

Contribution of GLOBE students' research to the issue of water and agriculture in Ferlo, Senegal



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TABLE OF CONTENTS

| | Pages |
|---|--------------|
| ABSTRACT | 3 |
| 1. INTRODUCTION | 3 |
| 1.1 Research questions..... | 3 |
| 1.2 Research hypotheses..... | 3 |
| 2 MATERIALS ET METHODS..... | 4 |
| 2.1 Study areas | 4 |
| 2.1.1 The PITERKI water retention basin..... | 4 |
| 2.1.2 The Lake GUIERS..... | 5 |
| 2.2 Materials..... | 5 |
| 2.3 Methods | 6 |
| 2.3.1 GLOBE data collection | 6 |
| 2.3.2 Market gardening:..... | 8 |
| 2.3.3 Local visits :..... | 8 |
| 3 RESULTS..... | 8 |
| 3.1 Document 1 : annual distribution of rainfall at Alboury Ndiaye (basin Piterki), Linguère and CEM de Syer (lake Guiers), Louga 2023..... | 8 |
| 3.2 Document 2 : comparative rainfall histograms of Alboury Ndiaye (Piterki) and CEM de Syer (lac de Guiers), 2023..... | 9 |
| 3.3 Document 3 : table of variation of pH and water temperature de l'eau on the 2 hydrology sites | 9 |
| 3.4 Document 4 : PITERKI water retention basin : livestock watering trough | 10 |
| 3.5 Document 5 : introducing students of Clubs GLOBE/SERVIR-AO to agriculture | 10 |
| 3.6 Document 6 : outreach visits to the community..... | 11 |
| 4 DISCUSSION | 12 |
| CONCLUSION | 12 |
| GLOBE BADGES..... | 13 |
| REFERENCES/BIBLIOGRAPHY | 14 |
| ACKNOWLEDGEMENTS | 15 |

ACRONYMS/ABBREVIATIONS

GLOBE : Global Learning and Observation to Benefit the Environment

CEFE : Centre d'Education et de Formation Environnementale

CEM : Collège d'Enseignement moyen

CSE : Centre de Suivi Ecologique

DEMSG : Direction de l'Enseignement Moyen et Secondaire

IVSS : International Virtual Science Symposium

SERVIR-AO : Servir Afrique de l'Ouest

STIM : Sciences, Technologie, Ingénierie et Mathématiques

WENDOU : Water Environment Dashboard for Observation in support of Users in Ferlo, Senegal

ABSTRACT

Ferlo is an agro-sylvo-pastoral zone with a tropical, semi-arid or semi-desert climate and located in the northeast of Senegal. It is mainly made up of shrub and tree savannah, very exposed to climatic hazards such as low rainfall and lack of water for livestock and agriculture. Since 2021, with the support of the SERVIR-AO/CSE program, we students of the GLOBE program from 3 Ferlo schools have carried out research on the WINDOU platform, rainfall and the study of water quality: **pH and temperature of the PITERKI retention basin and Lake GUIERS**. This high-level research has made it possible to direct agriculture and breeders towards retention basins or ponds supplied with water during the dry season which lasts 8 months in Senegal. The results of this study confirm the characteristics of the Sahelian climate with a long dry season and a short rainy season: **annual rainfall of 531 mm** of rain in 2023 (Alboury Ndiaye site) and **200 mm** (Syer site). The pH values of the water from these 2 **study** sites (between 6 and 7) as well as the temperature (between 27 and 33 °C) showed the population that the water is usable and compatible **with the life of herds/livestock and crops** throughout the year. In perspective, **with the support of administration** and financial technical partners we want to go further in research and consider making soil protocols including fertilization to better supervise breeders and farmers and also improve quality teaching-learning in STEM.

1. INTRODUCTION

Ferlo is an almost semi-arid area receiving annually small amounts of poorly controlled precipitation. To provide a solution to this situation, the State of Senegal has been pursuing a water control policy for several decades aimed at making sufficient water available to populations. The evolution of this Senegalese hydraulic policy was achieved in part with the construction of rainwater retention basins including that of Piterki. Lake Guiers is a body of fresh water located in the north of Senegal, in the upper delta of the Senegal River. The lake occupies an area of almost 300 km² and contains some 600 million cubic meters of water. Lake Guiers is the largest fresh water reserve in Senegal. In this research we studied rainfall, pH and water temperature and assured breeders and farmers about water quality.

1.1 Research questions

- 1/ Are there artificial retention basins with water that can be used permanently during the long dry season ?
- 2/ Does the fluctuation of the water level during the dry season and the rainy season affect the pH and temperature of the water in Lake Guiers and the Piterki retention basin ?
- 3/ are the pH and temperature measurement values compatible with the life of herds and crops ?
- 4/ Does the investigation of GLOBE/SERVIR-AO clubs have a measurable impact on school life and community life ?

1.2 Research hypotheses

- 1/ The WINDOU platform provides information on the water level in the retention basins, with permanent water in Piterki.

2/ The drop in pond water level during the dry season does not affect the pH and temperature of the water.

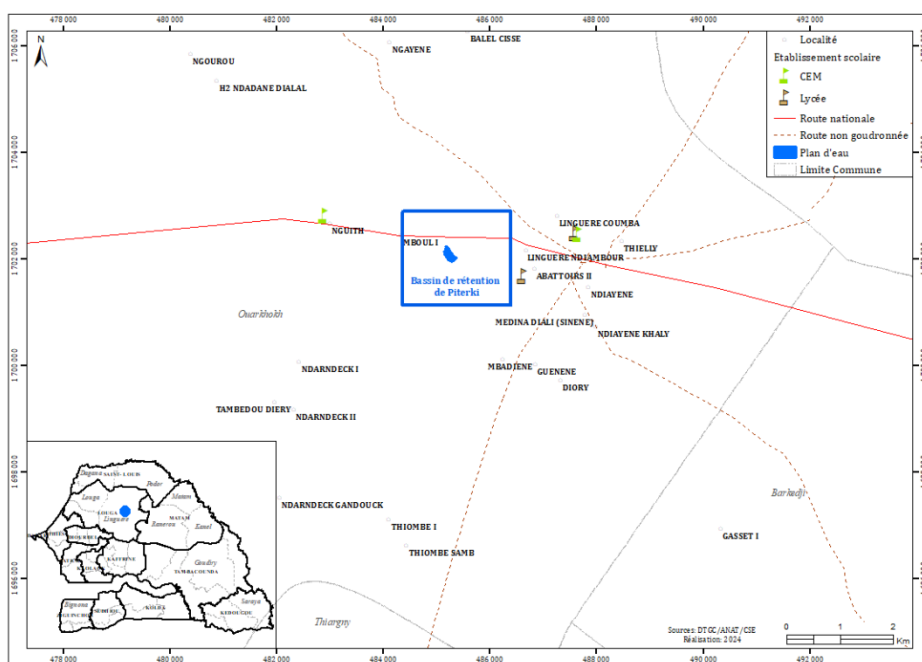
3/ Data from the GLOBE/SERVIR clubs showed that the pH and temperature of the water in Lake Guiers and the PITERKI basin are compatible with life.

4/ the work of the GLOBE/SERVIR Clubs has a positive impact on STEM teaching at school and on the community.

2 MATERIALS AND METHODS

2.1 Study areas

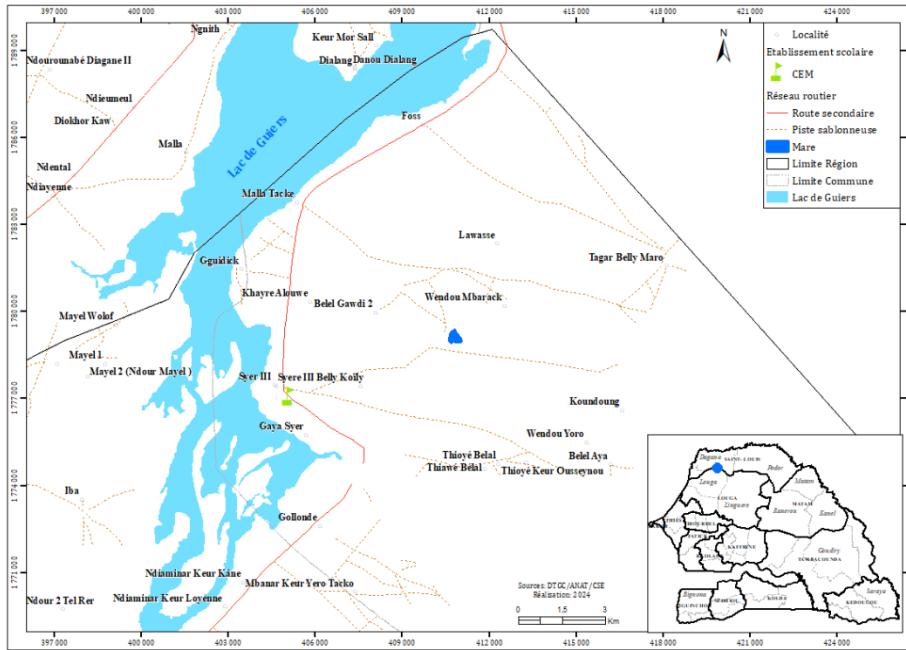
2.1.1 The PITERKI water retention basin



PITERKI water retention basin, located at Alboury Ndiaye high school, Linguère department, région Louga region, Senegal

Latitude 16.39633, longitude -15.13744, elevation 15m, SITE_ID : 239683

2.1.2 The Lake GUIERS



GUIERS lake, located at CEM Syer III, Louga department, Louga region, Senegal

Latitude 16.07965, longitude -15.53154, elevation 4m, SITE_ID : 240374

2.2 Materials

Reception of school equipment between SERVIR-AO, GLOBE managers and administration



The materials used in this research are :

Water pH :

- ✓ pH paper
- ✓ beachers
- ✓ gloves
- ✓ Bots
- ✓ Cellphone
- ✓ sheet and pencil

Water temperature :

- ✓ water thermometer
- ✓ string
- ✓ stick
- ✓ beachers
- ✓ sheet and pencil

Precipitation/ rainfall

- ✓ pluviometer
- ✓ sheet and pencil

2.3 Methods

2.3.1 GLOBE data collection

With the support of the SERVIR-AO program, the supervising teachers of the clubs of the three project schools were trained on atmospheric and hydrological protocols and all the necessary equipment was purchased and made available to the students. The students of the 3 clubs in turn have been trained by the supervisory teachers and are carrying out GLOBE surveys in accordance with the GLOBE program and as indicated in the photos below.



Club Syer/lake de Guiers



club Ranérou



club Alboury Ndiaye/Piterki

Hydrology protocols:

- For the pH of the water : the students take periodic data at Lake Guiers and the Piterki basin, using pH paper.



pH reading in CEM Syer III classroom

-for the water temperature : at the same time as studying the pH, the students take the water temperature with a water thermometer respecting the protection of water and the environment.



Careful reading of the water temperature d'eau at the edge Piterki basin

Precipitations : rainfall :

At each solar noon, the students go to the atmospheric site located in the school to measure the amount of rainfall.

Rainfall is measured with 2 different rain gauges. For one of the rain gauges whose data is intended for **GLOBE**, the reading is taken at solar noon at the same time as the air and cloud temperature readings. The other rain gauge whose data is intended for **national meteorology**, readings are taken at 8 a.m. and 6 p.m.



Reading the thermometer at CEM de Syer

All data collected is recorded in learners' notebooks for use in classroom (STEM) and for sending to GLOBE website www.globe.gov

2.3.2 Market gardening:

Vegetable gardens have been set up inside the Schools and near the lake Guiers for the quality control of the lake water on agriculture and to initiate the students in plant biology (STEM) and entrepreneurship.

2.3.3 Local visits :

These local visits to breeders and farmers allowed us to communicate with the community about the water quality of the retention basin and the lake.

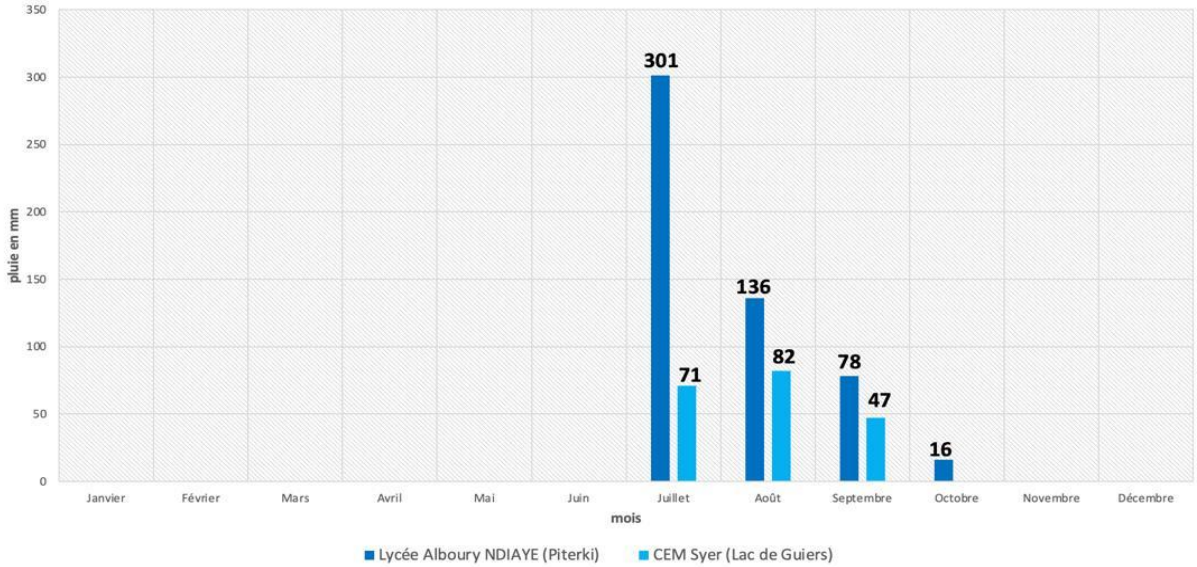
3 RESULTS

3.1 Document 1 : annual distribution of rainfall at Alboury Ndiaye (basin Piterki), Linguère and CEM de Syer (lake Guiers), Louga 2023

| mois | January | february | march | april | may | june | july | aug. | sept | oct. | nov. | déc. |
|----------------------------|---------|----------|-------|-------|-----|------|------|------|------|------|------|------|
| rainfall (mm) PITERKI 531 | 0 | 0 | 0 | 0 | 0 | 0 | 301 | 136 | 78 | 16 | 0 | 0 |
| rainfall (mm) GUIERS 200 | 0 | 0 | 0 | 0 | 0 | 0 | 71 | 82 | 47 | 0 | 0 | 0 |

Nota bene : this data collected by the clubs GLOBE/SERVIR-AO is already sent to the GLOBE website : www.globe.gov and to the national meteorology office.

3.2 Document 2 : comparative rainfall histograms of Alboury Ndiaye (Piterki) and CEM de Syer (lac de Guiers), 2023



Pluviométrie au Lycée Alboury NDIAYE (Piterki) et CEM Syer (Lac de Guiers) au Sénégal en 2023
GLOBE schools

Comparative rainfall histograms of Alboury Ndiaye (Piterki) and CEM de Syer (lac de Guiers), 2023

This graph confirms the sahelian climate of Ferlo with a long dry season from november to June and a short rainy season from July to October, low rainfall and uneven distribution of rain. The area of lake Guiers located further north is less rainy than the Piterki area. These data are from the Alboury Ndiaye high school located near the Piterki basin and the CEM de Syer located near Lake GUIERS. The Piterki watershed is fed only by runoff water. The platform WENDOU and periodic visits by students show the constant presence of water throughout the year. However, the water level gradually drops during the long dry season. Lake Guiers, a natural body of water, is the largest fresh water reserve in Senegal.

3.3 Document 3 : table of variation of pH and water temperature de l'eau on the 2 hydrology sites

| Sites | average pH de l'eau | | | | | average temperature de l'eau en °C | | | | |
|---------------|---------------------|----------|-----------|-----------|---------------|------------------------------------|----------|-----------|-----------|---------------|
| | R1 | R2 | R3 | R4 | R5 | R1 | R2 | R3 | R4 | R5 |
| No relevé | | | | | | | | | | |
| Date | april 2021 | may 2021 | june 2021 | nov. 2023 | february 2024 | april 2021 | may 2021 | june 2021 | nov. 2023 | february 2024 |
| Piterki | 7 | 7 | 7 | 6 | 7 | 33,3 | 27.75 | 28,9 | 28,5 | 23.7 |
| Lac de Guiers | 6 | 6 | 7 | 7 | 7 | 33 | 30 | 31.5 | 31 | 31 |

Document 3 : variation of pH and water temperature at Piterki and lake Guiers

3.4 Document 4 : PITERKI water retention basin : livestock watering trough



The data in document 3 show that the pH at the 2 sites varies between 6 and 7, so the waters are soft and neutral throughout the years. These values are compatible with the life of the animals which drink there (document 4) and the market gardening crops developed along these two water sources. Likewise, water temperatures are between 27 and 33 °C so the drop of water level during the dry season does not affect the physicochemical characteristics of the water.

3.5 Document 5 : introducing students of Clubs GLOBE/SERVIR-AO to agriculture



Composting and transplanting at Ranérou high school



Water drainage canal from lake GUIERS for watering the Syer school garden and field



Harvests in the school garden of Alboury Ndiaye high school

Document 5 brings together photos illustrating the stages of market gardening activities which accompany the GLOBE program in Senegal. This initiative allows students to answer their research questions. Indeed, the irrigation canal dug by the students themselves, with a motor pump, makes it possible to water the field and show that the physico-chemical characteristics of the water from the lake and the retention basin are well compatible with plant life throughout the years. The Financial resources generated by the sale of products are intended to support financing of club activities.

3.6 Document 6 : outreach visits to the community



Document 6 illustrates the local visits of students accompanied by club supervisors to the community to share their research results. They confirmed to farmers that the physicochemical values of pH between 6 and 7 and water temperature between 27 and 33 °C are indeed compatible with the life of animals and plants. The water from the retention basin can be used all year round. In return, the market gardeners made the students understand that when the water level in the basin drops, the water becomes more or less cloudy and this can hinder the beauty of the crops.

4 DISCUSSION

The operation of the WENDOU Platform <https://wendou.csesn.dev>, with the support of the SERVIR-AO program and the CSE, allowed learners to know the location of retention basins and ponds at the Ferlo level. The research results showed that the rainy season is short (3 to 4 months) and that the total annual rainfall is low (531 mm in Piterki and 200 mm in Syer). These quantities of rain do not cover the water needs of the agriculture and breeders, hence the importance of our two sites of Study : the PITERKI basin and Lake Guiers. The GLOBE surveys carried out by the establishments showed that pH (6-7) as well as the water temperature (27-33°C) have normal physiological values compatible with the life of farm animals and that of market gardens developed throughout these 2 water points.

To verify these hypotheses, the CEM Syer garden located at lake Guiers is watered from an irrigation canal dug by the students themselves. This also allowed us to have introductory experiences in entrepreneurship. We have also started local visits to populations to discuss our GLOBE data and the issues of livestock farming and agriculture with them. Other issues such as the presence of mud, i.e. the transparency of the water in the basin towards the end of the dry season, were raised by farmers.

In addition, the practical activities of GLOBE as well as the analysis of data in class allowed us to strengthen our level and STEM skills both for boys and girls, accordance with the orientations of the SERVIR-AO program.

CONCLUSION

In conclusion, we can highlight the importance of the two sites of this study in resolving the water problem in Ferlo. The values of the physicochemical constants of the water, namely pH and temperature, are compatible with livestock breeding and agriculture throughout the year. The work has a very positive impact in schools and in the community.

In perspective, subsequent studies will focus on water transparency and soil protocols including fertilization to better support scientists and the Ferlo landscape community.

GLOBE BADGES

I am a problem solver

By working on this climate project linked to the resolution of the lack of water in Ferlo, we helped the breeders to move directly during the long dry season towards the water retention basins and the ponds which have permanent water, with the use of the WENDOU platform. The study of pH and temperature which are compatible with the life of herds and crops reassures breeders and farmers in the Ferlo zone with an arid or semi-desert climate. Thus we have solved the problem of lack of water linked to low rainfall and a short rainy season.

Be a Data Scientist

In this report we used data collected as part of the GLOBE program (see documents 1 and 3). Drawing the graphs and in-depth analysis of the results allowed us to inform ourselves correctly and scientifically about water quality. The data allowed us to contribute to solving the problem of lack of water in Ferlo. We also used geospatial data from the WENDOU platform. Our level in STEM has improved.

Make a impact

The strong point of our research is its positive impact on the local community by informing populations about the location of retention basins and the presence of water. The study of physicochemical constants reassures breeders and farmers about the neutrality of water (document 6). Our research also has a strong impact in schools by helping teachers and students to better master STEM. The establishment of gardens (see document 5) with the participation of students, club supervisors, the coordinator of GLOBE Senegal, ministries and partners made it possible to introduce learners to entrepreneurship through the exploitation of Earth.

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- national coordinator of GLOBE/Senegal ;
- heads of the Alboury Ndiaye, Ranérou high schools and CEM de Syer;
- supervising teachers of the GLOBE/SERVIR-AO clubs of the Alboury Ndiaye, Ranérou high schools and CEM de Syer ;
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- national SERVIR club ;
- farmers and breeders Ferlo.