ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug1072

Physicochemical and Bacteriological Quality of Irrigation Water for Market Gardening Crops in the KIMPE District of Delvaux in the Municipality of Ngaliema in Kinshasa

Archal Ngandote Mutemusa[1]; Daniel Mudinga Mudinga[2]; Camille Kande Tshimanga[3]; Patience Ngelinkoto Mpia[4]; John Keyembe Mputu[5]; Francklin Ngwibaba Ansuele[6]

[1]Teacher and Researcher at the National Pedagogical University
[2]Teacher and Researcher at the National Pedagogical University
[3]Student at the National Pedagogical University
[4]Teacher and Researcher at the National Pedagogical University,
Researcher at the Water and Environment Research Center
[5]Teacher and Researcher at the National Pedagogical University
[6]Researcher at the University of Kinshasa and Seed Analyst at the National Seed Laboratory, Senasem

Publication Date: 2025/09/11

Abstract: This study was conducted to determine the physicochemical and bacteriological quality of agricultural water in the KIMPE district of Delvaux, in the Ngaliema municipality of Kinshasa.

To this end, two points, including the Djelo River (P1) and a pond (P2), were targeted for water sampling, which were collected manually in November 2024.

The physicochemical analyses, carried out in situ using the WTW multi-parameter probe, consisted of measuring several parameters (temperature, pH, electrical conductivity, and dissolved oxygen), while in the laboratory, the major dissolved ions (nitrates, phosphate, and sulfates) were measured by spectrophotometry.

The bacteriological analyses consisted of the identification and quantification by the membrane culture method of bacteria indicating fecal pollution including Escherichia coli, Enterococcus and total coliforms.

The results obtained revealed the following average values for the studied parameters:

- **Temperature (in °C): 36.6 °C (P1) and 36.7 °C (P2). These values recorded during this study are slightly higher than the limit value (35 °C) of the WHO guidelines for agricultural irrigation water. This slight thermal pollution can be explained by domestic wastewater discharge.**
- **pH: 4.5 (P1) to 5.0 (P2). All these average pH values recorded demonstrate that the studied waters are all more acidic than the standard value (5.5-6.5). This could be explained by the contribution of potentially acidic runoff water, which tends to lower the pH of the waters in the study environment.**
- **Dissolved oxygen (in mg/L): 5.3 (P1) and 4.5 (P2). These levels are all below the WHO guideline (≥ 7 mg/L) for agricultural irrigation water. There is therefore an oxygen deficit in the study environment, linked in part to the organic matter pollution present in these waters.**
- **Electrical conductivity (in µS cm−1): 10.0 (P1) and 12.0 (P2). In both samples, the electrical conductivity values recorded comply with the WHO standard, which sets the maximum conductivity value at 12 µS/cm for agricultural irrigation water.**
- **NO3- ion concentration (in mg/L): 47.61 (P1) and 25.17 (P2). The nitrate ion concentration complies with the WHO standard for water.**

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug1072

Agricultural irrigation (limit value 27 mg/L) in the pond water (P2), while it exceeds the limit for the Djelo River water (P1).

- **Concentration of PO_4^{3-} ions (in mg/L): 7.04 (P1) and 11.0 (P2). All these concentrations are above the limit required by the WHO standard for agricultural irrigation water (1.5). They indicate organic pollution that could lead to eutrophication.**
- **Concentration of SO_4^{2-} ions (in mg/L): 15 at both sampling points. These values are within the normal range (<200) and sufficient for plant growth.**

As for bacteriological analyses, the following average concentrations were recorded in CFU/100 mL:

- **For E. coli: 24 (P1) and 52 (P2)**
- **For Enterococcus: 110 (P1) and 18 (P2)**
- **For total coliforms: 220 (P1) and 152 (P2)**

All these concentrations are above the limit value (i.e., 10 CFU/100 mL).

The results of this study indicate that the irrigation water used for market gardening in the Delvaux neighborhood of the Djelo site, in the Ngaliema commune of Kinshasa, is generally of a quality that does not comply with WHO standards for agricultural irrigation water. They are characterized by remarkable acidity, phosphate enrichment, and fecal contamination.

Keywords: *Vegetable Crops, Irrigation Water, Water Quality, Fecal Contamination*

How to Cite: Archal Ngandote Mutemusa; Daniel Mudinga Mudinga; Camille Kande Tshimanga; Patience Ngelinkoto Mpia; John Keyembe Mputu; Francklin Ngwibaba Ansuele (2025) Physicochemical and Bacteriological Quality of Irrigation Water for Market Gardening Crops in the KIMPE District of Delvaux in the Municipality of Ngaliema in Kinshasa. *International Journal of Innovative Science and Research Technology*, 10(8), 2909-2917. https://doi.org/10.38124/ijisrt/25aug1072

I. INTRODUCTION

Humans have always exploited nature to meet their basic needs. They engage in agricultural activities whose impacts can lead to significant socio-environmental and health changes (D. V BASKA TOUSSIA, 2013, p. 41). The physical and chemical quality of irrigation water is an essential parameter for crop yields, maintaining soil productivity, and protecting the environment (LACHACHE A, et al 2022).

Urban and peri-urban agriculture is now recognized as being of vital importance for food security because of its role in supplying cities with agricultural products (K. J. KOUAKOU, 2019, p. 6747). Furthermore, this exploitation is the basis for the degradation of water quality, even though water is essential for life.

The physical, chemical, and bacteriological assessment of irrigation water is essential to guarantee its quality for irrigation.

In the Democratic Republic of Congo (DRC), access to good quality water for agricultural use is catastrophic. Poor water quality is the cause of several waterborne diseases that lead to poor health among the population (lufwila, 2003).

In Kinshasa in general, and the Delvaux district in particular, farmers are often confronted with the problem of the quality of the water used to irrigate their market gardens. It is with this in mind that our research will focus on the Physico-chemical analyses (pH, EC, T, O_2, PO_4^{3-}, NO_3^-, SO_4^{2-}) and bacteriological analyses (E. coli, ENT, and CT) to determine the quality of the water used by market gardeners at the Delvaux site in the municipality of Ngaliema.

II. DESCRIPTION OF THE ENVIRONMENT, MATERIALS, AND METHOD

➢ *Presentation of the KIMPE Neighborhood*

- *Location*

Our work or study presents the KIMPE neighborhood in the municipality of Ngaliema in Kinshasa.

The KIMPE neighborhood is located on an erosive site and has lost a large part of its area due to damage caused by poorly channeled rainwater, which has caused erosion by carrying away and washing away many homes. Some streets and avenues have been cut in two or even into several parts, and others no longer exist, replaced by erosion. This situation has made traffic difficult, as some avenues have become impassable and inaccessible.

- *The KIMPE Neighborhood is Bordered as Follows:*

✓ To the north: we have MASIALA Avenue, which separates the KIMPE and MANENGA neighborhoods

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug1072

- ✓ To the south: we have Artisanale Avenue and Makanda Kabodi, which extend to the BINZA River, which separates us from the DJELO BINZA neighborhood
- ✓ To the east: we have the MATADI road, which separates us from the PUNDA and BANGU neighborhoods
- ✓ To the west: we have the BINZA River, commonly known as MAYI YA ZELO, which separates us from the BUMBA neighborhood.

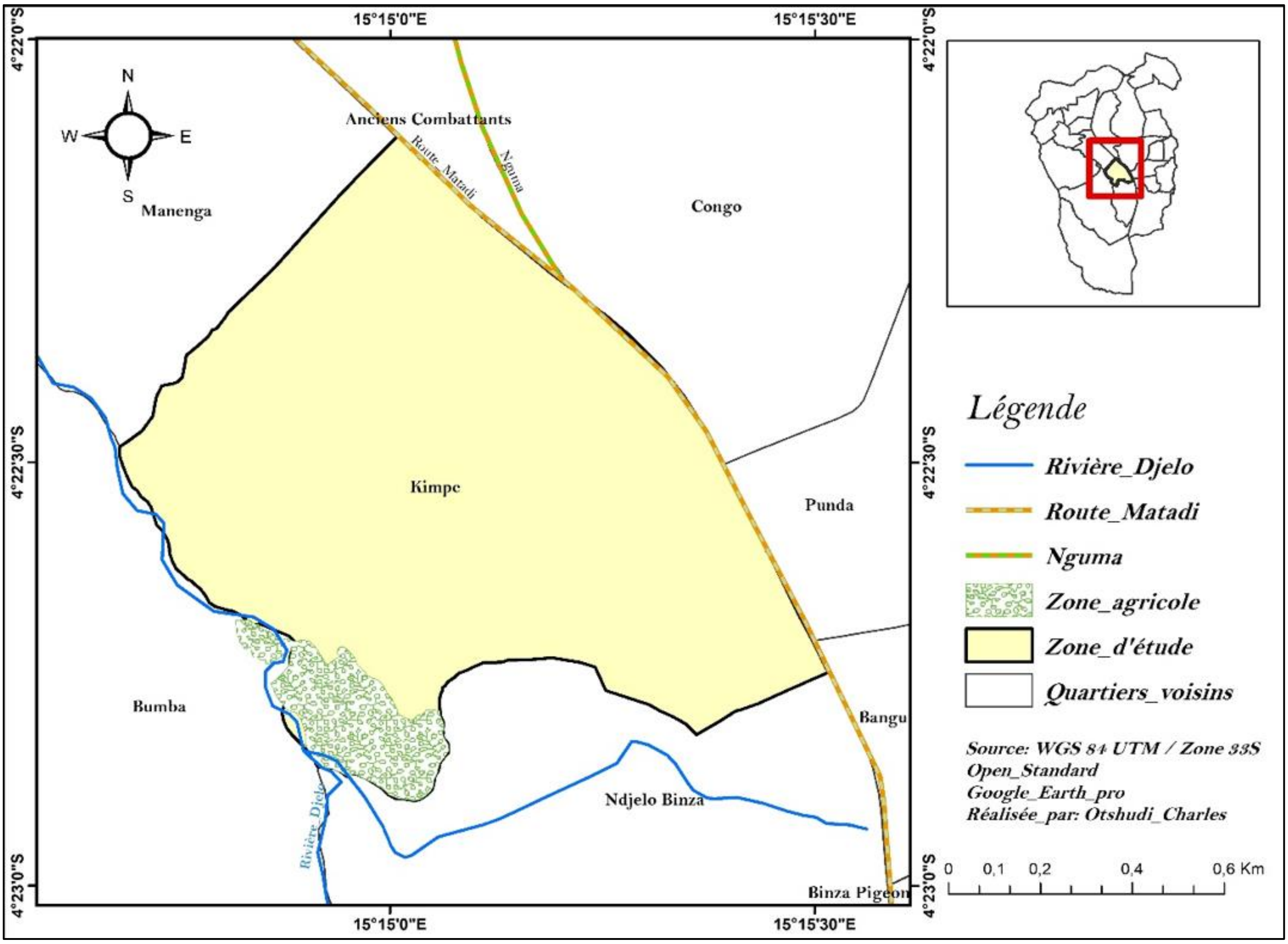

Fig 1 Map of the KIMPE Neighborhood and its Boundaries

III. MATERIALS AND METHODS

The physical and chemical analyses carried out in situ using the WTW multi-parameter probe consisted of measuring several parameters (temperature, pH, electrical conductivity, and dissolved oxygen), while in the laboratory, spectrophotometry was used to measure the concentration of major dissolved ions (nitrates, phosphates, and sulfates).

Bacteriological analyses consisted of identifying and quantifying fecal pollution indicator bacteria, including Escherichia coli, Enterococcus, and total coliforms, using the membrane culture method.

In addition, a summary of the analytical approach used in this research is presented in Figure 2.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug1072

➢ *Summary of the Analytical Approach*

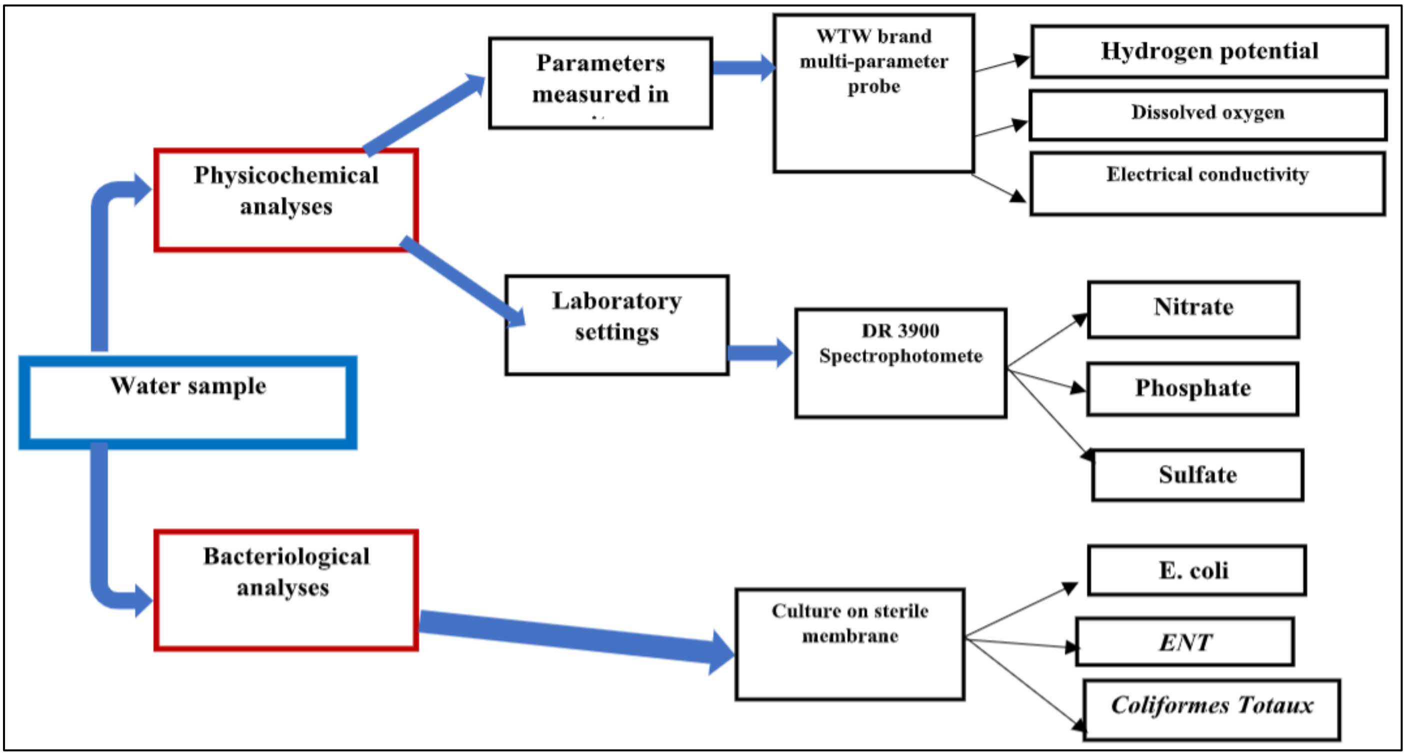

Fig 2 Summary

IV. RESULTS

A. *Physicochemical Characterization*

➢ *Physicochemical Parameters Measured in Situ*

- *Temperature*

The average temperatures (in °C) measured in situ are around 36.6 and 36.7 for irrigation water at sites P1 and P2, respectively. All these values are slightly higher than the WHO standards (35°C) for agricultural irrigation water quality.

These values are close to those found by KAYEMBE et al. (2018) for the waters of the Makelele River.

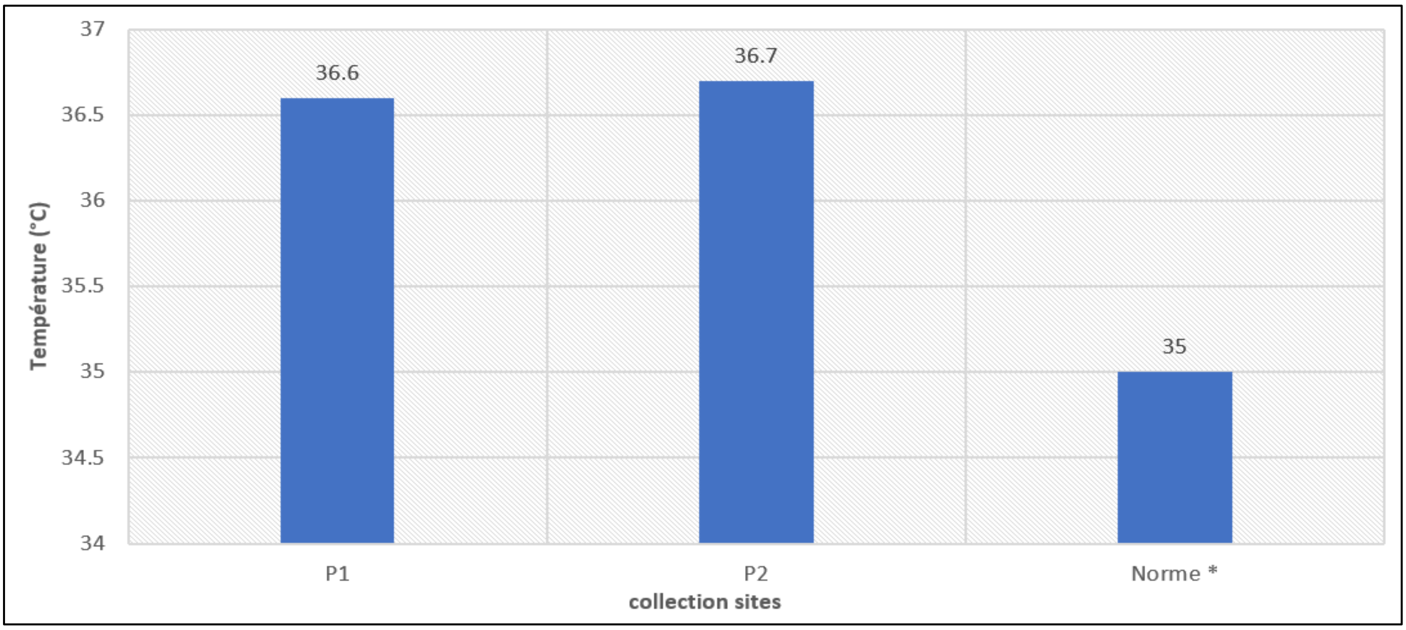

Fig 3 Graphical Representation of Average Temperature Values

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug1072

- *Electrical Conductivity*

The average conductivity values (in µScm-1) recorded are 10 and 12 for sites P1 and P2, respectively.

These values comply with the WHO standard (≤ 12 µScm-1) for agricultural irrigation water. These values are close to those found by (NIENIE et al. 2018) in the waters of Kikwit. They indicate very low mineralization.

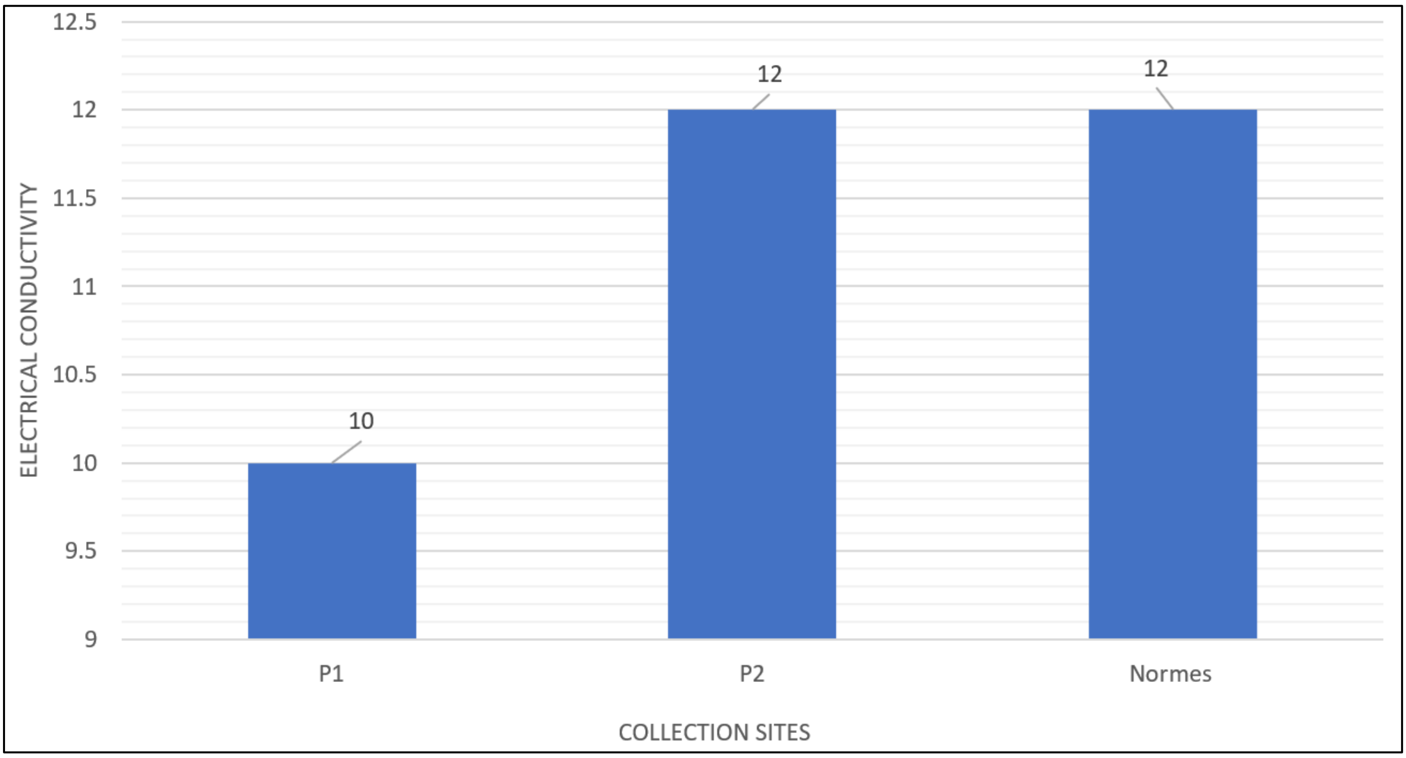

Fig 4 Graphical Representation of Average Electrical Conductivity Values

- *Dissolved Oxygen*

The average dissolved oxygen levels (mg/L) recorded are around 5.3 and 4.5 for P1 and P2 respectively. These values are all below the minimum concentration (≥7 mg/L) set by the WHO for agricultural irrigation water. This shows that these waters are particularly low in dissolved oxygen. This value is similar to that found by (MUMELE et al. 2018) in the rivers of Kenge.

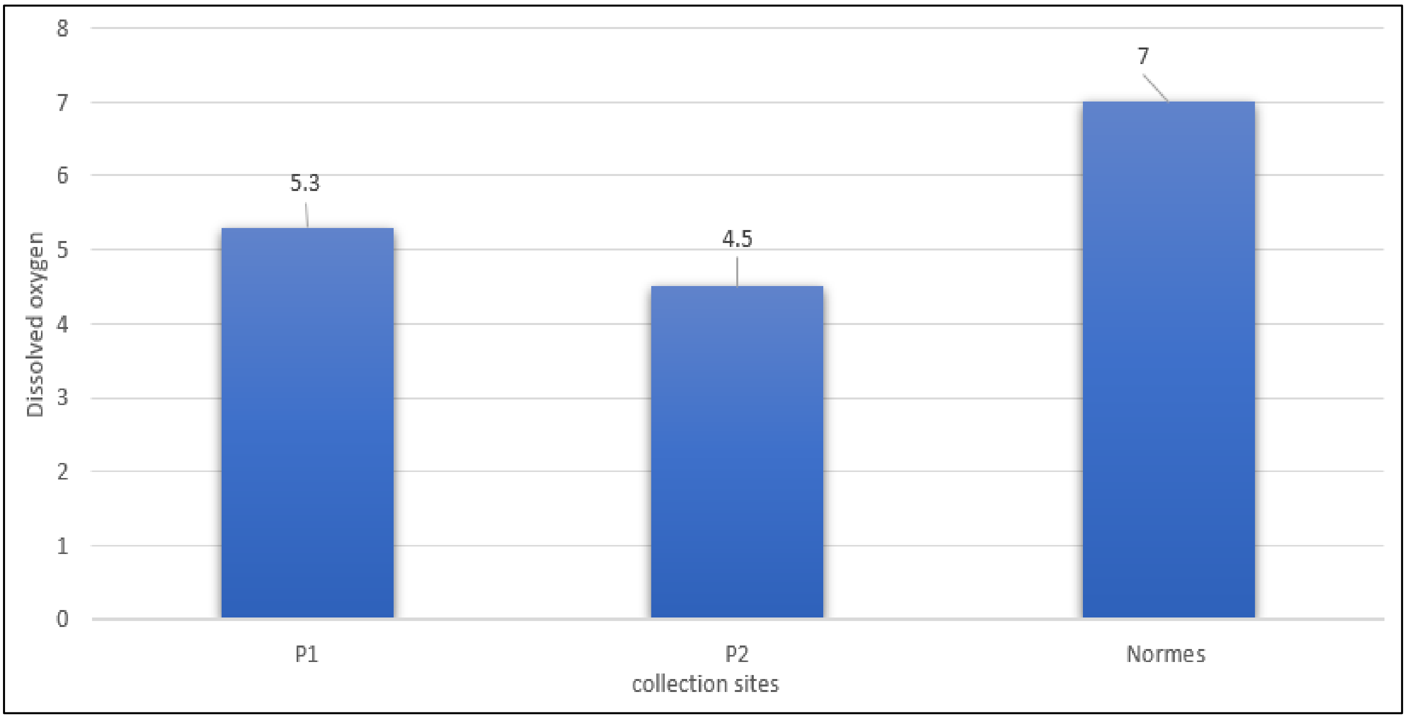

Fig 5 Graphical Representation of Average Dissolved Oxygen Values

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug1072

- *Hydrogen Potential (pH)*

The average pH values recorded are 4.5 and 5.0 for water samples from sites P1 and P2, respectively;

These pH values, which do not comply with the WHO standard (5.5-6.5), indicate the acidic nature of the irrigation water used in our study environment. This increased acidity of the water can cause toxicity due to the accumulation of certain elements, while also causing deficiencies in nutrients such as phosphate and potassium, which also harms microbial life in the soil. These values corroborate with the sandy soil that constitutes the groundwater table of the environment (MBAWALA et al., 2010; KAPEMBO 2019).

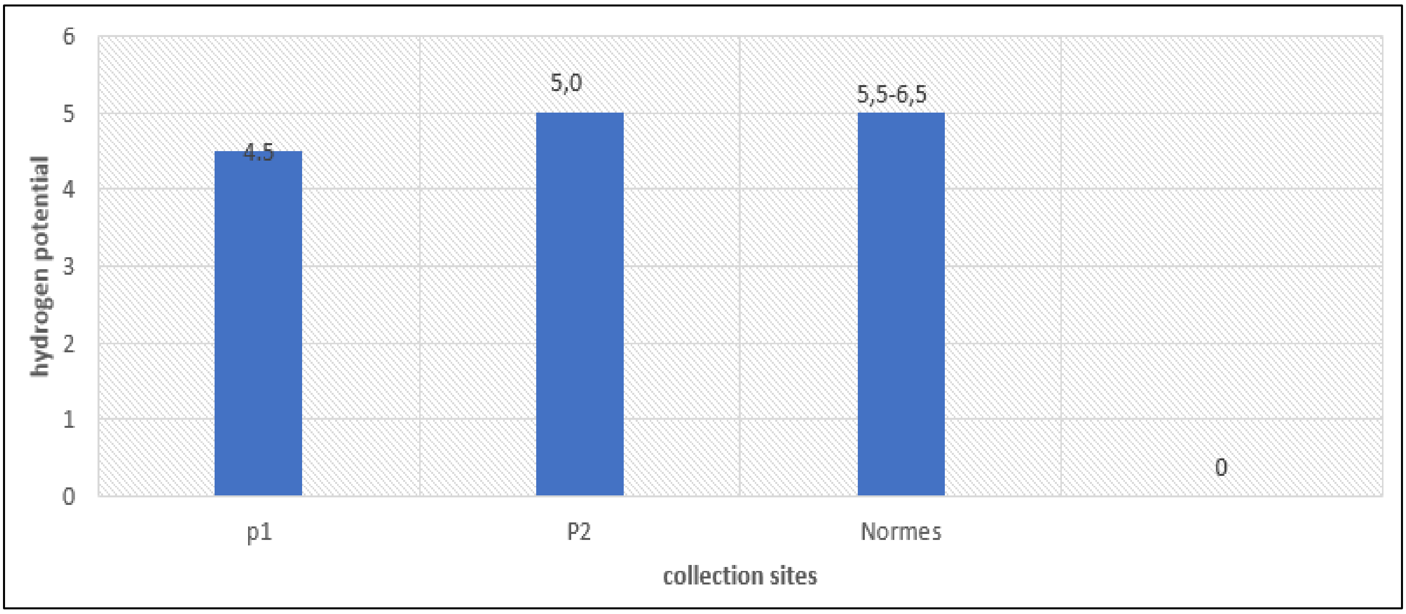

Fig 6 Graphical Representation of Average pH Values

➢ *Laboratory Physical and Chemical Parameters*

- *Djelo River Site*

✓ *Sulfates*

Values of 15 mg/L for site P1 and 15 mg/L for site P2 for sulfates in agricultural irrigation water at the Delvaux site intended for crop irrigation.

These sulfate values in irrigation water can be evaluated from several angles, particularly with regard to their impact on crops and water quality. Plants are generally very tolerant to sulfates. A concentration of 15 mg/L is considered adequate for plant nutrition, as sulfur deficiencies are generally not a concern as long as sulfate levels remain below 250 mg/L. This means that this concentration is sufficient to prevent deficiencies in sulfur, which is essential for the synthesis of amino acids and proteins. (ABDELHAFID, Y et al., 2019).

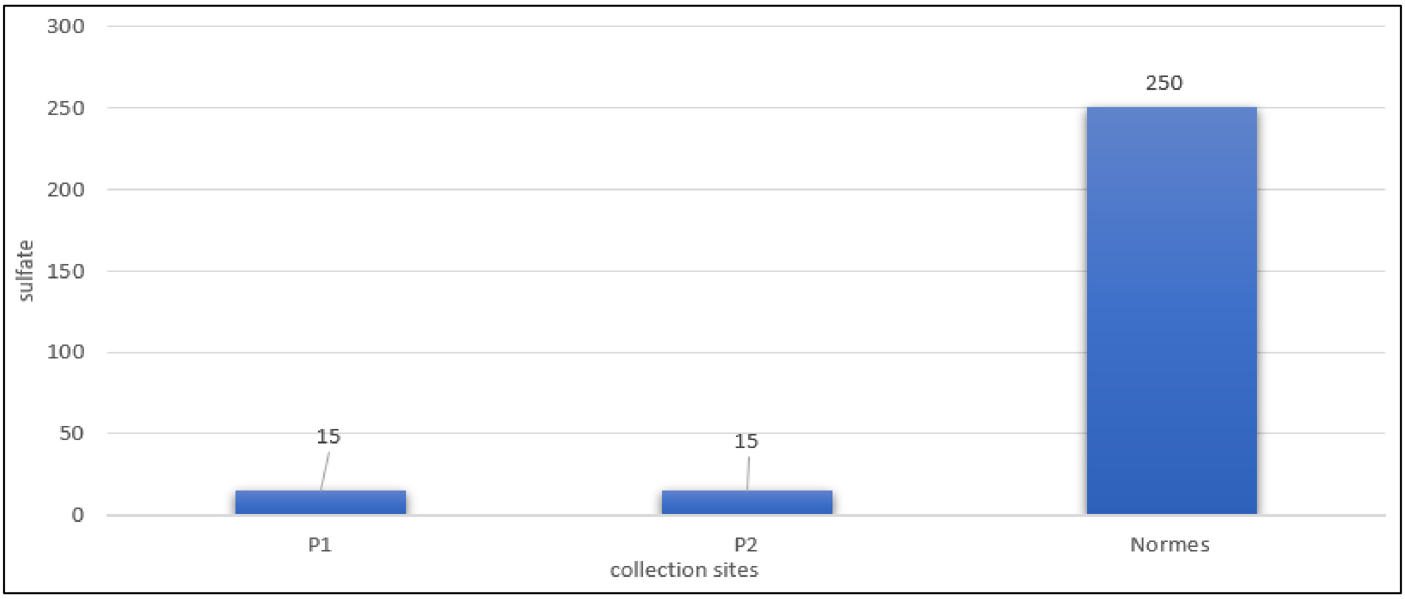

Fig 7 Graphical Representation of Average Concentrations of the Major Ion Sulfate

✓ *Phosphate*

In an agricultural context, the ideal concentration of phosphorus in the soil for optimal growth is often around 1.5 mg/L. Higher levels may indicate over-fertilization or pollution, so the values of 7.04 mg/L at site P1 and 11 mg/L at site P2 found in our sample are significantly higher than the norm. High concentrations of phosphates in water can lead to eutrophication. This occurs when algae proliferate due to an excess of nutrients, which can degrade water quality and harm aquatic ecosystems (NGANDOTE et al, 2024).

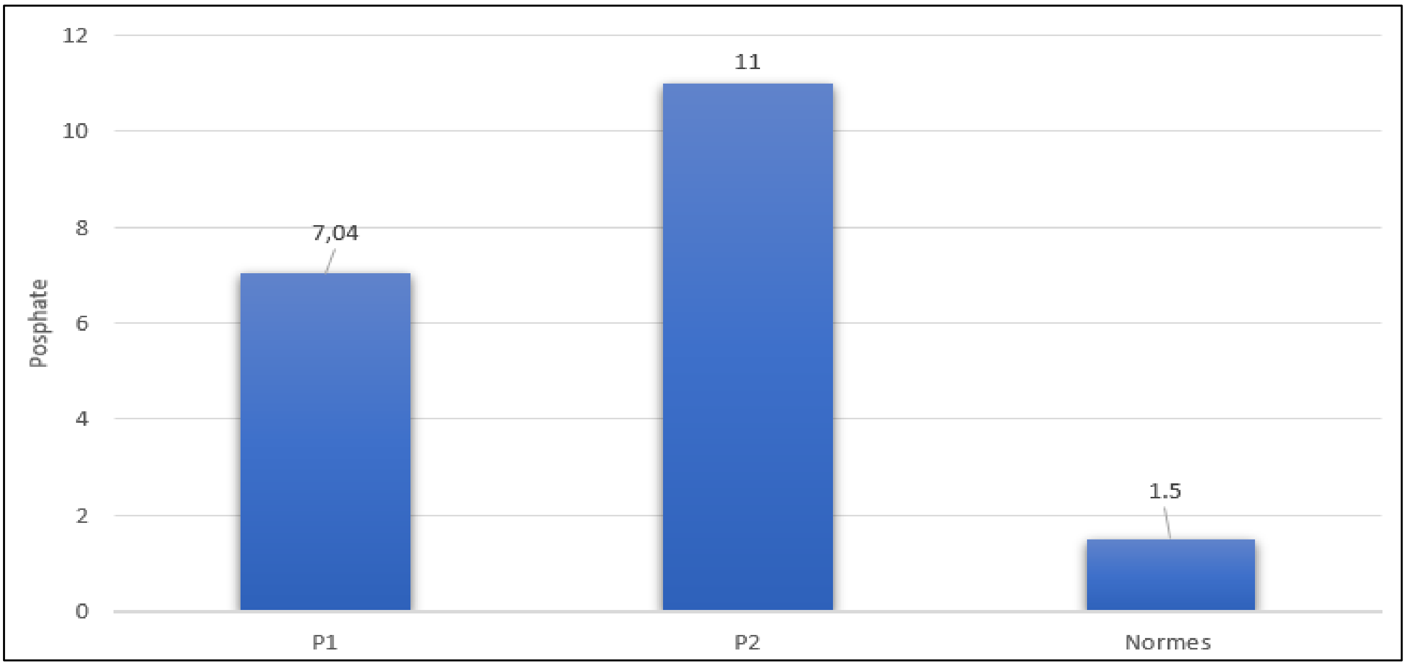

Fig 8 Graphical Representation of Average Concentrations of Phosphate Ions

✓ *Nitrates*

The nitrate concentrations (mg/L) in the irrigation water samples from our study area are 47.61 and 25.17 for sites P1 and P2, respectively. Nitrates are a form of nitrogen that is easily assimilated by plants and essential for their growth. A concentration of 27 mg/L is generally considered adequate to support crop nitrogen requirements, although this may vary depending on the type of plant and stage of growth. A concentration of 27 mg/L of nitrates in the irrigation water of this pond may be beneficial for crops, but it requires careful management to avoid negative environmental impacts. Regular monitoring of nitrate levels and other water quality parameters is recommended to ensure sustainable and responsible irrigation.

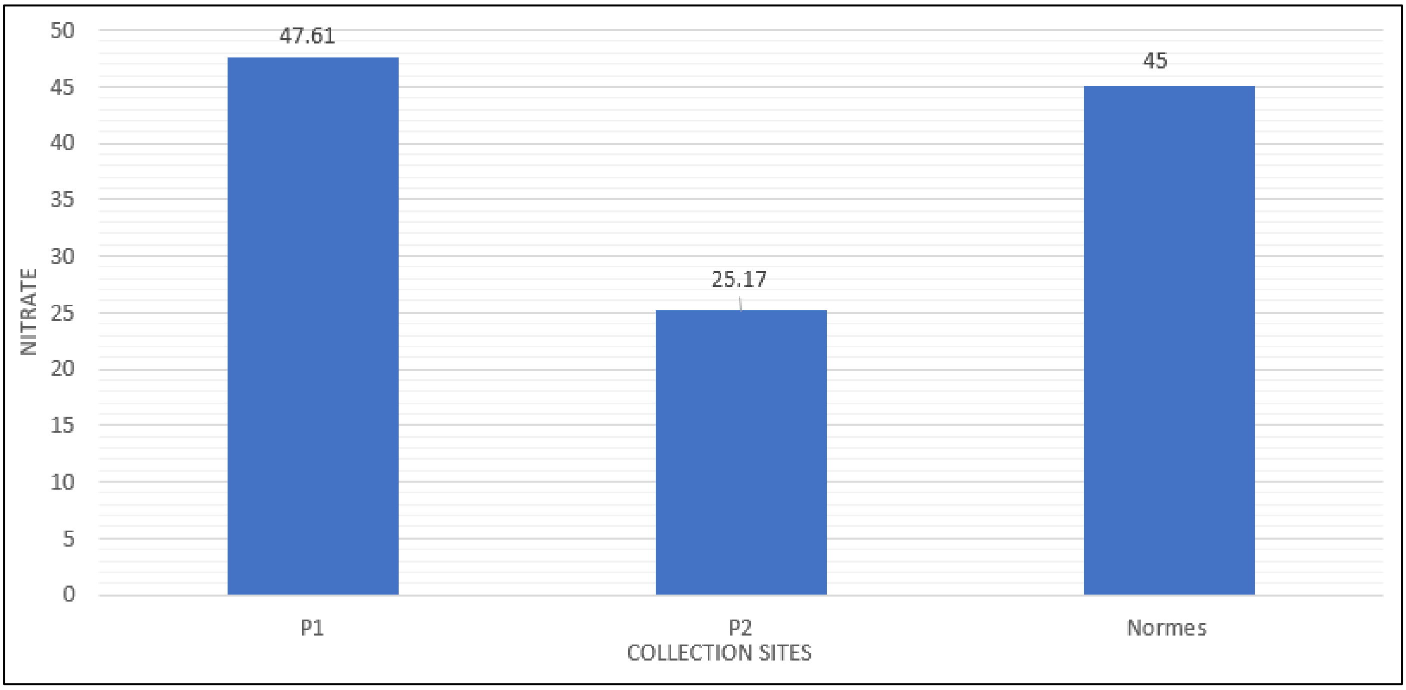

Fig 9 Graphical Representation of Average Nitrate Ion Concentrations

B. Bacteriological Characterization

At both sampling sites, bacteria indicative of fecal pollution were detected.

➢ *For E. Coli*

The average E. coli concentrations in CFU/100 mL are 24 and 52 for sites P1 and P2, respectively. All these values indicate that the irrigation water (agricultural irrigation) from the Djelo River and the pond shows potential recent heavy fecal contamination. The use of this contaminated water for crop irrigation could pose significant risks to public health and food safety (Diariou et al 2024).

Contaminated irrigation water can transmit E. coli to crops, especially during heavy rains that promote runoff and the spread of pathogens.

In addition, consumption of vegetables contaminated with E. coli can lead to serious illnesses, such as gastroenteritis and systemic infections. Some strains of E. coli, such as those that produce shigatoxins, are particularly virulent and can cause severe complications (LACHACHA A. et al 2022).

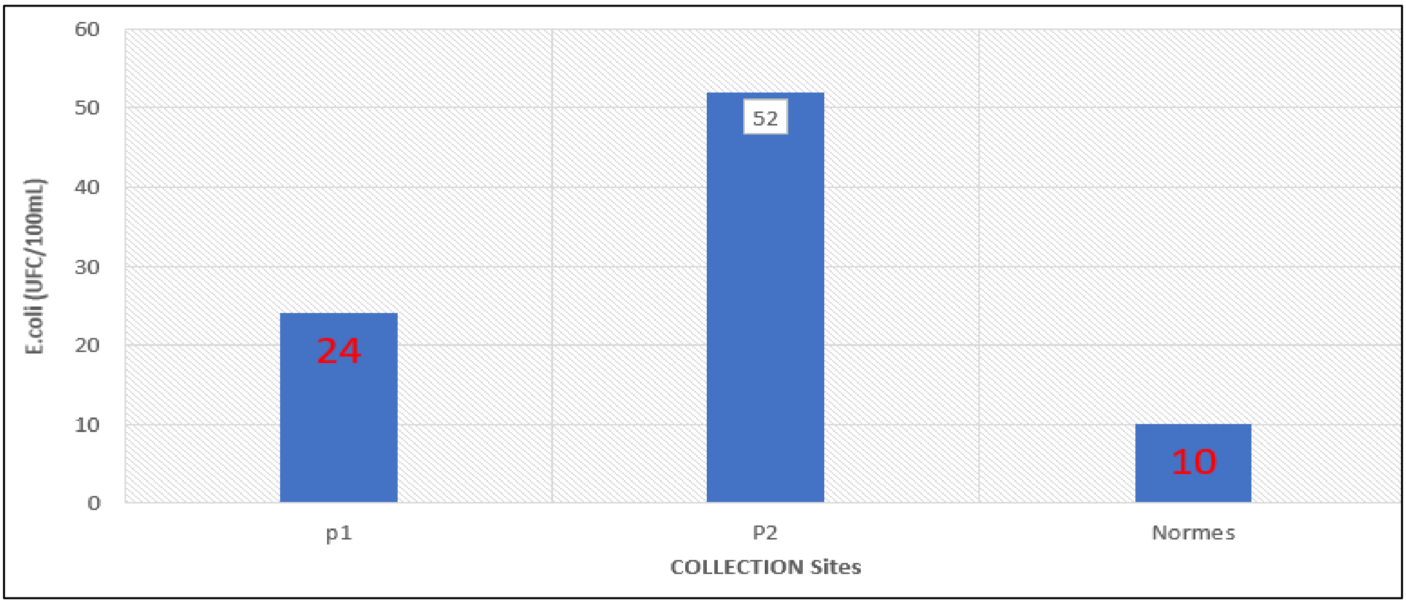

Fig 10 Graphical Representation of Average Concentrations of Escherichia Coli

➢ *For Total Coliforms*

Total coliforms, which include a variety of bacteria, are often present in the environment and may indicate contamination from fecal sources. Although not all are pathogenic, their detection at high levels suggests that the water may also contain other pathogens, thereby increasing the risk to public health. (Diariou et al 2024).

The total coliform concentrations recorded in CFU/100mL are 220 and 152 for P1 and P2, respectively. These concentrations are very concerning for irrigation water.

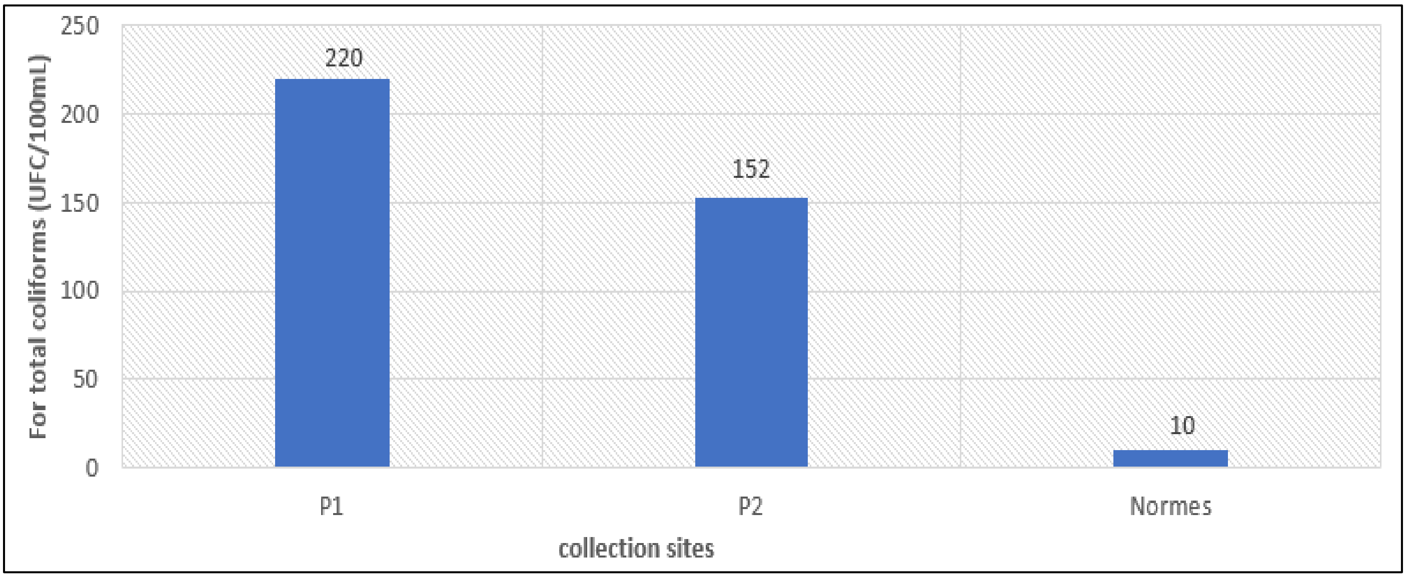

Fig 11 Graphical Representation of Average Total Coliform Concentrations

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug1072

V. CONCLUSION

In conclusion, the assessment of the physical, chemical, and bacteriological quality of water used for agricultural purposes at the Delvaux site in the municipality of Ngaliema revealed worrying results. The study highlighted significant pollution of the water used to irrigate market gardens, characterized by marked acidity, high concentrations of phosphates and nitrates, and significant bacterial contamination by E. coli, enterococci, and total coliforms. These parameters, which often exceed WHO standards, pose a health risk to consumers of these products and compromise soil and crop quality.

The main sources of this pollution appear to be domestic wastewater discharges, runoff of rainwater laden with contaminants, and the lack of irrigation water treatment measures. The impact of this situation on the environment and human health underscores the urgent need for action to improve the management of water resources used in agriculture.

In light of these findings, it is imperative to implement appropriate solutions, including water treatment systems prior to use, awareness programs for farmers on good irrigation practices, and strengthened public policies on solid and liquid waste management. Finally, regular monitoring of water quality in accordance with international standards is essential to ensure sustainable agriculture and protect public health.

REFERENCES

[1]. Abdelhafid, Y., Rechachi, M.Z., Halitim, A. (2019), Geochemical characterization of irrigation water in the Oumache palm grove (Ziban Oasis, southeastern Algeria). Journal of Water Science, 32(1), 69-81. https://doi.org/10.7202 /1059881ar
[2]. Abdoulaye Diallo (2021), Study of irrigation water pollution in the market gardening areas of Bamako, final thesis, University of Bamako – Agricultural and Environmental Sciences, 128P.
[3]. Camuzard j. P., (2005), Soil, a complex environment with limited purifying power, Engref Paris.
[4]. El Hali (2015), The impact of pressurized irrigation on soil and water in the N'fis N4 sector - Oudaia region, Cadi Ayyad University, Faculty of Science and Technology, Marrakech, p23-p26.
[5]. El Hali (2015), The impact of pressurized irrigation on soil and water in the N'fis N4 sector - Oudaia region, Cadi Ayyad University Faculty of Science and Technology, Marrakech.
[6]. F. Bouchemal (2020/2021), Reuse of wastewater in agriculture from the El Oued wastewater treatment plant (step 2), Echahid Hamma Lakhdar El Oued University, pp. 29–31.
[7]. Horning H M. (1973), Role of rational irrigation water management at the farm level. FAO/UNDP regional seminar, Damascus. December 7-13, 1971. pp. 10-21.
[8]. Aouata (2015), Study and development of underground irrigation in Algeria, master's thesis, École Nationale Supérieure d'Hydraulique -Arbaoui Abdallah-, p1.
[9]. Kaboré Alfred (2019), Assessment of the quality of surface water used for irrigation in the Ouagadougou region, final thesis, University of Ouagadougou-Sciences and Technology., 112 p.
[10]. Kouamé Ange-Marie (2018), Quality of water used in irrigated agriculture in the Bouaké region: the case of catchment basins, Houphouët-Boigny University, final thesis, 140 p.
[11]. Mbaya Lufuluabo Christine (2022), Analysis of the quality of groundwater used in agriculture in the Lubumbashi region, final thesis, University of Lubumbashi - Agricultural Sciences, 110 pages.
[12]. Mbuyi Tshibangu Claudine (2020), Comparison of the physical-chemical (pH, COD, etc.) and bacteriological parameters of water used for irrigation in different agricultural sites in Kinshasa, National Pedagogical University (UPN), 135 pages.
[13]. Ngoma Mbala (2018), Analysis of the quality of water intended for agricultural use in urban livestock farming sites, final thesis, University of Kinshasa – Agricultural Sciences, 120 pages
[14]. NGANDOTE ET AL 2025, Assessment of drinking water quality in the city of Kenge in the Democratic Republic of Congo.
[15]. Niyongabo Jean Pierre (2020), assessment of agricultural pollution caused by irrigation water in peri-urban areas, final thesis, University of Burundi, 102 pages