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Assessment of quality and acquisition of groundwater mineralization in the Mbour Fatick area, central-western Senegal

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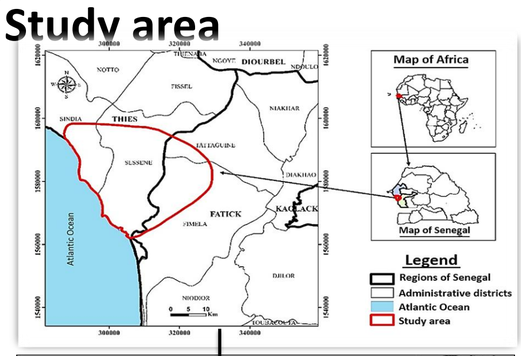
INTRODUCTION & AIM

- **Global Context:** Water resource management is a major global challenge, affecting agriculture, industry, and direct consumption.
- **Local Issue:** In the Mbour-Fatick region (Senegal), groundwater is the only source of water supply, subject to significant climatic and anthropogenic pressures. Access to drinking water is a major priority.
- **Problematic :** Several aquifers contain significant groundwater quantities, but the quality does not meet consumption standards due to deterioration caused by natural and/or anthropogenic processes.
- **Research Objective:** this work aims to update knowledge on the chemical quality of groundwater. We employed a three-tiered approach:
  - ✓ To assess changes in groundwater chemistry.
  - ✓ Identify the processes responsible for mineralization.
  - ✓ Determine the suitability of the water for consumption.

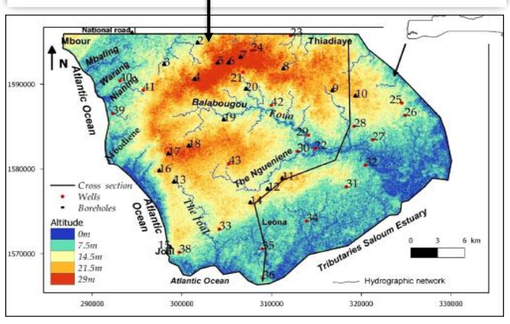
METHOD

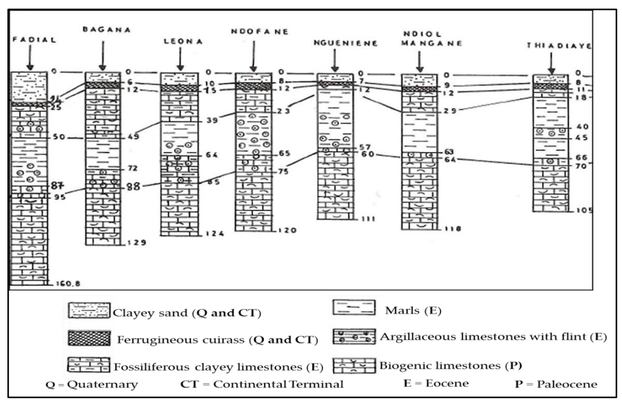
Study area



Located between
Longitude: 17°02'12"and 16°35'06"W
Latitude: 14°27'11"and 14°35'13"N

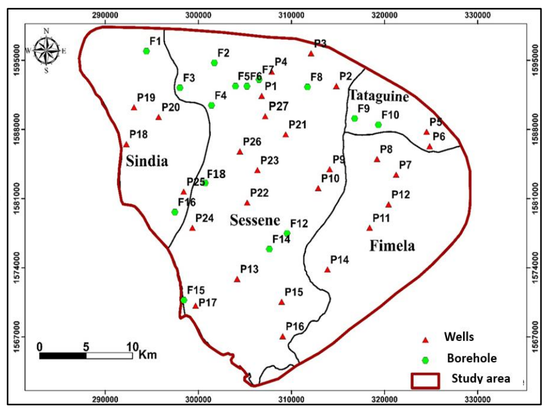
Study area is part of the Senegal-Mauritania sedimentary basin





- **Approach** Hydrogeochemistry and multivariate statistical analysis (Ascending Hierarchical analysis).

- **Sampling**
  - ✓ **September 2019**: 42 samples (22 wells and 20 boreholes)
  - ✓ **May-June 2023**: 42 samples (27 wells and 15 boreholes)
  - ✓ *Comparative data*: *Use of SARR data (1982) for temporal analysis.*



- **Analyses**
  - ✓ **Physicochemical parameters:** Electrical conductivity, pH, and temperature were measured in the field using a WTW-multi 350i portable multi-parameter device
  - ✓ **Chemical analyses (HCO_3^-, Cl^-, SO_4^{2-}, F^-, NO_3^-, Ca^{2+}, Mg^{2+}, Na^+, K^+)** of the collected samples were performed at the Civil Engineering and Geo-Environment Laboratory (LGCgE) – Lille University (France).

- **Health Risk Assessment:** Calculation of the Total Health Index (THI) for fluoride.

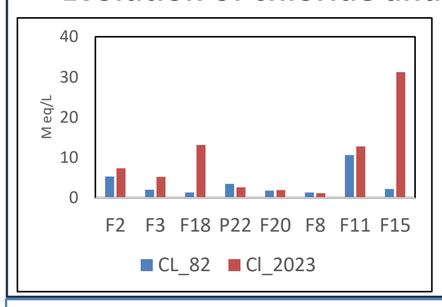
RESULTS & DISCUSSION

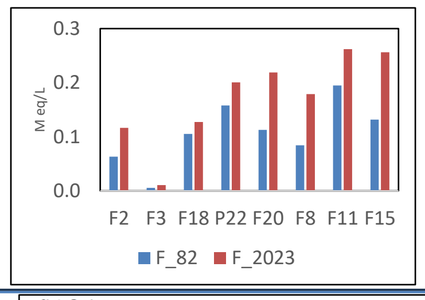
General parameters

- ✓ **pH** ranges from 6.89 to 8.2, indicating that the water is neutral to slightly alkaline.
- ✓ **Electrical conductivity**
  - ranged from 127 to 5,800 µS/cm, with an average of 1,524.4 µS/cm.
  - 26% of water samples exceeded the WHO permissible limit of 1,500 µS/cm
- ✓ **Order of abundance** of ions in groundwater
  $HCO_3^- > Cl^- > SO_4^{2-} > NO_3^-$ for anions
  $Na^+ > Ca^{2+} > Mg^{2+} > K^+$ for cations.

Parameters	Units	Moy	Min	Max	Med
pH	(-)	7.8	6.9	8.2	7.8
CE	µS/cm	1524.4	127	5800	1107
TDS	mg/L	1021.4	85.1	3886	741.7
Ca^{2+}	mg/L	105.5	13.5	353	79.1
Mg^{2+}	mg/L	44.8	0.7	188	45.5
Na^+	mg/L	116.4	13.4	609.4	65.8
K^+	mg/L	4.7	0.1	23	2.3
HCO_3^-	mg/L	330.5	18.3	457.5	366
SO_4^{2-}	mg/L	69.6	1.8	587	37.6
NO_3^-	mg/L	54.8	0.5	425	24.2
Cl^-	mg/L	267.3	17.5	1556	129
F^-	mg/L	3.2	0.1	9.4	2.6

- ✓ **Evolution of chloride and fluoride concentrations in the same boreholes**

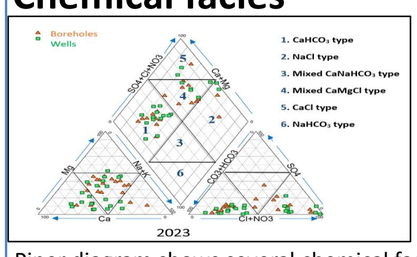




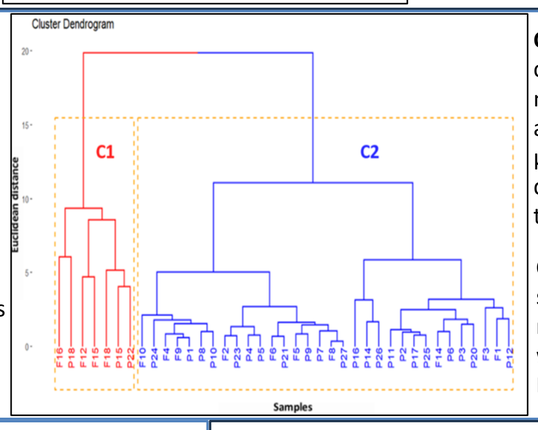
Why choose both ions?

- ✓ Salty taste: abandoned Wells
- ✓ Dental fluorosis observed in the population
  - Cl^- and F^- show significant spatial and temporal variations between 1982 and 2023.
  - increase in chloride and fluoride content

Chemical facies



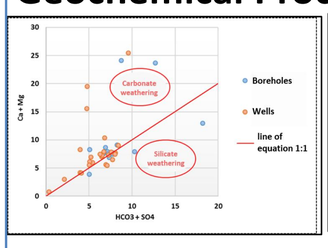
Piper diagram shows several chemical facies
- Ca-HCO_3 facies 54% of samples
- Na-Cl (10%) and Ca-Cl facies (10%)
- Mixed Ca-Mg-Cl type 26% of samples

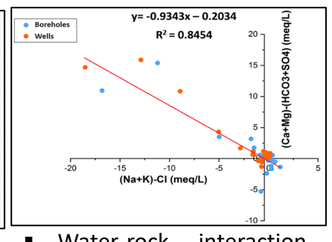


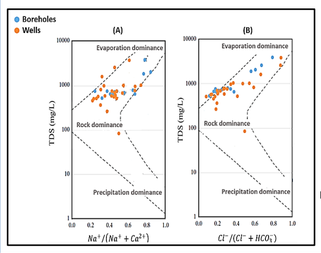
Cluster 1(C1): 18% of samples, characterized by highly mineralized water with high average values for EC (3944 µS/cm) and mixed facies with a dominant Cl^- type; located in the vicinity of the sea.

Cluster 2 (C2): 82% of water samples and is associated with moderately mineralized, alkaline waters with a dominant mixed HCO_3^- facies

Geochemical Processes

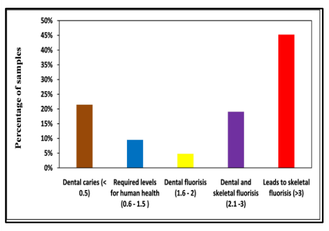






- Water-rock interaction (dissolution/weathering of carbonates and silicates) is the main process regulating water chemistry.
- Other processes include ion exchange and evaporation

Health Risks Associated with Fluoride



- Dental fluorisis 5% of samples
- Dental and skeletal fluorisis 20%
- Leads to skeletal fluorisis 45%

Total Health Index

THI > 1: Carcinogenic Risk
THI ≤ 1 :No-Carcinogenic Risk

Fluoride	Man	Woman	Children
THI	0.13-11.74	0.15-13.87	0.18-15.87
Samples exceed permissible limit	82.05%	84.62%	87.18%

- Calculation of THI for fluoride indicates a very high risk
- Increased risk of diseases such as dental and skeletal fluorosis, particularly in children.

CONCLUSION

- ➢ Overview: Water quality in the Mbour-Fatick area is strongly influenced by natural processes (water-rock interaction, evaporation) and is highly mineralized.
- ➢ Health threat: Fluoride contamination poses a serious threat to public health and requires special attention

FUTURE WORK / REFERENCES

Perspectives: Sustainable water resource management and appropriate treatment solutions are needed to ensure access to drinking water in the region

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