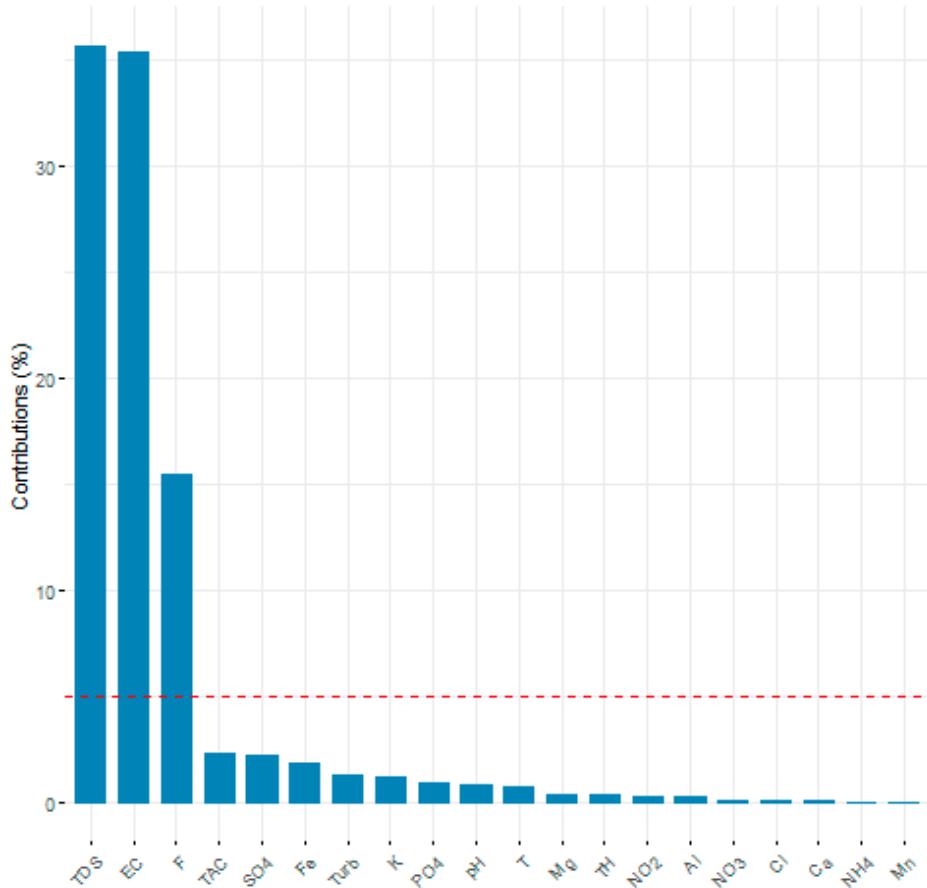


Figure S1. Representation of correlation circle of variables and individuals in axis 1 × axis 3 and their contributions referring to axis 3 within watersheds studied in the R-NO.



Contribution of variables to Dim-3



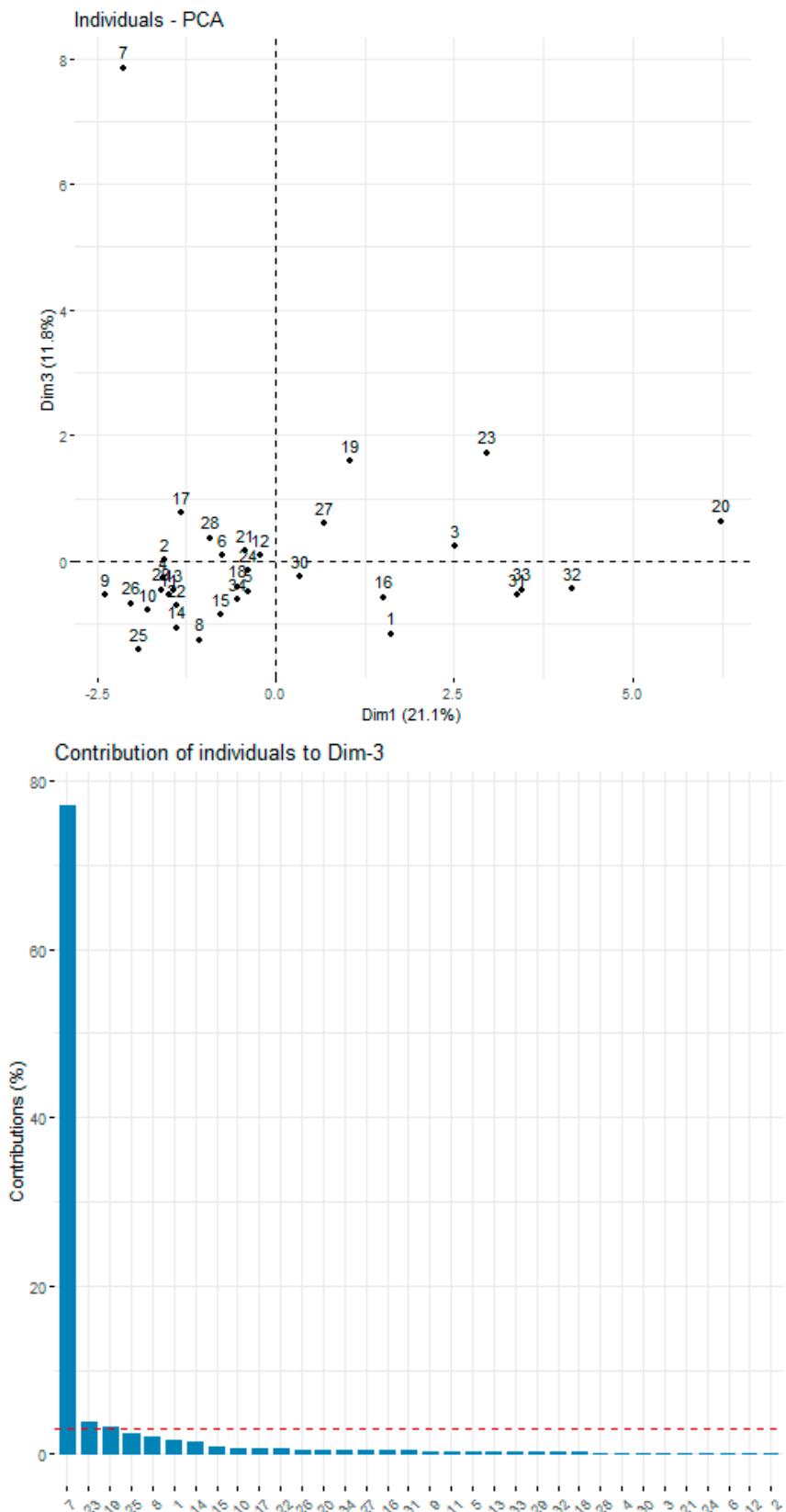


Figure S2. Representation of correlation circle of variables and individuals in axis 1 × axis 3 and their contributions referring to axis 3 within watersheds studied in the R-AD.

Reference

1. Sridharan, M.; Nathan, D. S. Groundwater quality assessment for domestic and agriculture purposes in Puducherry region. *Appl. Water Sci.* **2017**, *7*, 4037–4053.
2. Moran, S. Water chemistry. In *An Applied Guide to Water and Effluent Treatment Plant Design.*; 2018; pp. 15–24.
3. Martínez-Alvarez, V.; González-Ortega, M. J.; Martin-Gorriz, B.; Soto-García, M.; Jose F. Maestre-Valero Seawater desalination for crop irrigation-Current status and perspectives. In *Emerging Technologies for Sustainable Desalination Handbook*; Spain, 2018.
4. Abbasnia, A.; Alimohammadi, M.; Mahvi, A. H.; Nabizadeh, R.; Yousefi, M.; Mohammadi, A. A.; Pasalari, H.; Mirzabeigi, M. Assessment of groundwater quality and evaluation of scaling and corrosiveness potential of drinking water samples in villages of Chabahr city , Sistan and Baluchistan province in Iran. *Data Br.* **2018**, *16*, 182–192.
5. Taghavi, M.; Hasan, M.; Radford, M.; Fakhri, Y.; Javan, S. Assessment of scaling and corrosion potential of drinking water resources of Iranshahr. *MethodsX* **2019**, *6*, 278–283.
6. Olumana, M. D.; Loiskandl, W.; Ndambuki, J. M. Hydrochemical characterization of various surface water and groundwater resources available in Matahara areas , Fantalle Woreda of Oromiya region. *J. Hydrol. Stud.* **2015**, *3*, 444–456.
7. Asadi, O.; Mollaefar, E.; Soltani, E.; Karvarinasab, M. Data in brief Data on assessment of corrosion-scaling potential and chemical parameters of groundwater quality for industrial and agricultural sectors in the Piranshahr Watershed in the West Azerbaijan province , Iran. *Data Br.* **2019**, *27*, 104627.