PRESS NO & SW

Projet Ressources du Sol et du Sous-sol des Régions du Nord et du Sud-Ouest | Project on Soil and Subsoil Resources of North and South-West Regions

Hydrochemistry and water quality of surface water and groundwater in the upper Benoue river catchment around Garoua, North Cameroon

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Introduction

The Northern Region of Cameroon is under pressure as rapid population growth, over-utilization of natural resources, and removal of such resources as agriculture and urban development become more predominant. Although this growth and development provide economic opportunity, they also alter local ecosystems by changing land use and land cover; causing changes in groundwater chemistry, watershed-level hydrology and dissolved nutrients in waterways. Hence, the present study is focused on understanding dry season hydro-geochemical dynamics as the main driver of physical water scarcity-related problems in the Benue River catchment which is a major tributary of the Niger River (Fig.1).

Methods of study

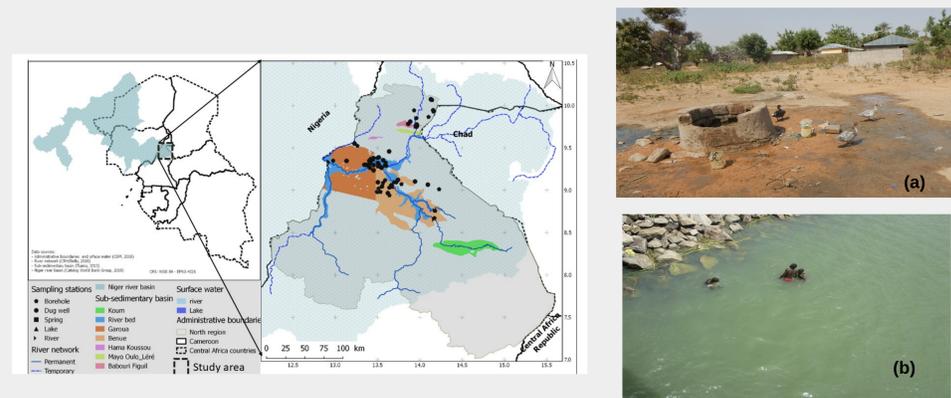### 1. Study area, description of water points investigated

Fig.1: Location of the study area within the River Niger system in Africa. It also shows sampling points and geology.

Fig. 2: (a) Dug well in Soulkata, Guider; (b) algal bloom of Lagdo lake.

2. Geology

- Precambrian crystalline granitic and metamorphic basement,
- Cretaceous sandstone, gritstone, quaternary sediment and calcium phosphate-rich soils.

3. Sampling description, methods

- January 2017 (dry season aspect), 86 water samples (37 dug wells, 34 boreholes, 12 rivers and 2 lakes) as seen in Fig.1;
- Field measurements of pH, EC, water T°C using portable Hanna kits;
- Cations and trace elements (100 ml PE bottle, prepared with 1 wt.% (1 ml) HNO 3ccsp, sample filtrated through 0.45 µm cellulose acetate membrane disposable filter after conditioning of syringe and filter;
- Anions (50 ml PE bottle, pre-rinsed with sample).

4. Laboratory analysis

- Major elements were analysed in the laboratory of the Federal Institute for Geosciences and Natural Resources (BGR), Hanover/Germany, using ICS 3000 (DIONEX) based on DIN EN ISO 10304-1(1995) and spectrophotometry with a Unicam UV 300 according to DIN 38 406, E5 (1983).

Results
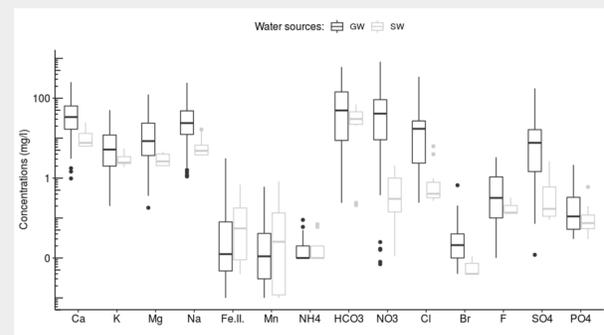
1. Statistical variation of major ions

- The hydrological regime is dominantly a stream loosing system by surface water recharging the groundwater aquifer.
- The concentration of anions were distributed in the order of NO_3^- > HCO_3^- > Cl^- > SO_4^{2-} > F^- > PO_4 > Br^- in groundwater, compared to HCO_3^- > NO_3^- > Cl^- > SO_4^{2-} > PO_4 > NO_2 > F^- > Br^- in surface water.
- Relative concentration of cations in both groundwater and surface water was in the order of Ca^{2+} > Na^+ > Mg^{2+} > K^+ > NH_4

Fig. 3: Statistical variation of major ions (anions and cations).

Acknowledgments

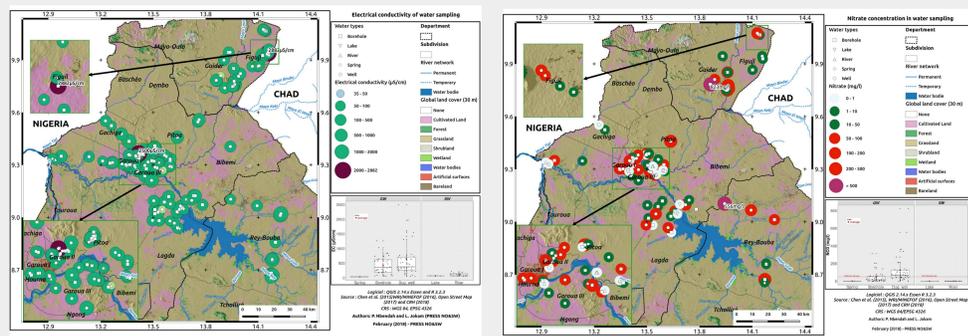## 2. Spatial distribution of Electrical Conductivity (EC) and Nitrate (NO_3^-)

Fig. 4: Spatial distribution of EC (µS/cm). Fig. 5: Spatial distribution of NO_3^- (mg/l).

- The spatial distribution of EC measured in groundwater and surface water in the Benoue catchment varied over a wide range (35 - 2500 µS/cm, median = 376 µS/cm). Compared to groundwater, EC in surface water has a range between 50 and 222 µS/cm (median = 81 µS/cm) only.
- NO_3^- is a dominant nitrogen compound in TIN and exceed the WHO limit (50 mg/l) for 37% of all groundwater points. These concentrations are actually 16 times higher than those reported by Njitchoua et al. (1995), 25 years ago.

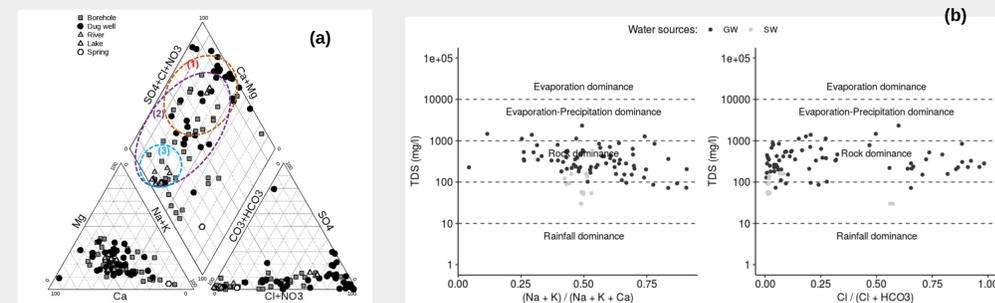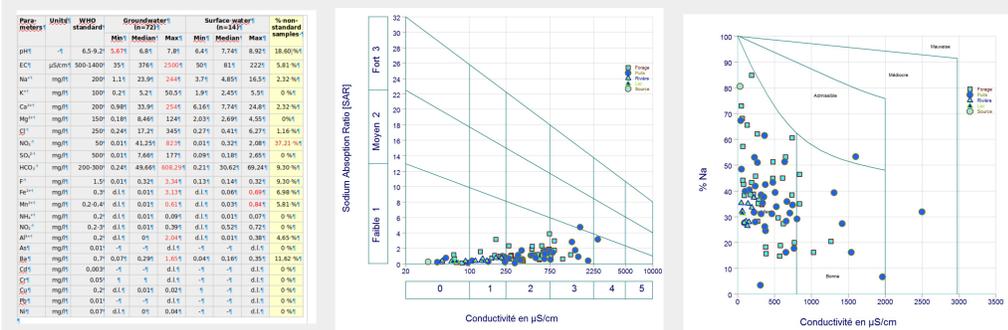### 3. Processes controlling groundwater chemistry

Fig. 6: (a) Hill Piper trilinear plot of observed water samples; (b) Gibbs plots indicating rock domain (water–rock interaction) as main process controlling groundwater chemistry in the study area.

4. Groundwater usability

- Concentrations of certain parameters including nitrate (37 % of samples) and fluoride in groundwater in the study area exceeded the WHO guidelines and expose the local population to various unhealthy clinical phenomena.
- Irrigation suitability assessment of all samples show salinity hazards for 21% of water investigated that have EC are above 750 µS/cm, suggesting doubtful quality for irrigation and high risk of sodization in 14% of water samples mostly located in the northern part of study area.

Conclusion

- Hydro-chemical facies evolved predominantly from $Ca+Mg-NO_3$ rich water in shallow wells to $Na+K-HCO_3$ rich water in boreholes, and surface waters;
- Weathering of silicate minerals controls the concentration of major ions such as calcium, magnesium, sodium and potassium while NO_3 and Cl^- are of anthropogenic origin.
- Analysis of waters for irrigation, revealed that surface water have low salinity which is chemically suitable for agricultural uses, but groundwater with high salinity indicated high risk of sodization for (14%) of the water points, thus reflecting risk of soil sodization;
- The analyses have also revealed levels of nitrates, fluoride, manganese, iron in groundwater exceeding limit set by the WHO.
- Management strategies in the whole study area need to be improved to avoid punctual pollution via animal or human feces that give place to nitrate.