Appendix B Water quality studies from arid and semiarid areas in Africa

S/no	Source type	Country/region	Analyzed water quality parameters	The objective of the study/drivers of water quality analysis	Findings/Results	Reference
1	Groundwater	Khenchela City, Eastern Algeria	pH, EC, TDS, Sal., Temp., Turb., Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-}, NO_3^{-}, and HCO_3^{-}.	To determine the quality of groundwater supply meant for drinking in Khenchela city.	The study discovered the susceptibility of water to mineralization and the surplus of organic mineral contents.	(Benrabah et al., 2016)
2.	Groundwater	Ain Azel plain, Algeria	pH, EC, TDS, Sal., Temp., Turb., Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{+}, SO_4^{2-}, NO_3^{-}, HCO_3^{-}, SiO_2, and Al.	Application of multivariate statistical methods to groundwater quality analysis.	PCA results indicate that the parameters responsible for groundwater quality variations mainly relate to rock weathering, resulting in different water types.	(Belkhiri *et al.*, 2010b)
3	Groundwater	Northern Gafsa basin, Central Tunisia	Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-}, NO_3^{-}, HCO_3^{-}, Er, $\delta^{18}O$, $\delta^{2}H$, and δD.	To classify the main recharge zones, the groundwater condition, the mineralization, and the effect of changing groundwater's climate.	Geogenic processes primarily control the geochemical outline.	(Mokadem et al., 2016)
4	Groundwater	Chtouka-Massa, Morocco	pH, EC, TDS, Sal., Temp., Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-}, NO_3^{-}, HCO_3^{-}, K^{-}, $\delta^{18}O$, $\delta^{2}H$, and δD	Effect of over-abstraction, drought, saltwater intrusion on quality and availability of groundwater.	The historical evolution of the groundwater level indicates that the water table was exposed to a gradual decline, leading to low chemical concentrations.	(Malki *et al.*, 2017)
5	Groundwater	Bahira plain, Morocco	pH, EC, Temp., Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{+}, NO_3^{-}, HCO_3^{-}, K^{-}, $\delta^{18}O$, $\delta^{2}H$, δD, Br, and F^{-}	To describe the groundwater's chemical characteristics and evaluate the processes governing the groundwater composition.	There are three potential processes affecting groundwater: Evaporation; Water-rock interaction, and an Admixture of waters exposed to different salinities and stable isotope compositions.	(Karroum et al., 2017)
6	Groundwater	Poura, Burkina Faso	pH, Eh, DOC, TIC, EC, Temp., Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-}, NO_3^{-}, HCO_3^{-}, K^{+}, F,	Impact of high geogenic arsenic (As) levels (>10 mg/L) stemming from the sulfide minerals	The proximity to mineralized regions is the most critical factor governing detected redox/pH	(Bretzler et al., 2018)

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			Br, PO_4^{3-}, Li, B, Al, Si, V, Cr, Mn, Fe^{3+}, Co, Ni, Cu^{2+}, Zn^{2+}, As, V, Se, Sr, Mo, Cd, Sn, Sb, Ba, La, Ce, W, Tl, Pb, U, $\delta^{18}O$, and $\delta^{2}H$.	oxidation minerals in mineralized regions.	conditions.	
7	Surface water	Fez and Sebou, Morocco	pH, DOC, DO, EC, Temp., TH, Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-}, NO_3^{-}, K^{+}, PO_4^{3-}, Al, V, Cr, Mn, Co, Ni, Cu^{2+}, Zn2+, As, Cd, Pb, U, and NH_4.	Surface water quality and toxicity of contaminated Rivers.	Sites situated near the most industrialized and urbanized areas are sternly impaired.	(Koukal et al., 2004)
8	Groundwater	Murzuq basin, southwest Libya	EC, TDS, Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, HCO_3^{-}, SO_4^{-}, NO_3^{-} and K^{-}.	Evaluation of quantity and quality of irrigation water.	There is a significant improvement in water use efficiency, which, if attained, should improve the overall sustainability of groundwater utilization.	(Shaki and Adeloye, 2006)
9	Groundwater	Bou-Areg, NE Morocco	EC, Temp., Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-}, NO_3^{-}, HCO_3^{-}, K^{-}, $\delta^{18}O$, δD, and TU.	To determine the primary factors and mechanisms controlling the groundwater chemistry and salinity of the unconfined aquifer.	There is salinization in the littoral and the upstream areas and groundwater dilution by recharge.	(El Yaouti et al., 2009)
10	Groundwater	Bou-Areg, North Morocco	pH, Eh, Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-}, NO_3^{-}, HCO_3^{-}, K^{+}, Br, Li, B, Sr, $\delta^{13}C$, $^{15}N\_NO_3^{-}$, $\delta^{18}O$, $\delta^{2}H$ δ $^{18}O\_NO_3$ (δ‰)	To identify the key processes initiating groundwater salinization.	Agricultural return flow has suggestively altered groundwater composition, and it is a prominent example of human-induced vagaries over coastal areas.	(Re et al., 2013)
11	Groundwater	Souss Basin, Morocco	EC, TDS, Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-}, NO_3^{-}, HCO_3^{-} and K^{+},	To identify the chemical characteristics and the origin of groundwater.	Rock weathering is the primary process of controlling water chemistry.	(Dindane et al., 2003)
12	Groundwater	Cap Bon Peninsula Tunisia	pH, Alk., EC, TDS, Temp., Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-},	Variation in quality of groundwater in a coastal aquifer.	About 80% of the Grombalia aquifer system shows different	(Charfi et al., 2013)

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			K^+, $\delta^{18}O$ and δ^2H.		susceptibilities to human activities.	
13	Groundwater	Tazoghrane, Tunisia	pH, EC, Temp., Ca^{2+}, Mg^{2+}, Na^+, Cl^-, SO_4^{2-}, NO_3^-, HCO_3^-, K, $\delta^{18}O$ and δ^2H.	To identify the sources and processes that affect the groundwater composition.	High nitrates levels show that farming activities are perhaps the most critical human sources of nitrogen pollution.	(Ben Moussa et al., 2014)
14	Groundwater	Nouakchott, Mauritania	pH, EC, TDS, Temp., Ca^{2+}, Mg^{2+}, Na^+, Cl^-, NO_3^-, HCO_3^-, K^-, Br, δ^2H and δ $^{18}O\_NO_3$ (δ ‰)	Impacts of climate change and human activities on groundwater resources	The amplified supply of domestic water and the absence of wastewater nets have added significant water volumes to the Quaternary aquifer.	(Mohamed et al., 2017)
15	Surface and groundwater	Niamey, Niger	pH, Ca^{2+}, Mg^{2+}, Na^+, Cl^-, PO_4^{3-}, SO_4^{2-}, NO_2, NO_3^-, HCO_3^-, K^-, F, Li and NH_4^+	Qualitative and quantitative depiction of surface water, groundwater, and aggregates.	Highlighted the local singularities of contamination.	(Lasagna et al., 2015)
16	Surface water	River Nile, Egypt	pH, Alk., BOD, DO, EC, TDS, Temp., Turb., Ca^{2+}, Mg^{2+}, Na^+, Cl^-, PO_4^{3-}, SO_4^{2-}, NO_2, NO_3^-, HCO_3^-, CO_3^{2-}, K^+, Al, V, Cr, Mn, Fe^{3+}, Co, Ni, Cu^{2+}, Zn^{2+}, As, Se, Mo, Cd, Sn, Sb, Ba, La, Pb and NH_3^-	To examine the water quality of the River Nile at the Rosetta branch and five main drains located on its sides.	Water quality along the studied area in the Rosetta branch is noticeably predisposed to drain ejection.	(Ezzat et al., 2012)
17	Surface and groundwater	Bamako, Mali	pH, BOD, COD, SS, NO_3^-, Mn, Fe^{3+} and Cu^{2+}	Assess chemical and biological pollution.	Specific anthropogenic contamination issues are frequently detected.	(Orange and Diakite, 2006)
18	Groundwater	N'djamena Chad	pH, EC, Temp., Ca^{2+}, Mg^{2+}, Na^+, Cl^-, SO_4^{2-}, NO_3^-, HCO_3^-, K^+, $\delta^{18}O$ and δ^2H.	To characterize the recharge and factors controlling the quality of groundwater.	The upper aquifer is the most susceptible to contamination, particularly during the recharge time.	(Kadjangaba et al., 2017)
19	Groundwater	Ain Azel plain, Algeria	pH, EC, Ca^{2+}, Mg^{2+}, Na^+, Cl^-, SO_4^-, HCO_3^-, K^+, Fe^{3+},	Defining the main controls on the hydrochemistry at the direct scale.	PCA and inverse geochemical modelling show that rock	(Belkhiri et al., 2010b)

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			and Pb.		weathering is the primary factor controlling water chemistry.	
20	Groundwater	Tahoua Region, Niger	Temp., EC, TH, pH, TDS, Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-}, NO_3^{-}, HCO_3^{-}, Mn and K^{+}.	Evaluation of quality of groundwater in parts of the Tahoua region.	The Continental Intercalaire has weakly mineralized water (conductivity <130 µS/cm) which can be utilized for all uses.	(Ikpokonte et al., 2007b)
21	Shallow groundwater	Nyos, Cameroon	pH, DO, EC, TDS, Temp., Cl^{-}, $\delta^{2}H$ and $^{18}O\_NO_3$ (δ ‰).	To characterize the recharge process of the shallow groundwater leaking in the splintered rock.	The speedy circulation and the truncated solubility lead to minor mineralization.	(Kamtchueng et al., 2015)
22	Surface water	Sétif, Algeria	pH, BOD, COD, DO, TDS, Temp., Turb., Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, PO_4^{3-}, SO_4^{2-}, NO_3^{-}, HCO_3^{-} and V	Assessment of temporal variations of quality of surface water.	There is a significant relationship between salinity and all variables and a negative relationship between the dam's water volume and all variables.	(Bouguerne *et al.*, 2017)
23	Groundwater	Ain Djacer, Algeria	pH, TDS, Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{-}, NO_3^{-}, HCO_3^{-} and K^{+}.	To highlight the hydrochemical processes of groundwater.	The occurrence of three salinity assemblies with growing important according to the flow direction.	(Bencer *et al.*, 2016)
24	Groundwater	Sfax, Tunisia	pH, EC, Na^{+}, Cl^{-}, SO_4^{2-}, and NO_3^{-}.	Impacts of onsite wastewater ejection structures on the groundwater aquifer.	Results showed a very variable chemical composition of groundwater.	(Chamtouri *et al.*, 2007)
25	Groundwater	Ain Azel, Algeria	pH, EC, Temp., Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-}, HCO_3^{-}, K^{+}, Al, Fe^{3+}, Pb, and SiO_2.	Assess water-rock interaction and geochemistry of groundwater.	The dominant processes are the consumption of CO_2 and the dissolution of rock minerals.	(Belkhiri et al., 2012)
26	Groundwater	Kankara, NW Nigeria	pH, EC, TDS, Temp., Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2+}, NO_3^{-}, HCO_3^{-}, K^{+}, and Fe^{3+}.	To determine groundwater geochemical facies and suitability of water for drinking.	Water–rock interaction was the dominant stimulus of groundwater composition.	(Abusu, 2019)
27	Groundwater	Kano, NW Nigeria	pH, EC, Temp., Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-}, NO_3^{-}, HCO_3^{-}, K^{+}, Cr, Zn^{2+} and Cd	To examine the level of groundwater pollution.	The mean concentration of heavy metals is above standard water quality prerequisites.	(Amoo et al., 2018)

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28	Groundwater	Katsina, Nigeria	Alk., TDS, Temp., TH, Cl, SO_4^{2-}, NO_3^-, F^- and Fe^{3+}	Assessing the Groundwater quality in Basement complex formation.	Groundwater sources have met the requirement for drinking water.	(Danhalilu et al., 2018)
29	Surface water	Sokoto, Nigeria	pH, Acidity, Alk., BOD, COD, DO, TS, TSS, EC, TDS, Temp., TH, Cl, PO_4^{3-}, SO_4^{2-}, NO_3^-, NH_4^+.	To determine water quality using standard methods.	Parameters showed marked temporal variability between dry and wet seasons.	(Raji *et al.*, 2015)
30	Groundwater	Qus City, Upper Egypt	pH, EC, TDS, TH, Ca^{2+}, Mg^{2+}, Na^+, Cl^-, SO_4^{2-}, NO_3^-, HCO_3^-, CO_3^-, K^+, Cr, Mn, Fe^{3+}, Zn^{2+}, Cd, and Pb.	Possible effects of groundwater and surface water pollution in an urban zone.	Most of the significant contamination points occurred in the middle part of the urban area.	(Abdalla and Khalil, 2018)
31	Groundwater	Ethiopian Aquifers	Ca^{2+}, Mg^{2+}, Na^+, Cl^-, SO_4^{2-}, NO_3^-, HCO_3^-, CO_3^-, K^+, and F.	Assess the hydrogeological framework and occurrence of groundwater in the Ethiopian aquifers.	Hard waters are dominant in basic volcanics.	(Ayenew et al., 2008)
32	Surface and groundwater	Kadugli, Sudan	pH, Alk., TH, Ca^{2+}, Mg^{2+}, Cl^-, SO_4^{2-}, NO_3^-, HCO_3^- and CO_3^{2-}.	To assess the ^{238}U, ^{226}Ra, ^{222}Rn, and ^{232}Th activity concentrations	The overall yearly operative dose was below the WHO reference dose level.	(Osman *et al.*, 2008)
33	Groundwater	Windhoek aquifer, Namibia	Mn, Fe^{3+}, Ni, Cu^{2+}, Zn^{2+}, and Pb.	Impact of human activities on soil and groundwater quality.	Some areas in the northern and southern industrial areas show heavy metals pollution.	(Mapani and Schreiber, 2008)
34	Groundwater	SemiaridKalahari of Botswana	pH, Eh, DO, EC, Temp., Ca^{2+}, Mg^{2+}, Na^+, Cl^-, SO_4^{2-}, NO_3^-, HCO_3^-, NH_4^+, Fe^{2+}	To determine recharge conditions and define the regional scale hydrogeochemical evolution of groundwater.	Mixing between aquifers limits an explicit derivation of one regional flow regime and hydrochemical composition.	(Stadler et al., 2010)
35	Groundwater	Bangui, Central African Republic	pH, EC, Temp., Ca^{2+}, Mg^{2+}, Na^+, Cl^-, SO_4^{2-}, NO_3^-, HCO_3^-, and K^+.	Assessing the type and quality of the groundwater resources of the Bangui region of the Central African Republic.	The major problem in terms of abstraction is to appreciate the depth of the resource and the more or less fractured/palaeo-karstified type of permeability.	(Djebebe-Ndjiguim et al., 2013)