Basrah Journal for Engineering Sciences, Vol. 26, No. 1, (2026), 35-43

Original Article

Journal homepage: https://bjes.edu.iq/bjes
ISSN (Online): 23118385, ISSN (Print): 18146120

Assessment of Wastewater Characteristics and Potential Environmental Impacts: A Case Study at Basrah University/ Engineering College

Samar A. Al-Khafaji [1]*

[1]*Department of Civil Engineering, College of Engineering, University of Basrah, Basrah, Iraq*
E-mail addresses: samar.kareem@uobasrah.edu.iq

Article Info

Article history:
Received: 4 May 2026
Revised: 1 Jun 2026
Accepted: 6 Jun 2026
Published: 28 July 2026

Keywords:
Wastewater treatment, Environmental impact, BOD, Oxygen demand.

https://doi.org/10.33971/bjes.26.1.5

Abstract

Higher education institutions, as one of the powerful actors contributing to pollution and impact on the environment, are not an exception in adoption of sustainable practices. Thus, this study aims to investigate the sewage disposal condition at University of Basrah situated adjacent to the Shatt al-Arab, which is estimated as the artery that feeds water to Basra/southern Iraq regions. The release of non-treated or poorly treated water is a real danger to the aquatic and terrestrial species in Governorate. Consequently, samples were collected for analysis during summer and winter seasons to investigate their physical, chemical and biological characteristics acknowledged as basic criteria for assessment of environmental degradation: DO, TDS, NO_3, NO_2, PO_4, SO_4 pH. Also, measured are BOD and COD. Preliminary studies suggest that wastewater properties differ with its origin and associated practices. These differences emphasize the need for targeted management strategies depending on the origin of wastewater. In order to be able to decide whether the treatment of wastewater and measures for environmental protection are appropriate, this study provides valuable information on the nature of wastewater generated in University of Basrah, College of Engineering. The findings help decision makers in the field of wastewater management for implementing the exact strategies of sustainable sewage treatment and disposal legislations, which consequently saving water resources.

1. Introduction

The problem of water resources shortage in Iraq is, especially, attributed to the losing of water coming from neighbor countries, increasing water demand for different human activities, and climate changes that linking with low rates of rainfall. The southern Iraq city of Basra, which is rapidly urbanizing and industrializes ding, has put the already scarce water resources under greater stress. For this reason, we should control on an optimum utilization of all available water resources by virtually using it. And environment needs protection on the other hand, from pollution by treating wastewater prior to disposal. The control of wastewater represents an important environmental challenge worldwide, especially in developing countries where treatment and monitoring are often insufficient to preserve the natural balance of rivers and ensure safety for local populations. For this, an evaluation of the wastewater is needed, contaminants to be removed should be recognized and applicability for a safe disposal must be assessed. Then the suitable treatment plant needed to choose when the wastewater is hazardous or severely polluted. Some treatment technologies are well-established, including SBR (sequence batch reactor), MBR (membrane bioreactor) and MBBR (moving bed biofilm reactor). There are several stages to wastewater treatment that collectively remove toxins, and hazardous and no-hazardous pollutants. There is currently a trend all over the world, wherever located either in municipality or industry both at large and small scale of installing and operating treatment plants. Various options are provided by water recycling technology. Treatment trains have become pivotal in advanced wastewater reclamation and reuse concepts that are used, for example, in international guidelines on schemes ranging from industrial water production to indirect potable reuse and augmented groundwater recharge [1]-[3]. These techniques are well-known from the other water treatment processes and have been practiced [4], [5].

Diverse wastewater treatment technologies are utilized in recent years. However, constructed wetlands (CWs) technology is proven to be an efficient and low-cost process for successfully reduce the concentrations of different pollutants in wastewater, such as zinc (Zn), lead (Pb), Phosphate (PO_4^{-3}), Nitrate (NO_3^-), Sodium (Na^+), Calcium (Ca^{2+}), Total Dissolved Solids (TDS) [6]. Other used Box-Behnken Design and the response surface methodology to removing hexavalent chromium and electrochemical turbidity from industrial wastewater. The results showed that electrical voltage and analysis time had a strong positive effect on removal efficiency, exceeding 92% [7], [8].

The selected objective of most Waste Water Treatment (WWT) bacteriologists to be in the minimization or elimination of organic material, solids, nutrients, pathogenic microorganisms and other undesirable substances in wastewater. Possible onset of water shortage and the growing need for pure water are some factors contributing to wastewater treatment [9]. University campuses are high-density communities that produce a great amount of domestic and laboratory wastewater. Classrooms, laboratories, and utility facilities all are constantly discharging wastewater. With potential consequences to the environment, limited efforts have been made to systematically evaluate wastewater quality in university campuses within the area. It is difficult to identify the type and amount of pollutants present.

Characterization and identification of pollutants must therefore be first examined. This study adds to the existing body of knowledge on management policies in wastewater from academic institutions. The objective of this study was to assess the physicochemical and biological properties of wastewater from a College of Engineering campus in the University of Basrah, and assess its effects on the environment based on comparison with national and international standard values. This research provides a scientific justification to the proactive strategies of waste water and for the choice of an effective treatment processes to mitigate these urgent environmental issues and further reuse in Basra city or elsewhere.

1.1. Research objectives

The aim of this study is to clarify, in depth, the environmental impact of campus wastewater. The objectives are as follow:

- Campus Wastewater Properties: To assess the chemical and biological characteristics of campus wastewater by conducting a rigorous and exhaustive analysis for understanding its variation on the local eco-system.
- Identification and Quantification of Pollutants: To assess the type and quantity of pollutants in campus wastewater, such as oxygen demand, nutrients, and organic matters, for critically evaluating the water quality, environmental effect, and find the appropriate protection strategies.
- Seasonal Variability Analysis: To compare the impact of some factors that related to the seasonal conditions on the variation of campus wastewater characteristics, such as temperature variations, human activities, and others.
- Environmental Risk Assessment: To examine the effect of campus wastewater on the water quality of the Shatt Al-Arab River and soil quality of the surrounding area for recognizing the environmental risks and suitable waste management solution.
- Strategic Recommendations: To propose practical and implementable wastewater management and treatment solutions that are specifically tailored for university campuses located in ecologically sensitive areas, establishing important guidelines and frameworks for future improvements and sustainability measures to mitigate risks.

1.2. Sources of wastewater in universities and colleges

Universities and colleges are large complexes with diverse activities, which generate different types and quantities of wastewater [7]. These sources can be classified mainly as follows, as shown in Fig. 1.

1. Domestic wastewater: This is the most common type of wastewater and is produced by the daily activities of individuals on campus. It includes:

- Toilets and bathrooms: Water resulting from the use of toilets and urinals.
- Washbasins and showers: Water resulting from washbasins and showers in university residences and sports facilities.
- Kitchens and cafeterias: Water from dishwashing, food preparation, and cleaning of restaurants and cafeterias.
- University housing: Wastewater from student rooms, including bathrooms and kitchenettes.

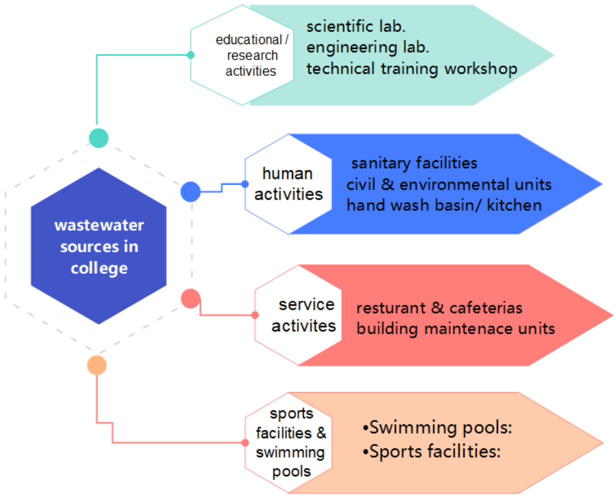

Fig. 1 Sources of wastewater in universities and colleges.

2. Industrial/laboratory wastewater:

This wastewater originates from specialized activities within colleges and institutes, especially those with laboratories or workshops, and often contains hazardous pollutants, such as:

- Scientific laboratories (chemistry, biology, medicine): acids, bases, organic solvents, heavy metals, and biological waste.
- Engineering laboratories (mechanical, civil, chemical): may contain oils, greases, and various metals.
- Technical workshops and art studios: produce water containing dyes, paints, and solvents.
- University hospitals and clinics: Water may contain pharmaceuticals, disinfectants, biological waste, and sometimes radioactive materials.
- Cooling and heating systems (non-contact cooling water): Water may contain chemical additives to prevent corrosion or bacterial growth.

3. Wastewater from sports facilities and swimming pools:

- Swimming pools: Usually contain chlorine and other disinfectants.
- Sports facilities: Water from changing rooms, showers, and toilets in gyms and stadiums.

4. Rainwater and stormwater runoff:

This is not wastewater in the traditional sense, but it collects on the roofs of buildings and roads within the campus and may carry pollutants such as oils, greases, sediments, pesticide residues, and fertilizers. In some older systems (combined sewer systems), it may be mixed with wastewater.

5. Other sources:

Washing of university vehicles and building maintenance.

1.3. An overview of wastewater treatment procedures

The process of removing contaminants from water through physical, chemical, and biological processes is a simplified definition of wastewater treatment before it is safely discharged to the environment or reused for other purposes [11]. This process is repeated in several stages as shown in Fig. 2:

- Preliminary Treatment: This includes protecting mechanical equipment from clogging and damage by using screening and grit removal to remove large particles present in raw wastewater.
- Primary Treatment: Discharging wastewater into settling tanks to allow solids to settle and be separated from the wastewater.
- Secondary Treatment: Pumping wastewater into aerobic or anaerobic biological treatment systems to remove biodegradable organic matter, suspended solids, and nutrients.
- Tertiary Treatment: This is used as an additional stage to remove specific constituents that cannot be removed through previous steps, such as heavy metals, non-degradable solids, and some resistant organic materials.

1.4. The contribution of academic institution

Educational institutions, including universities, are considered a significant source of non-domestic wastewater [12]. While wastewater from residential facilitates on campus often resembles municipal sewage, the effluents generated from hospitals, laboratories, kitchens and other facilities contain a variety of liquid wastes that require specialized treatment. In particular, research laboratories in engineering and science faculties are major source of pollutants not typically found in domestic wastewater, such as heavy metals, toxic chemicals, organic solvents, pharmaceuticals, and even radioactive substances [13].

These pollutants not only pose direct threats to the environment but can also inhibit or disrupt biological process in conventional wastewater treatment plants, thereby reducing treatment efficiency and increasing the risks of harmful discharge. University of Basrah lies at the heart of this water crisis; its wastewater management practice has consequence that extends beyond the immediate environment. They also represent a crucial opportunity to demonstrate leadership and environmental responsibility. The college of engineering, while being a contributor to the problem through laboratory wastewater discharge, is simultaneously a key part of the solution by conducting advanced research in the fields of water treatment [14].

2. Literature review

University campus wastewater has a unique composition, distinguishing it from domestic, municipal, and industrial wastewater, as it contains laboratory chemicals, detergents, and other pollutants. However, there is little research on this topic, as there remains a gap in linking the characteristics of local wastewater to global research. This gap could provide valuable insights into both environmental monitoring and sustainable water management strategies in academic institutions. In Basrah, the elevation of organic load and salinity level of the Shatt Al-Arab River by the discharge of untreated wastewater [15]. In terms of treatment applications, technologies, a sequencing batch reactor (SBR) system was used at the Garmat Ali campus of the University of Basrah and authors achieved high pollutant removal efficiency, confirming the system suitability for localized wastewater management [16]. Eexamined utilization of SBR treatment after (zeolite) coagulation stage, the treatment system successfully improved the wastewater quality to be within the standard limits of Iraqi discharge [17]. Others offer a sustainable treatment system of constructed wetland with Lemna minor that effectively treats greywater from different pollutants [18]. At the city levels; wastewater challenges in Basrah have been widely documented. Basrah raw domestic water sewage was classified as a strong-strength wastewater due to high Biochemical Oxygen Demand (BOD_5), COD and salinity related parameters (TDS, Ec, Cl) with additional issues of oil and grease, while most other parameters remain with acceptable limit [19]. The Hamdan wastewater treatment plant was evaluated, emphasizing the limited efficiency of existing infrastructure [20], while the impacts of untreated sewage on the pollution of Basrah's inland rivers is highlighted, posing risks to aquatic eco-systems and human health [21]. At the national scale, sustainability assessment in [22] and later LJMU researchers (2021) concluded that a MBR represent one of the most sustainable treatment technologies for Iraq. Together, these local studies underline the urgent need for effective wastewater management in higher education institutions, particularly in Basrah province, where environmental pressure such as salinity and water scarcity exacerbate pollution risks.

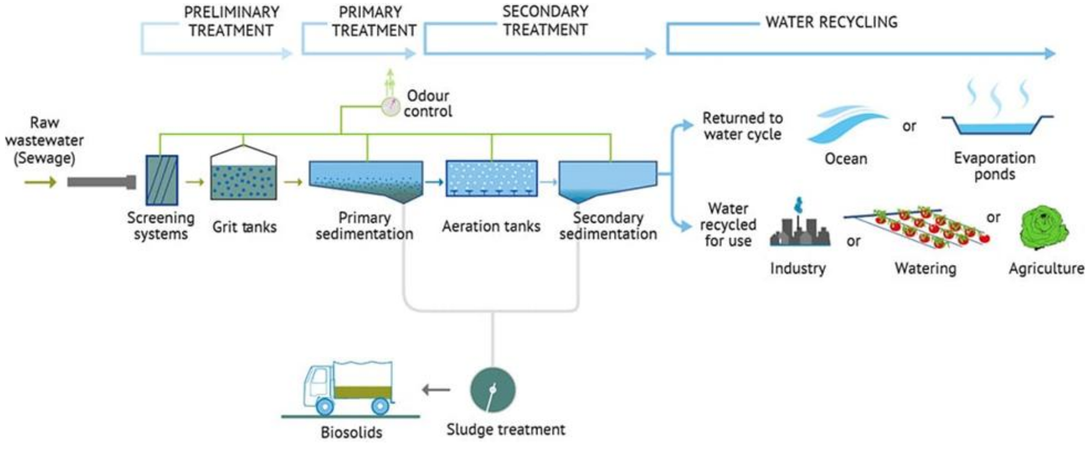

Fig. 2 Process of removing contaminants from water [8].

3. Study area description

The College of Engineering at the University of Basrah is strategically located within Garmat Ali, a well-known suburb of Basra City, right adjacent to the western bank of the Shatt Al-Arab River, a key waterway that supports numerous livelihoods as shown in Fig. 3. The campus serves a substantial and diverse population composed of students, faculty. And support staff, all contributing to wastewater generation through various facilities and amenities such as restrooms, laboratories, cafeterias, and maintenance areas. The position of college of engineering campus for various facilities leads it to discharge wastewater with diverse pollutants (from: human, agriculture, chemicals, and other wastes). These pollutants could extremely harmful to the ecosystems. The continuous discharge of unregulated wastewater could adversely deteriorate the river natural characteristics and/or the nearby soil due to pollutants accumulation, which enhances the risk of environmental degradation. In addition, the residential and agricultural zones that proximity to the campus is possibly influenced by contamination widespread that affect the human health and ecosystem. These challenges encourage the importance of applied a sustainable management of this vital resource of water in this area.

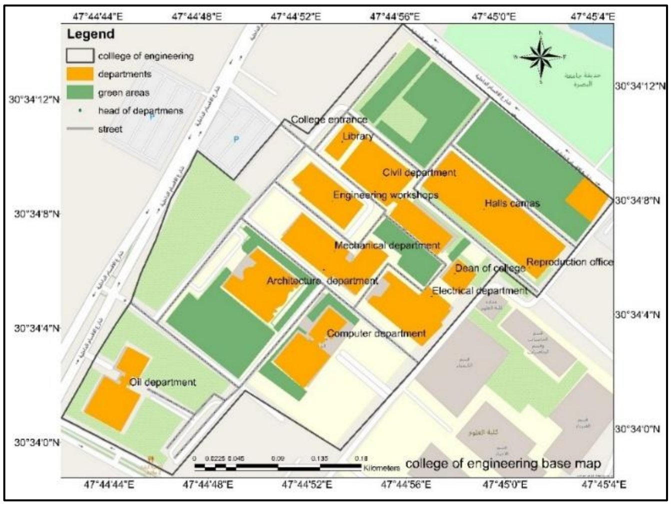

Fig. 3 Location map of the study area at the college of engineering/University of Basrah

4. Materials and methods

4.1. Sampling approach

From the primary discharge manhole samples were collected, located on the engineering college campus. Weekly over two distinct three-month periods: summer and winter. To accurately capture and represent seasonal variations, all samples were collected in sterile glass containers in accordance with strict protocols, and were promptly transported to the sanitary laboratory of the Civil Engineering Department to ensure accurate, strictly adhering to the standards set forth by the American Public Health Association (APHA, 2017), thus underscoring the importance of rigorous scientific methodology in environmental studies and data gathering for comprehensive analysis.

4.2. Analytical methods

To guarantee the integrity and reliability of the obtained results in the context of wastewater quality monitoring using an electrode device to examine Dissolved Oxygen (DO), TDS, Electrical Conductivity (EC), PH, and temperature. As for the DR5000 and DR 1900 devices, the rest of the parameters such as Concentrations of Nitrite (NO_2), NO_3, Orthophosphate (PO_4) and Sulfate (SO_4) were examined as show in Fig. 4. Finally, BOD_5 and COD were methodically determined through using the devices available in the laboratory and the 1200 incubator according to the specifications for each examination. The method and timing of sampling for water quality parameters are crucial for obtaining accurate and representative results; samples were taken and tested according to APHA specification. Closely aligned with APHA (2017) standards and methodologies [23].

4.3. Standards used for comparison

The Iraqi standards (IQS No. 417/2011) [24] and WHO guideline (2017) [22] specifications define permissible limits for pollutants in wastewater that can be legally discharge into natural water bodies. These standards serve as regulatory benchmarks to control the quality of effluents and mitigate their adverse impact on the environment and public health. Table 1 below summarized the key parameters and threshold values established for wastewater discharge in Iraq.

Fig. 4 Laboratory equipment used foe wastewater analysis in college of Engineering/University of Basrah.

Table 1. Iraqi standards [21] and WHO guideline [25].

Parameter	Iraqi standard (IQS 417/2011)	WHO guideline (2017)
pH	6 – 9	6.5 – 8.5
BOD_5 (mg/L)	≤ 40 (for surface water discharge)	Not specified for drinking water (organic pollution indicator)
COD (mg/L)	≤ 100	Not specified for drinking water (organic pollution indicator)
TDS (mg/L)	≤ 1500	Desirable < 600 – Max 1000
Dissolved Oxygen (DO)	≥ 4 (for safe river discharge)	Not specified for drinking water – indicator of source quality
Nitrate (NO_3^-)	≤ 50	≤ 50 mg/L
Nitrite (NO_2^-)	≤ 3	0.2 mg/L (short-term up to 3 mg/L)

5. Results and discussion

This section aims to analyze the results of wastewater quality tests conducted at the College of Engineering at the University of Basrah during the winter and summer seasons, compare them with approved Iraqi wastewater standards, and demonstrate their impact on the environment and society. The data includes key indicators such as nitrogen dioxide (NO_2), nitrogen trioxide (NO_3), phosphorus tetroxide (PO_4), sulfur tetroxide (SO_4), BOD_5, COD, TDS, DO, pH, and temperature. Tables 2 and 3 summarized the measured laboratory parameters of raw sewage of the college.

5.1. Dissolved oxygen

Dissolved oxygen considered an important parameter to assess the health degree of aquatic environment. As presented in Tables 2 and 3, the DO values were very low, and ranging from 0.22 to 0.94 mg/L in winter season and from 0.11 to 0.56 mg/L in summer season, respectively. The mean DO level during winter was 0.62 mg/L comparing with mean DO level of 0.29 mg/L in summer (See Fig. 4). It's obvious that all DO values for both seasons were less than 1 mg/L, reflect the high level of organic matters that consequently depleting the DO level in wastewater. In the river environment, the reduction of DO below 1 mg/L resulted in fish death, low biodiversity, and promotes the presence of anaerobic conditions, which enhances the anaerobic bacteria. These bacteria produce toxic gases (hydrogen sulfide) and disturb the river environment.

Table 2. Physico-chemical parameters of raw domestic sewage water at the college of engineering during Winter.

	Temp. (°C)	pH	DO (mg/l)	TDS (mg/l)	COD (mg/l)	BOD_5 (mg/l)	SO_4 (mg/l)	PO_4 (mg/l)	NO_3 (mg/l)	NO_2 (mg/l)
1	19.3	6.9	0.94	1395	136	55	20.7	2.08	28.5	98.1
2	19.6	7.1	0.92	1065	136	76	38.8	2.11	23.4	91.3
3	18.9	6.7	0.80	1211	86	42	40.2	3.01	28.6	90.4
4	20.7	7.9	0.90	1126	126	63	37.8	2.95	27.8	85.0
5	19.7	6.8	0.82	1234	101	45	37.9	2.85	24.8	102.5
6	18.4	6.5	0.72	1054	108	58	28.7	3.04	20.6	98.7
7	19.6	7.1	0.61	1062	97	42	36.6	4.10	28.4	101.7
8	20.1	7.3	0.23	1102	101	51	40.8	3.82	29.7	112.3
9	20.0	6.4	0.42	1211	124	76	42.9	4.41	25.8	98.2
10	21.1	6.4	0.22	1105	97	62	41.2	4.60	24.2	85.1
11	17.2	7.3	0.54	1097	104	65	32.1	2.30	25.7	65.0
12	18.6	6.9	0.37	1120	87	56	30.8	3.05	30.0	67.8

Table 3. Physico-chemical parameters of raw domestic sewage water at the college of engineering during summer.

	Temp. (°C)	pH	DO mg/l)	TDS (mg/l)	COD (mg/l)	BOD_5 (mg/l)	SO_4 (mg/l)	PO_4 (mg/l)	NO_3 (mg/l)	NO_2 (mg/l)
1	25.9	5.8	0.34	1398	120	59	44.1	3.1	30.0	65.7
2	24.3	6.1	0.22	1286	165	58	37.2	3.0	29.9	78.9
3	26.9	7.8	0.27	2153	109	65	40.6	3.2	28.2	109.5
4	29.4	6.3	0.25	2065	203	71	50.8	4.0	30.0	187.4
5	30.3	7.1	0.19	1897	117	88	68.4	4.1	27.4	99.4
6	28.5	6.0	0.41	1863	167	49	43.8	3.0	26.5	78.5
7	29.6	6.2	0.29	2165	201	66	38.8	2.9	23.7	100.5
8	34.7	5.9	0.33	2216	216	78	32.1	2.8	27.7	99.3
9	37.8	6.3	0.56	1547	199	101	40.5	3.1	19.5	89.2
10	39.9	7.1	0.36	1873	187	87	57.7	4.3	22.8	87.4
11	38.5	6.2	0.19	1066	176	73	40.6	2.2	20.8	78.3
12	39.8	6.8	0.11	1376	99	62	43.2	2.9	27.2	72.6

5.2. Biochemical oxygen demand and chemical oxygen demand

The mean values of BOD_5 in winter and summer seasons were 57.6 mg/L and 71.4 mg/L (Fig. 5), respectively. However, the average COD values in winter and summer were 108.5 mg/L and 163.2 mg/L (Fig. 6), respectively. All the values within both seasons were higher than the standard value. The results of BOD_5 to COD ratio showed a high value confirming the high level of organic contamination in the wastewater sample. This high level of organic load confirmed the serious concerns of pollutants spreading and long-term impact on the ecosystem and health within the study area. This study was designed to protect ecosystems.

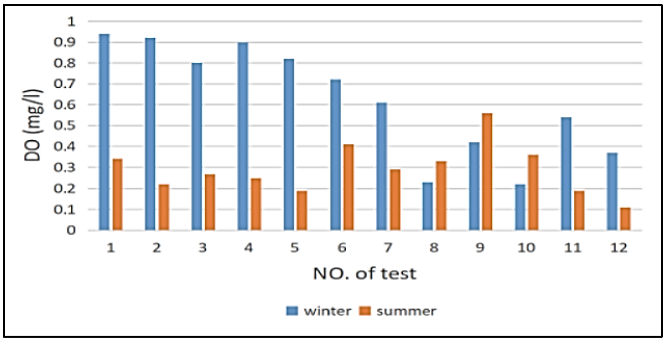

Fig. 5 Seasonal vibration of DO concentration (winter vs. summer).

It indicates high concentrations of both biodegradable and non-biodegradable organic matter, which consumes oxygen and increases environmental pressure on receiving water bodies. The BOD5 (42-76 mg/L in winter and 49-101 mg/L in summer) and COD (86-136 mg/L in winter and up to 216 mg/L in summer) values shown in the results Appendix indicate that the BOD_5 is approximately double the BCD and clearly exceeds Iraqi standards (40 and 100 mg/L, respectively). These levels lead to long-term water quality degradation.

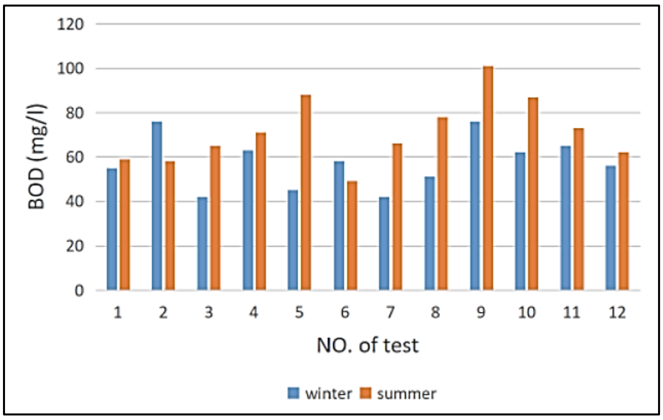

Fig. 6 Seasonal vibration of BOD concentration (winter vs. summer).

5.3. Phosphate (PO_4^{-3})

Results showed concentrations ranging from (2.08–4.60 mg/L) in winter and (2.2–4.3 mg/L) in summer. The levels of PO_4^{-3} consistently exceed the regulatory limit of 3 mg/L.

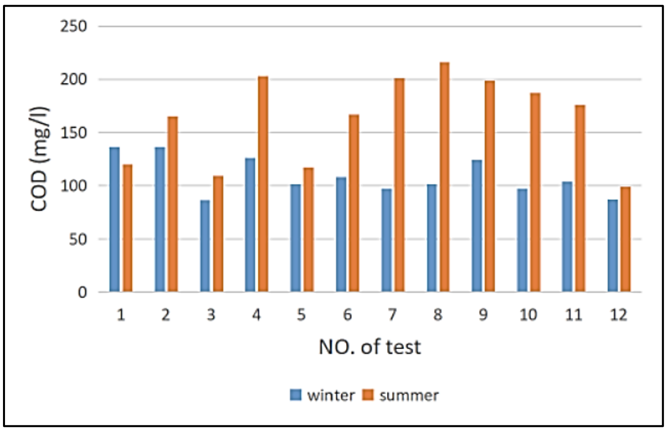

Fig. 7 Seasonal vibration of COD concentration (winter vs. summer).

High PO_4^{-3} levels indicate sources of detergents and laboratories and lead to eutrophication and increased algal growth, which, when decomposed, consumes oxygen and exacerbates oxygen deficiency. Therefore, strict control measures must be implemented to properly manage these discharges. If discharged into surface waters without proper regulation or effective treatment, they are at imminent risk of eutrophication, which directly impacts the aquatic ecosystem. See Fig. 7 below.

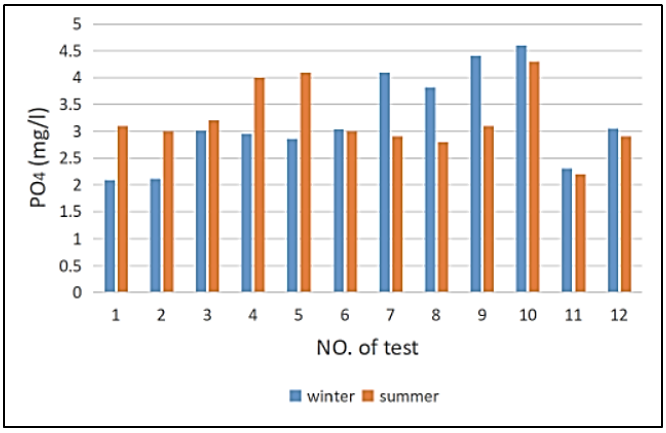

Fig. 8 Seasonal vibration of PO_4 concentration (winter vs. summer).

5.4. Sulfates (SO_4^{-2})

Although they increase in the summer (reaching 68 mg/L) as shown in Fig. 8 due to evaporation and salt concentration in Basra, are within the acceptable limits in Iraqi standards and there is no real or significant danger from these values to the aquatic environment.

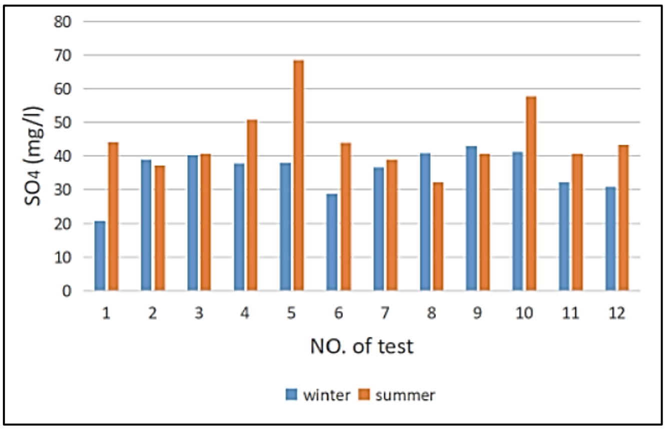

Fig. 9 Seasonal vibration of SO_4^{-2} concentration (winter vs. summer).

5.5. Nitrite (NO_2^-)

Nitrite (NO_2^-) concentrations were higher in summer (up to 187 mg/L) than in winter (65–112 mg/L). These levels are dangerously high due to their high toxicity, reflecting increased microbial activity and incomplete oxidation under low dissolved oxygen conditions. NO_2^- concentrations ranged between 20 and 30 mg/L in both seasons, but remained stable, although still somewhat elevated compared to natural water standards. See Figs. 10 and 11, and Tables 2 and 3.

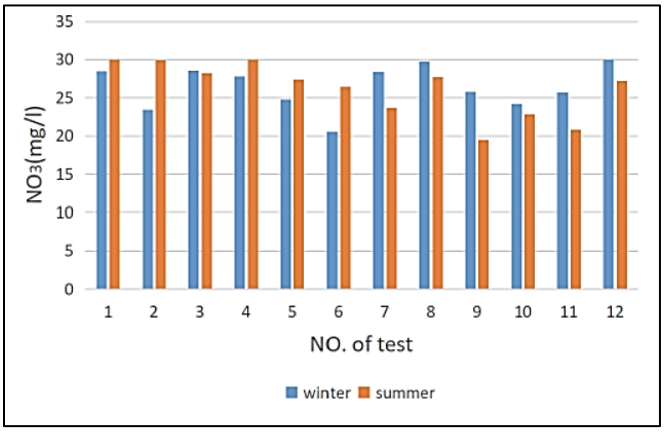

Fig. 10 Seasonal vibration of NO_3^- concentration (winter vs. summer).

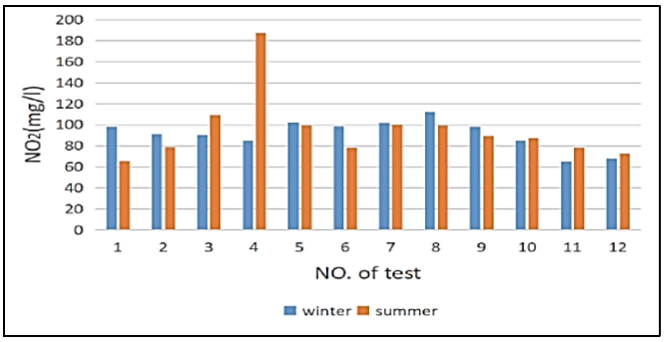

Fig. 11 Seasonal vibration of NO_2^- concentration (winter vs. summer).

5.6. Total dissolved solids (TDS), pH, and temperature

TDS is very high values were recorded in both seasons (1050-1395 mg/L in winter up to 2216 mg/L in summer). Values exceed the World Health Organization limits (1000-1200 mg/L), reflecting severe salinity, especially in summer, reflecting the accumulation of salts, minerals, and dissolved organic matter. This is one of the most significant problems facing Basra Governorate and requires immediate and radical solutions. Notice the Fig. 12.

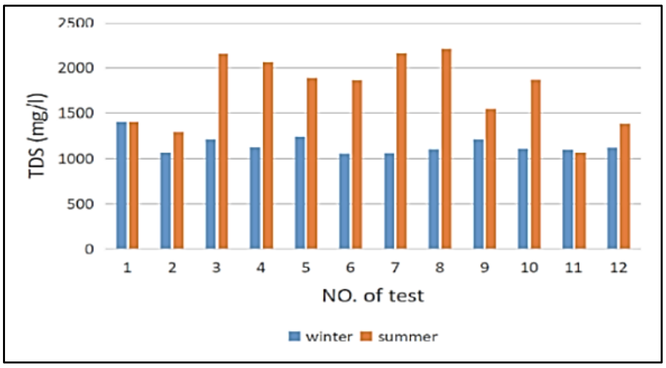

Fig. 12 Seasonal vibration TDS concentration (winter vs. summer).

5.7. PH

Ranged between 6.4–7.9 in winter and 5.8–7.8 in summer, which is mostly within the acceptable range, with a slight tendency toward acidity in summer, as shown in Fig. 13.

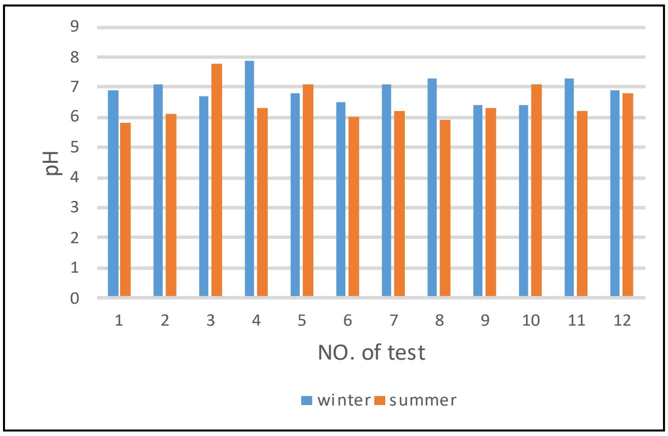

Fig. 13 Seasonal vibration pH (winter vs. summer).

5.8. Temperature

Temperatures vary between 17-21°C in winter versus 25-39°C in summer (note that this is the temperature of the tested samples and not the weather temperature), which explains the acceleration of microbial activity, which exacerbates oxygen consumption and increases the toxicity of some pollutants. Overall, the results confirm that University of Basrah wastewater is highly polluted, worsened in the summer due to heat and evaporation. Nutrient enrichment (NO_3 and PO_4) leads to the risk of eutrophication. Therefore, urgent treatment is needed, preferably through Shatt al-Arab bed reactors SBRs or MBBRs, with laboratory wastewater separation.

The analysis identified significant discrepancies between winter and summer data, and across several key parameters related to wastewater quality, it was observed that all of these factors significantly influence the quality of the wastewater produced, in addition to the resulting impacts on the Shatt al-Arab River ecosystem.

5.8.1. Environmental implication

The persistently low DO levels and rise elevated BOD_5 and COD values, substantial concerns about microbial dynamics in the receiving waters and the viability of aquatic life. Continuous and unregulated discharge into the Shatt Al-Arab River could lead to the emergence of localized anoxic zones, adversely affecting various fish populations and contributing to the within the river system. Heightened PO_4^{-3} and nitrogenous compounds concentrations may encourage the proliferation of harmful algal blooms that threaten local aquatic ecosystems and the overall health of the river system. While NO^3 values continue to remain within acceptable limits, and raise of TDS their ongoing presence could ultimately result in significant saline, further exacerbating concerns regarding the degradation of water quality, particularly in agricultural regions that adjoin the riverbank. This problem is one of the most dangerous issues in Basra Governorate. See Fig. 8 concentrations of different parameters during the times measured.

5.8.2. Institutional role and responsibility

As an educational institution, the University of Basrah has a critical responsibility to educate students and the local community about sustainability, while effectively implementing sustainable practices on campus. By neglecting to adequately treat wastewater on campus, the institution exacerbates accumulated environmental degradation and contributes to the ongoing environmental challenges in the region. This highlights the need to take strict measures to treat wastewater before it is directly discharged into the river. This will help reduce the environmental pollution resulting from this neglect, especially since the university houses several institutions and laboratories where numerous studies are conducted in various fields.

6. Conclusion

The problem of wastewater on campus may seem minor, but it actually poses a major environmental threat to the balance and the resulting environmental impact if neglected and not adequately and properly treated, especially given its proximity to the Shatt Al-Arab River. The analysis revealed significant discrepancies between winter and summer data, and it was observed that all these factors significantly impact the quality of the treated wastewater, in addition to the implications for the Shatt Al-Arab River ecosystem. Continuous and unregulated discharge into the Shatt al-Arab River could lead to the deterioration of the river system. Furthermore, high concentrations of PO_4^{-3} and nitrogen compounds may encourage the proliferation of harmful algae, threatening local aquatic ecosystems and the overall health of the river system. The problem of high TDS levels is one of Basra's most significant challenges, and its continued presence without fundamental solutions exacerbates the issue, increasing concerns about water quality deterioration, particularly in agricultural areas adjacent to the riverbanks. The results of this research highlight significant indicators of pollution, particularly with regard to organic content and nutrients. Therefore, treating wastewater before discharging it into the river has become a necessary and imperative matter to serve as a regional model for sustainable urban and environmental development. Many Recommendations must be used such as Install suitable, cost-effective, and easy-to-maintain treatment units for on-campus treatment, such as sequencing batch reactors (SBRs) or moving-bed biofilm reactors (MBBRs), among other available treatment systems. Reduce pressure on the sewage system by separating rainwater and recycling gray water for irrigation purposes. Develop a seasonal plan for sampling and testing according to specific protocols to assess wastewater quality. Involve faculty members and students in this research on a regular basis, and use the campus as an effective laboratory for sustainable engineering solutions.

Acknowledgments

The authors express their gratitude to the final-year civil engineering students whose laboratory work and sampling efforts substantially contributed to the success of this study.

References

[1] S. A. Al-Khafaji, W. S. Al-Rekabi, and S. A. Abbas, "Evaluation of the Efficiency of the AL-Mauany Hospital Sewage Treatment Plant in Basrah City," Journal of Ecological Engineering, vol. 24, no. 10, pp. 205-213, 2023. https://doi.org/10.12911/22998993/170085

[2] W. S. Al-Rekabi, S. A. Al-Khafaji, A. H. Hasan, and H. Janna, "Effectiveness of Sequencing Batch Biofilm Reactor Technology to Treat Domestic Wastewater in Basrah City," Journal of Ecological Engineering, vol. 22, no. 8, pp. 234-242, 2021. https://doi.org/10.12911/22998993/138999

[3] R. Borkar, M. Gulhane, and A. J. Kotangale, "Moving Bed Biofilm Reactor: A New Perspective in Wastewater Treatment," Journal of Environmental Science, Toxicology and Food Technology, vol. 6, pp. 15-21, 2013. https://doi.org/10.9790/2402-0661521

[4] S. A. Al-Khafaji and W. S. Al-Rekabi, "Evaluation of the Hospital's Wastewater Treatment Plant in Basrah Province," Journal of Physics Conference Series, vol. 1073, no. 1, p. 012033, 2021. https://doi.org/10.1088/1742-6596/1973/1/012033

[5] J. A. Scott and K. L. Smith, "A Bioreactor Coupled to a Membrane to Provide Aeration and Filtration in Ice-Cream Factory Wastewater," Water Research, vol. 31, no. 1, p. 69, 1996. https://doi.org/10.1016/S0043-1354(96)00234-5

[6] R. A. Aylan, D. A. Al-Abbawy, D. A. Yaseen, "Greywater treatment using constructed wetlands modified with biochar and ceramic media," Environmental Technology, vol. 46, Issue 25, pp. 5189-5213, 2025. https://doi.org/10.1080/09593330.2025.2530790

[7] A. S. Khudier, M. J. Mawat, A. S. Dawood, "Evaluation of Electrocoagulation Process for Hexavalent Chromium Removal from Artificial Wastewater Using Box-Behnken Design," IOP Conference Series: Earth and Environmental Science, vol. 1567, no. 1, p. 012049, 2025. https://doi.org/10.1088/1755-1315/1567/1/012049

[8] A. S. Khudier, M. J. Mawat, A. S. Dawood, "Optimizing Electrochemical Turbidity Removal from Water Using Response Surface Methodology," Nigerian Journal of Technological Development, vol. 23, Issue 1, pp. 363-376, 2026. https://doi.org/10.63746/njtd.v23i1.4095

[9] K. M. Shahot and I. Ekhmaj, "Evaluation Biofilm Sewage Treatment Plant," International Journal of Environmental Science and Engineering, vol. 6, no. 2, pp. 250-253, 2012.

[10] R. Karri and M. H. Dehghani, "Wastewater-Sources, Toxicity, and Their Consequences to Human Health," 2021. https://doi.org/10.1016/B978-0-12-824463-0.00001-X

[11] Aquatech, "Wastewater: Our essential guide to wastewater treatment, management & solutions," Aquatech Trade, Jun. 14, 2019. https://www.aquatechtrade.com/news/wastewater/wastewater-essential-guide

[12] R. A. Al-Juboori and M. H. Hussain, "Sources and Characteristics of Wastewater from Educational Institutions," International Journal of Environmental Science and Technology, vol. 16, no. 8, pp. 4667-4678, 2019. https://doi.org/10.1007/s13762-018-1851-x

[13] M. M. Rahman, T. Li, and S. Khan, "Laboratory Wastewater: Composition, Impact and Treatment Approach," Environmental Monitoring and Assessment, vol. 192, no. 2, p. 117, 2020. https://doi.org/10.7537/marslsj160419.08

[14] H. A. Mahmood and Z. J. Hassan, "Academic Research Contributions to Sustainable Wastewater Management in Iraq Universities," Journal of Water and Environment Technology, vol. 19, no. 4, pp. 287-298, 2021. https://doi.org/10.2965/jwet.20-151

[15] S. A. Ali and H. T. Al-Saad, "Impacts of Untreated Wastewater on the Shatt Al-Arab River, Basrah, Iraq," Journal of Environmental Monitoring and Assessment, vol. 191, no. 6, pp. 345-359, 2019. https://doi.org/10.1007/s10661-019-7493-2

[16] M. A. Al-Zuhairi and A. A. Al-Hello, "Performance of sewage treatment of Basrah University Operated Using Sequencing Batch Reactor," AIP Conference Proceedings, vol. 2386, no. 1, p. 050013, 2021. https://doi.org/10.1063/5.0067931

[17] S. A. Al-Ajeeli, "Achieving combined wastewater treatment using zeolite and sequencing batch reactor," Master's thesis, College of Engineering, University of Basrah, Iraq, 2018.

[18] B. Y. Al-Khafaji, M. M. Al-Hejuje, and H. T. Al-Saad, "Improvement efficiency of constructed wetland system for treating pollutants from greywater using Lemna minor," Journal of Ecological Engineering, vol. 21, no. 6, pp. 216–224, 2020. https://doi.org.10.12911/22998993/125502

[19] R. A. Mohammed and A. Mohammed, "Characteristics of raw domestic sewage for Basrah City," Journal of Engineering Science and Technology, pp. 1-8, 2012. https://doi.org/10.1007/s12665-016-5632-1

[20] F. J. M. Al-Imarah and A. K. M. Al-Yaseri, "Characterization and performance of Hamdan wastewater treatment plant in Basrah, Iraq," Journal of Engineering, vol. 22, no. 3, pp. 115-131, 2016. https://doi.org/10.1016/j.jhydrol.2005.07.032

[21] D. N. Al-Khalidi, "Wastewater and its impact on the pollution of internal rivers in Basrah City," Basrah Research Journal for Human Sciences, vol. 43, no. 4, pp. 282-305, 2018. https://doi.org/10.1007/s11209-011-9919-z

[22] A. Al-Zubaydi and N. Al-Ansari, "Sustainability assessment of wastewater treatment technologies in Iraq," Environmental Engineering Journal, vol. 5, no. 2, pp. 55-68, https://doi.org/10.2166/wpt.2021.013

[23] American Public Health Association (APHA), Standard Methods for the Examination of Water and Wastewater, 23rd ed. Washington, DC: APHA, 2017. https://www.standardmethods.org

[24] Central Organization for Standardization and Quality Control (COSQC), "Iraqi standard No. 417: Water and wastewater discharge limits," Republic of Iraq, Ministry of Planning, 2011. https://www.cosqc.gov.iq

[25] World Health Organization (WHO), Guidelines for Drinking-water Quality: Fourth Edition Incorporating the First Addendum. Geneva: WHO Press, 2017.