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Physico-chemical characterization of soils and waters of livestock watering sites in Benin

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Abstract
Breeding is still extensive in sub Africa and mainly based on natural resources for feeding and animals watering. The inadequacy of these resources has led to the creation of countless watering points (dams, reservoirs, over digging and wells) in several locations. Unfortunately, various natural and anthropogenic factors endanger both soil and water quality at these sites. The results of this work aimed at determining the physico-chemical characteristics of natural and managed watering infrastructures and surrounding soils indicate eutrophication of the waters on the sites and a filling of those by strong organic pollution of some of them. Indeed the averages of recorded values are respectively (pH = 6.418 ± 0.576); median = 5.67); ([NTK] medium = 5.813 ± 7.563 mg/L; median = 3.75 mg/L) and ($[PO_4^{3-}]$ = 4.256 ± 2.369 mg/L; median = 3.225 mg/L) in the respective forms of nitrites and phosphates;([COD] = 94.105 ± 103.052) mg O_2/L; median = 54.16 mg O_2/L and [BOD5] = 26.443 ± 15.179 mg O2/L; median = 23 mg O_2/L).

Keywords: Quality, ground, cattle, Benin

1. Introduction
Livestock, the second most important economic activity after agriculture in sub-Saharan Africa, contributes to food security in pastoral and agro-pastoral communities. This breeding is still extensive and mainly based on natural resources for feeding and watering animals [1]. In the north of Benin, there are seasonal transhumance movements by Fulani pastoralists with cattle on limited routes and in various directions in search of water and grazing [2]. The inadequacy of natural water resources has led to the creation of innumerable watering points (Dam, impoundments, overcrowding and wells) in many villages spontaneously leading to the development of market garden crops and established farms on the outskirts. The different uses, especially market gardening and agriculture, through agricultural inputs used or transported by leaching of the soil by runoff water, cause water pollution. These waters are also enriched by pollutants from the various waste deposited on the banks because of human activities; these also cause the development of invasive plants in terms of water resources. All this pollution is not without consequence on the life of the breeding and consequently on the populations through the food chain. Indeed in case of epizootic, there are cases of contagion of a large number of animals through contaminated water. [1] For a better knowledge of the quality of the various available water reserves, a study of the physicochemical characteristics of natural and managed watering infrastructures and surrounding soils was carried out all over the Beninese territory in order to contribute to the preservation population health and sustainable livestock management in Benin.

2. Material and Method
2.1. Description of the study environment
The study was carried out in Benin (West Africa). By the South to the North the country has 700 km as lengh and two different widths in the East-West direction, the first on the coast (125 km), the second in the North (300 km) with 112,600 km^2 as area.
Two categories of watering points have been identified in the study area: managed water points and natural water bodies.

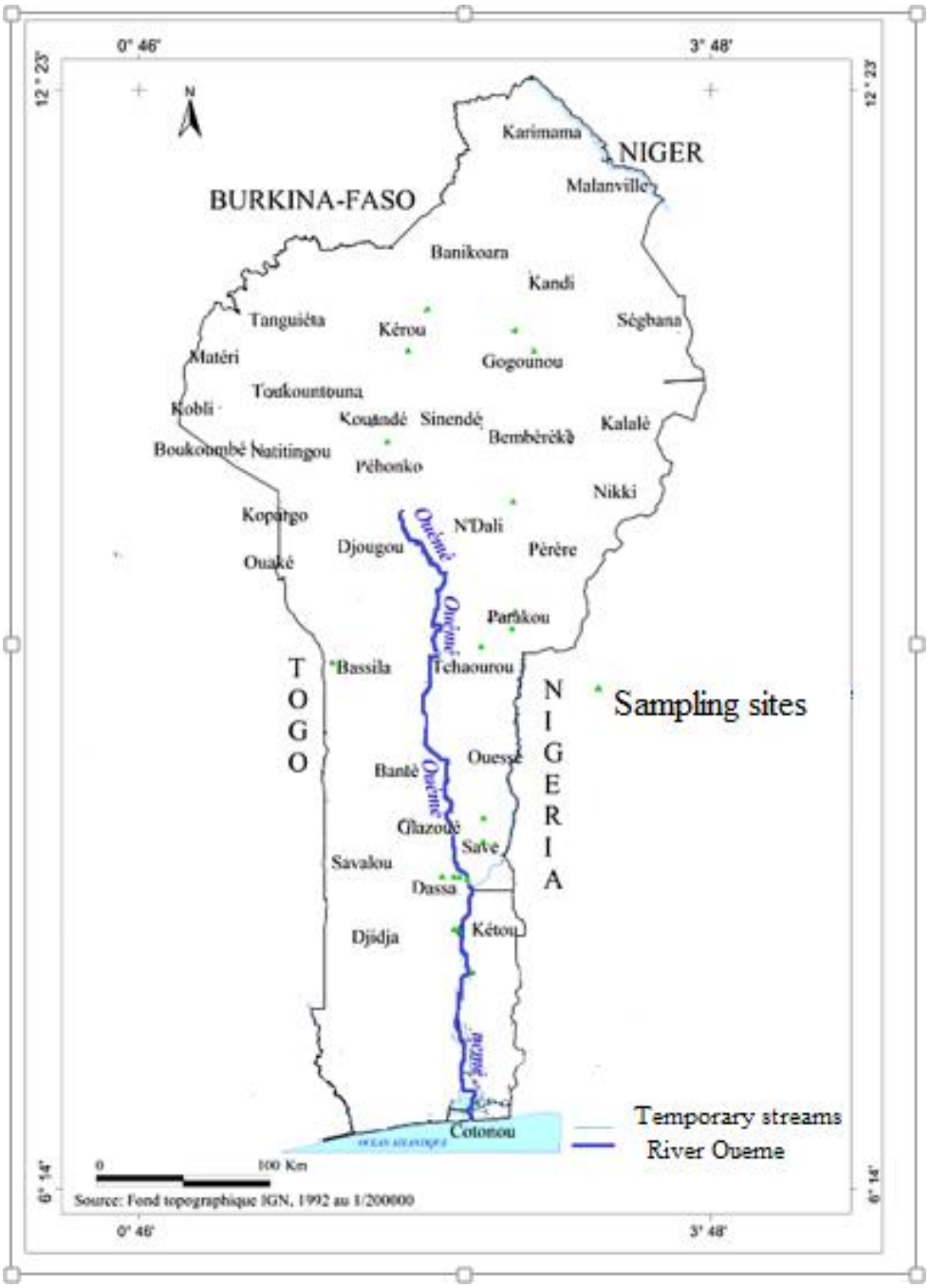

Fig 1: Location of sampling sites

The physical state of the soil is often dictated by the cycle of manure (Excrement, urine) at the level of the park sites (Enclosures) and grazing and feeding areas (Fodder).

The state of the immediate environments of the sites is exposed through tables 1 and 2 which present a description of each of the sites following the observations made during the field visits.

Table 1: Sites description

N°	Sites	Sites description
1.	Ketou/ Ayekotonian	Water retaining device for the regular watering of livestock and various domestic uses (drink, bath, laundry...)
2.	Left bank of Oueme river	Left bank of the Oueme river serving as a watering point for oxen
3.	Samiondji	Water retaining device on a farm serving as a watering point for livestock
4.	Samiondji/ Zogblagada	Water retaining device for animals watering
5.	Samiondji /Oueme river	Right bank of the Oueme river near a breeding farm.
6	Betecoucou 1	Retention of water protected by wooded banks. Watering point for animals
7	Betecoucou 2	Water retention protected by well-wooded banks and used as watering point for animals.
8	Dassa/Oueme river (Betecoucou)	Right bank of the river Oueme. Watering point for animals
9.	Save/ Akon	Water retention with banks heavily eroded and used as a watering place for animals.
10.	Save/ Diho	Water restraint: livestock watering site

11.	Tchaourou Bouksera	Well-maintained water retention for watering animals
12.	Okpara dam /Parakou	Water plan surrounded by a gallery forest. Watering point for animals
13.	Okpara/Parc 7	Water retention with gently sloping banks fed by runoff and used for livestock watering
14.	Ndali / Ina	Water retention device. Gently sloping refuge that serves as a well-used watering site for herds of animals
15.	Gogounou	Water restraint.Site located in a bowl in the middle of a flat area for livestock watering
16.	Kandi/Takongou	Dam and watering place for cattle herds
17.	Banikoara	Retention heavily attended by many herds of animals (sometimes estimated at 300/400 beasts at a time)
18.	Ouassa Péhunco	Retention well maintained (with an acceptable water level) frequented by domestic animals (ducks...)
19.	Bassila	Retention whose water is exploited by the National Water Company of Benin to produce drinking water

Table 2: State of the banks of sites studied during two large dry and rainy seasons

N°	Sites	Dispersion levels of animals déjections and wastes on the banks of water plans and water retaining	
		In dry season	In rainy season
1	Ketou/ Ayekotonian	++	++
2	Left bank of Oueme river	+	+
3	Samiondji/ Zogblagada and Oueme river	++	++
4	Betecoucou 1 and 2 and Dassa	++	++
5	Save /Akon	++	+++
6	Save/Diho	++	++
7	Tchaourou / Bouksera	++	++
8	Okpara dam /Parakou	+	+
9	Okpara/ Parc 7	++	++
10	Ndali / Ina	+	
11	Gogounou	++	++
12	Kandi /Takongou	++	++
13	Banikoara	++	++
14	Ouassa Péhunco	+	+
15	Bassila	+	+

+ : low ; ++ : medium ; +++ : high

2.2 Sampling and analysis methods

Samples were taken from the North, Hills and Plateau areas of the country where cattle are transhumant in search of new pastures and watering points. The sampled points are 15 on the developed sites (Dam and reservoirs), 3 in the natural sources (Oueme river) and 1 on a control site.

Two sampling campaigns were carried out; the first during the dry season (March) and the second during the rainy season (July) at 19 sites then at 16 sites, the other three becoming inaccessible due to high water and floating plants that invade the shores streams.

A total of thirty-five samples were collected and analyzed. Temperature, pH, conductivity and dissolved oxygen were measured on site. The samples were then stored at approximately 4°C and transported to the laboratory for determination of the chemical pollution parameters (COD, BOD_5, TDS, Turbidity, SS) and their Cl^-, SO_4^{2-}, NO_3^-, NO_2^- contents, PO_4^{3-}, total nitrogen of Kjeldhal and total phosphorus which were measured according to the standard methods recognized by the French Association of Normalization (AFNOR) [3].

3. Results and Discussion

3.1 First campaign (Dry season)

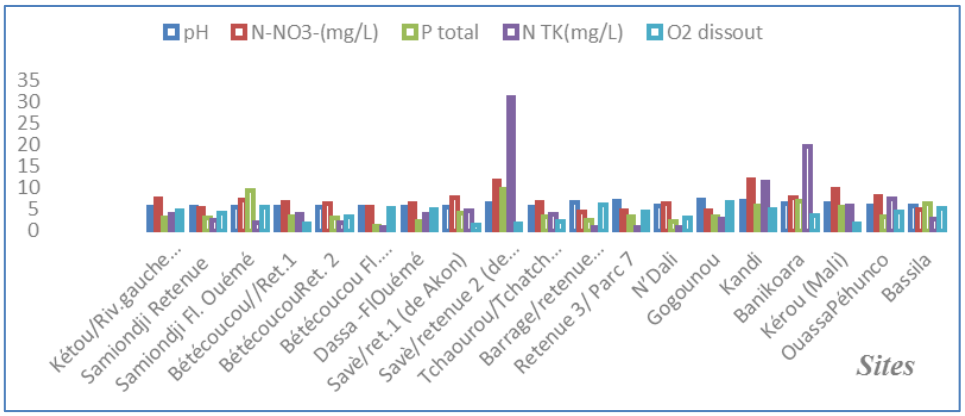

Fig 2: Physico-chemical characteristics of reservoirs and water bodies of sites

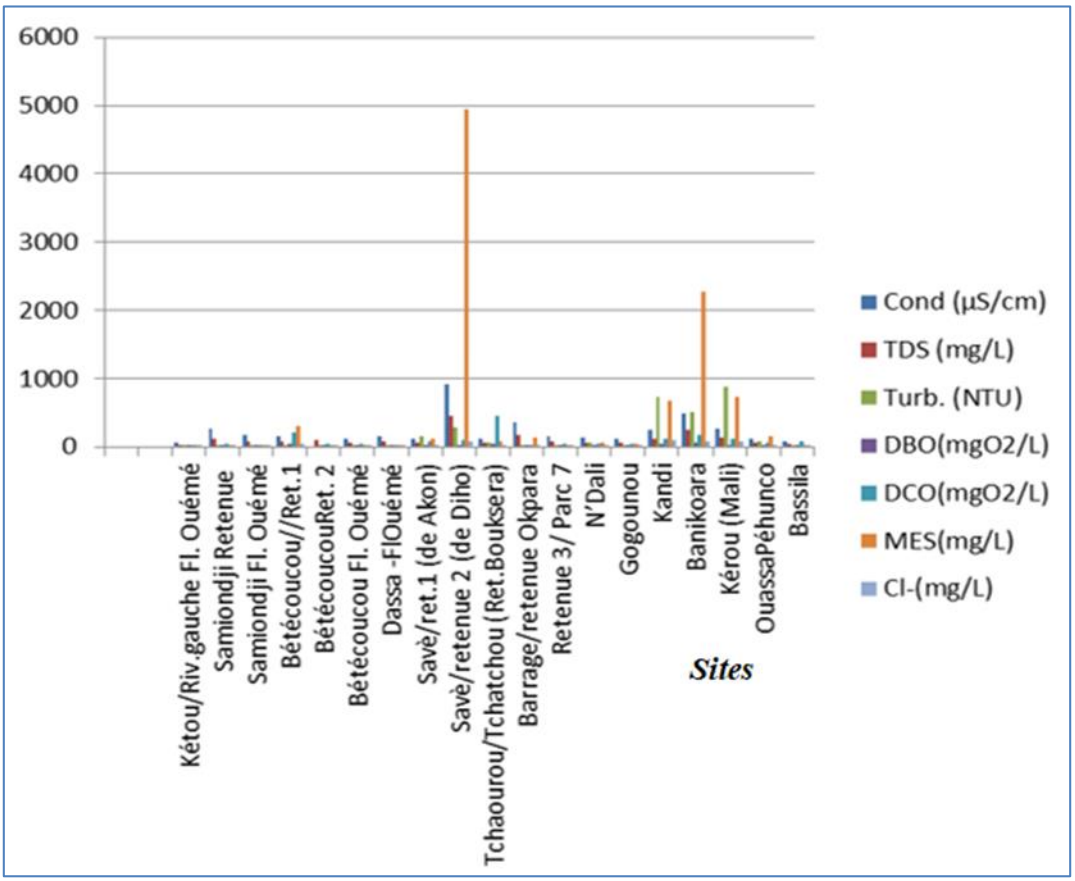

Fig 3: Physico-chemical characteristics of reservoirs and water bodies of sites (Continued)

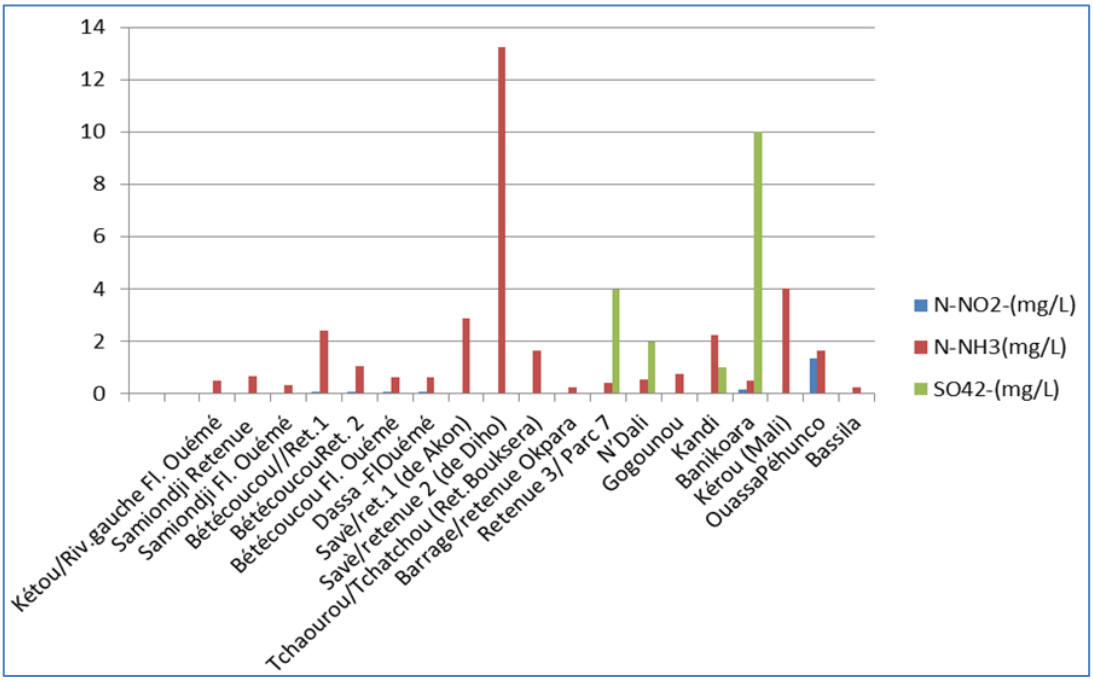

Fig 4: Physico-chemical characteristics of the reservoirs and water bodies of the sites (continuation and end)

3.2 Second campaign (Rainy season)

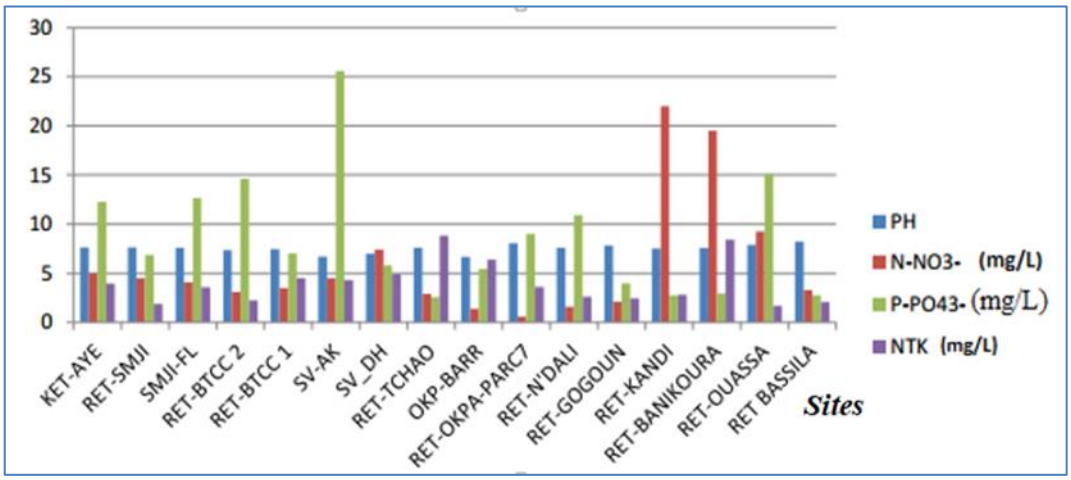

Fig 5: Physico-chemical characteristics of reservoirs and water bodies of sites

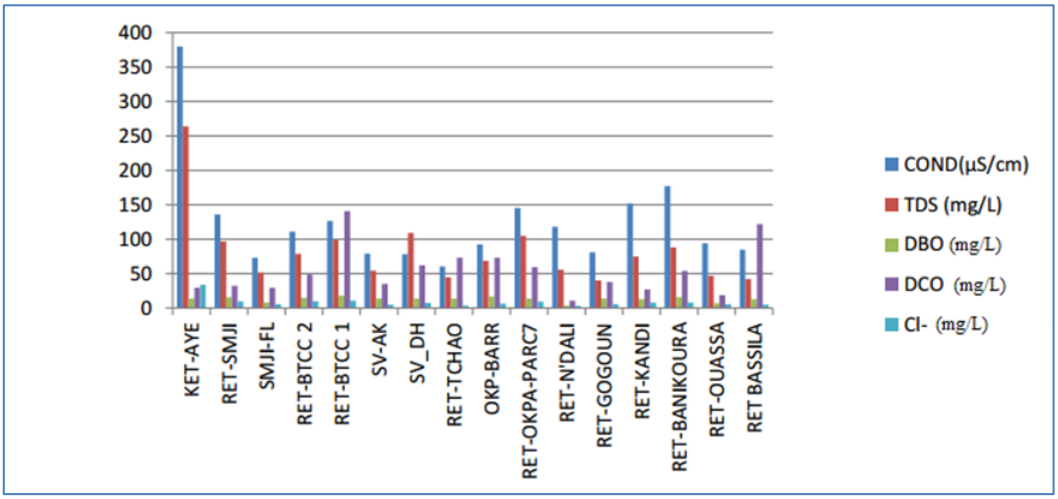

Fig 6: Physico-chemical characteristics of reservoirs and water bodies of sites ccontinued)

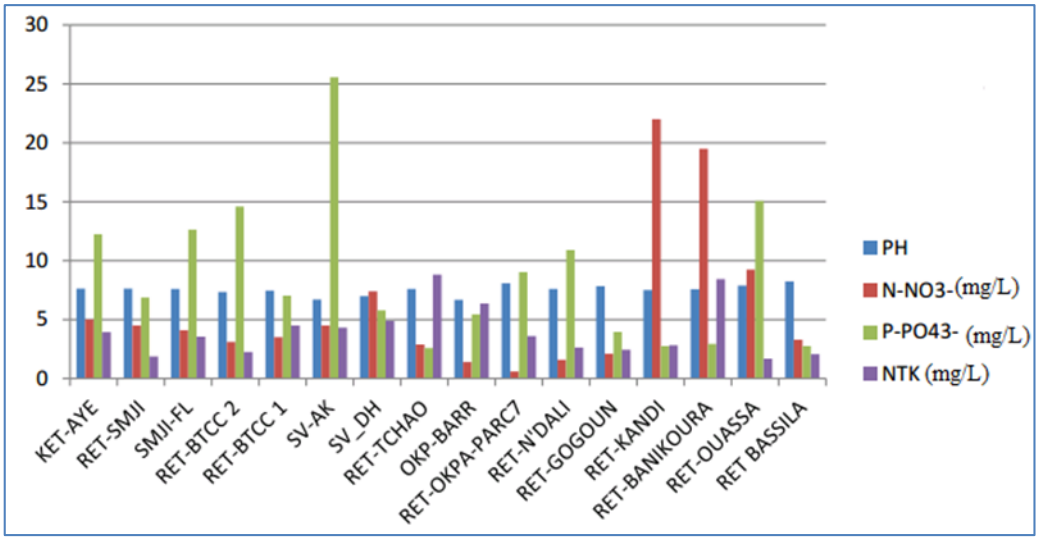

Fig 7: Physico-chemical characteristics of reservoirs and water bodies of sites (Continuation and end)

The analysis of the tables 1 and 2 datas reveals the following situations:

- The reservoirs and watering yards of the animals are receptacles for solid discharges of animal origin (Excrement, urine, etc.);
- Water reservoirs are threatened by colonization of aquatic plants, which sometimes stifle aquatic life;
- Most reservoirs are exposed to leaching water runoff from cotton fields or forage crops treated with pesticides or chemical fertilizers;
- The waters of the reservoirs or rivers bordering the livestock farms are for the most part used by the population as washing, bathing or sometimes drinking water.

Pesticides used in cotton and vegetable crops culture are applied to forage areas on some live stock farms and their

residues are run off in animals watering sites.

The histograms of figures 3 to 6 show, in the set of analyzed samples, more or less acidic pH values (pH = 6.418 ± 0.576, median = 5.67) for the waters of the reservoirs and water bodies probably revealing intake of acidic livestock soils (Contaminated by animal waste) having undergone physicochemical alterations that affect these receiving water bodies.

Nitrogen and phosphorus pollution levels are also higher in the rainy season than the dry season. These pollutions of the watering sites of the animals are due to the runoff of acid breeding soils which released, for example in the dry season, large quantities of nitrogen (average [NTK] = 5.813 ± 7.563 mg / L, median = 3.75 mg / L) and phosphorus ([PO43-] = 4,256 ± 2,369 mg / L, median = 3,225 mg / L) as nitrite and phosphate respectively to these aquatic systems in the downstream parts. These pollutions, come from animal parking areas as well as from forage areas. Indeed, the soils of these areas are amended with chemical fertilizers and urea, while the waste of cow dung and post-harvest residues, very rich in nutrients, could constitute excellent fertilizers for the soil. Eutrophication may already occur at relatively low concentrations of phosphates (50 µg P / L) [4]. It is considered as dangerous from a concentration of more than 3 mg NO2- / L [4].

Therefore, reservoirs and watercourses used for watering animals and watercourses near breeding sites are subject to the phenomenon of eutrophication which results in anarchic developments of aquatic plants such as water lilies and water hyacinth. These plants contribute to the asphyxiation of aquatic systems because the dissolved oxygen content is very low and a low dissolved oxygen content causes an increase of the solubility of the toxic elements that are released from the sediments.

Added to this is the organic pollution caused by livestock waste and dead plant litter, whose microbial decomposition explains the low values of dissolved oxygen but also the high COD and BOD5 values found in plants respectively ranged from (94.105 ± 103.052 mg O2 / L with a median value = 54.16 mg O2 / L) to (26.443 ± 15.179) mg O2 / L, with a median value = 23 mg O2 / L). These values are much higher than the accepted values, which are generally 6mg / L for BOD [4].

Conclusion

This study revealed very low dissolved oxygen levels inducing the eutrophication phenomenon of reservoirs and watercourses for watering animals and streams near breeding sites. In addition, it provides information on organic pollution caused by live stock waste and dead plant litter. It is recommended that some reservoirs and water bodies be constructed to limit their filling and harmful inputs (Pesticide and insecticide residues) for sustainable use.

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