Combining hydrogeochemical and stable isotopes approach to investigate groundwater mineralization within Volta River Basin in Benin (West Africa)

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1. CONTEXTE

Groundwater is the main source of water for domestic and other uses in many rural and urban areas of the Volta river basin in Benin [1] (**Fig.1**). Located in the Sudano-Sahelian zone, It is characterized by a relatively contrasting geomorphology, made up of hill chains to the east and center, and a lowland to the west. The mean annuel rainfall and potential evapotranspiration is 1173 mm and 1494 mm respectively [2].

In the West, the sedimentary sequences are monoclinic and are the sedimentary basin of Pendjari. It becomes increasingly folded and changed as we move on towards the East [3].

So, the study area has four geological sub-units namely from West to East : the Pendjari sedimentary basin, Buem, Atacora and the basement s.s. formations.

Half of the North area of the basin is occupied by the Pendjari National Park and the population's rate, in majority rural, is increasing around the park.

A better assessment of groundwater resources in this area is a strategic point for the sustainable management of water resources, which since the mid-twentieth century is experiencing drought persistence leading to increase climate aridity [4].

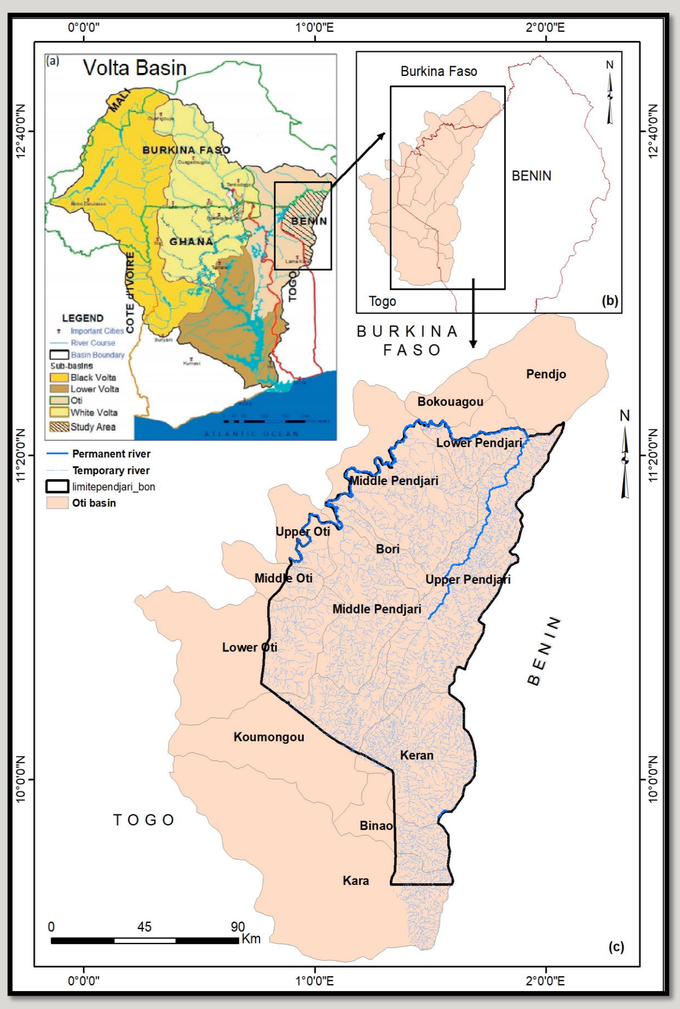

Fig.1 : Location of the study area

OBJECTIVE

This study aims at understanding. hydrogeochemical processes that typically control the groundwater mineralization and its vulnerability.

2. METHODOLOGY

A total of 93 water samples (from aquifers and surface water) were taken from the whole Benin's Volta River, of which 30 were collected during the February-March 2012 campaign and 63 during the October-November 2013 season. Each sample was tested at the Radio-Analysis and Environment Laboratory of Sfax (Tunisia) to determine the major components (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, SO_4^{2-}, HCO_3^{-}, NO_3^{-}) and stable isotopes (^{2}H and ^{18}O), respectively by Liquid-Phase Chromatography and laser absorption spectrometer

3. RESULTS

Hydrochemical investigations show that waters in this basin are of low to moderate mineralization where occur two main evolutions. Firstly, the evolution from Ca-HCO_3 to Na-K-HCO_3 indicates more interactions between groundwater and clay minerals due to isomorphic substitutions and exchange processes of cation and/or alteration of silicates [5].

Secondly, HCO_3 evolution to Cl-NO_3 point out the anthropogenic influence on groundwater by the intensive use of chemical fertilizers in agriculture through NO_3 and Cl relations (**Fig.2**).

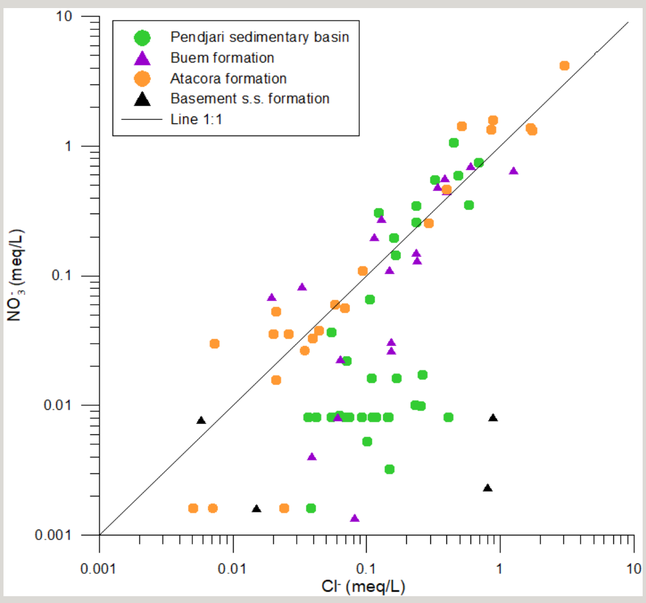

Fig. 2 : NO_3 and Cl relationship

Moreover, isotopic approach reveals that the enrichment of stable isotopes in water is accompanied by high nitrate levels (**Fig. 3**), sometimes exceeding 50 mg/L. The same is true for boreholes not exceeding 40 m.

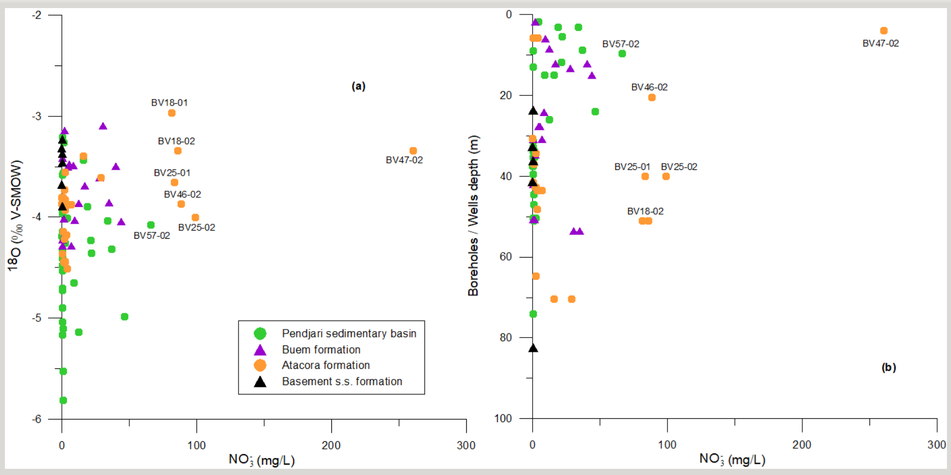

Fig. 3 : Relations $\delta^{18}O/NO_3^{-}$ **(a)** and depth/NO_3^{-} **(b)**

The spatial distribution of nitrates (**Fig.4**) confirms some towns, namely Nambouli, Natitingou, Tanguieta and Tchanwassaga, which are affected by pollution that is certainly related to agricultural and even tourist activities.

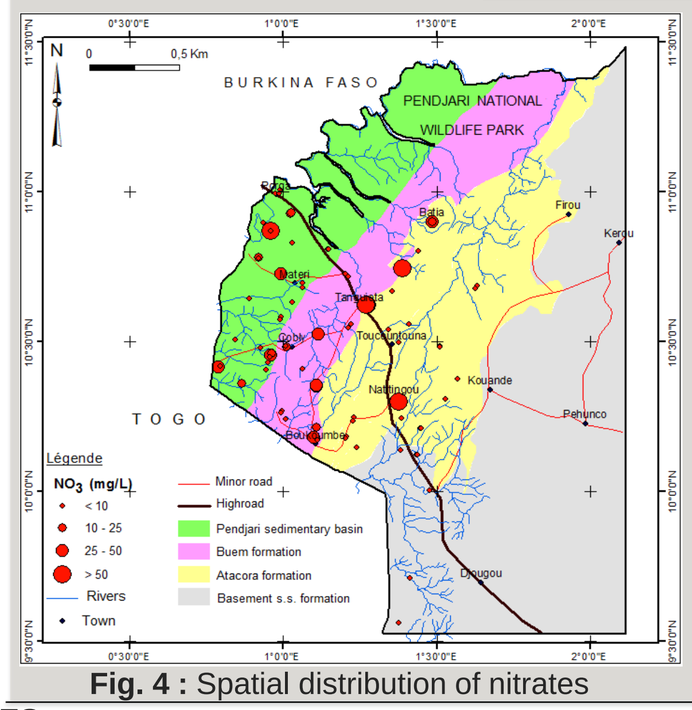

Fig. 4 : Spatial distribution of nitrates

4. CONCLUSIONS

1. Groundwater in this basin are of low to moderate mineralization
2. Groundwater vulnerability study show that Nambouli, Natitingou, Tanguieta and Tchanwassaga townships are under the influence of activities, namely agricultural and tourist activities.

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