Recycling and Sustainable Development

www.rsd.tfbor.bg.ac.rs

RSD

Online ISSN 2560-3132
Print ISSN 1820-7480

Quality of Wastewater Effects the Environment: Review

Shuokr Qarani Aziz [a], Enzar Khaleel Mahmood [a], Sazan Mohammed Ali [b, #]

[a] Salahaddin University-Erbil, College of Engineering, Department of Civil Engineering, Erbil, Iraq
[b] Noble Private Institute, Department of Surveying, Erbil-Iraq

A R T I C L E I N F O

Received 15 November 2024
Accepted 26 March 2025

Review article

Keywords:
Environment
Pollution
Treatment
Urbanization
Wastewater quality

A B S T R A C T

The repurposing of treated effluent for agricultural use and to augment potable water supplies is increasingly recognized as a reliable water source. This study investigates the ecological consequences of untreated or insufficiently treated wastewater. The quality of wastewater adversely affects the condition of receiving water bodies. Wastewater is a primary contributor to many water contamination issues. The substandard quality of discharged wastewater leads to the deterioration of the receiving water body. Microorganisms present in wastewater serve numerous advantageous roles within the systems; yet, many are considered significant contributors to different waterborne diseases. Additionally, wastewater must be comprehensively treated before release to mitigate pathophysiological hazards to users and aquatic ecosystems. The release of untreated and insufficiently processed wastewater into water bodies has both immediate and enduring effects on the ecology and human health. The sole approach to mitigate the effects of wastewater on the environment, human health, and public welfare is to rigorously implement water and environmental rules that safeguard both rural and urban regions, while ensuring sufficient wastewater treatment before release. This can be achieved by employing appropriate treatment methods that mitigate risks to public health and the environment. Attaining pristine wastewater discharge into receiving waters necessitates meticulous planning, sufficient and appropriate treatment, regular monitoring, and adherence to regulations.

1. Introduction

A fundamental challenge in the twenty-first century is the scarcity of clean water and sufficient sanitation. Over one-third of accessible freshwater is utilized for agricultural, industrial, and domestic purposes, contributing to the pollution of natural water sources. The contamination of natural water sources by chemical pollutants is a significant issue nowadays. (Huntington, 2021). Accelerated population expansion and urbanization, excessive water consumption, and climate change are pivotal elements in the depletion of freshwater supplies. That results in a deterioration in water quality. (Islam and Karim, 2019). Water is the primary resource that sustains all forms of life and is referred to as the lifeblood of our planet. Given its significance and inadequate wastewater management, the recycling and reuse of water have become essential in our pursuit of water sustainability and environmental conservation among the growing worldwide population (Jyotsana et al., 2023). The quality of wastewater is often assessed

Corresponding author: sazanengs@yahoo.com

doi: 10.5937/ror2501001Q

using physical, chemical, and biological analyses. The concentration of wastewater is contingent upon its source, purpose, and the operations of certain industries.

Wastewaters generated from residential, commercial, educational, and public facilities exhibit distinct properties in comparison to industrial wastewaters. Industrial effluents (For example, effluents generated by the tannery industry, food processing sectors, steel manufacturing facilities, and dairy production plants. etc.) comprise substantial quantities of organic and inorganic elements, as well as heavy metals (Aziz and Ali, 2016). Approximately fifty percent of human-generated wastewater is discharged untreated into rivers or oceans, adversely impacting the ecology and human health. Desertification, compelled migration, famine, diseases, and internal or regional wars may all ensue from a scarcity of clean and reliable drinking water. The Atatürk Dam on the Euphrates River has diminished both the quantity and quality of water in Iraq and northeastern Syria, while facilitating extensive irrigation in Turkey (Ayboga, 2019). The world faces challenges related to wastewater management. This is due to significant industrialization, increased population density, and highly urbanized societies (McCasland et al., 2008). The direct disposal of produced wastewater into the natural environment poses significant risks to human health, wildlife, and ecological systems. Various projects are generating substantial discharges into valleys and depressions, resulting in: 1) contamination of farmers' shallow wells utilized for irrigation and domestic needs; 2) isolated water usage for irrigation via pumps, leading to significant health issues; 3) the formation of swampy areas in the region, which contributes to health complications; 4) the dissemination of odors, resulting in air pollution; 5) degradation of environmental aesthetics; and 6) pollution of surface water sources (Aziz and Fakhrey, 2016). The effluents generated from traditional and contemporary practices constitute major sources of the environmental water pollution burden. This is a significant burden for wastewater management, potentially leading to point source pollution, which substantially increases treatment costs and introduces a diverse array of chemical toxins and microbiological contaminants into water sources (Mahvi et al., 2004). The possible environmental effects of wastewater treatment facilities can be assessed using many analytical approaches, including Environmental Impact Assessment (EIA), Material Flow Analysis (MFA), Life Cycle Assessment (LCA), and Strategic Environmental Assessment (SEA). Utilizing environmental impact assessment approaches would facilitate the design and building of optimal sewage treatment plants. By determining and examining the materials and resources used, as well as the waste discharged into the atmosphere during the life cycle, effects are assessed. Significant energy and resources are needed for the wastewater treatment facility's construction phase, and the energy and chemicals used for operation result in emissions into the air, soil, and water that could contaminate the environment (Dewalkar and Shastri, 2021). The objective of this research is to evaluate the attributes of wastewater discharged into receiving water bodies and their environmental impacts.

2. Wastewater and Sources of Wastewater

Wastewater is characterized as the contaminated water produced from rainwater runoff and human activity, originating from various sources, including home, medical, commercial, and other organizations. Water collected during a storm may be classified as domestic refuse. Water effluents from our regular hygiene practices constitute common sources of wastewater, including bathing, cooking, and cleaning meat, vegetables, and textiles. Domestic wastewater can be effectively treated despite its high pollution levels (Mehtab et al., 2017). The composition of wastewater is always fluctuating and very changeable, making it challenging to establish a definitive definition of the term. Wastewater consists of 99.9% water, with the remaining 0.1% comprising the substances that are eliminated. This 0.1% comprises organic stuff, microbes, and inorganic substances. The wastewater is discharged into several ecosystems, including lakes, ponds, streams, rivers, estuaries, and seas. Wastewater encompasses storm runoff, as deleterious compounds are washed off from highways, parking lots, and rooftops. (Britannica, 2005). Wastewater sources encompass domestic sewage, which consists of spent water from residences and flats, also referred to as sanitary sewage. Industrial sewage refers to wastewater generated from manufacturing or chemical operations, while storm sewage, or stormwater, is runoff from precipitation collected in a network of pipelines or open channels (Owhonka et al., 2021). The primary contributors to water pollution include the disposal of industrial and domestic waste, leaks from water tanks, sewage discharge near water sources, and the release of particulate matter and radioactive waste. (Mehtab et al., 2017). Blackwater is a type of domestic wastewater primarily generated by toilets, dishwashers, and kitchen sinks. Human excrement has been identified in this category of effluent. Consequently, effluent from flush toilets and bidets exacerbates the issue. This water encompasses all toxins that infiltrate our toilets, bathrooms, and washbasin drains. This sort of effluent is free from grey water feces contamination. Non-sanitary fixtures that produce this type of wastewater encompass bathtubs, washing machines, dryers, washbasins, laundry tubs, spa basins, and similar items. This sewage water is devoid of urine or human excrement.

3. Some Characteristics of Different Types of Wastewaters According to Standards

Treated wastewater has various applications, such as irrigation, groundwater replenishment, toilet flushing, and firefighting. Municipal wastewater treatment plants (WWTPs) function as the primary collection points for various harmful substances, pathogenic bacteria, and heavy metals. It gathers wastewater from several origins, including residential sewage, industrial discharge, medical or hospital wastewater, and urban runoff (Soni et al., 2020). Below are features of many types of wastewaters from diverse sources (Aziz and Ali, 2018).

4. Impacts of Wastewater

The rise in sewage volume is attributable to population growth and industrialization, exerting pressure on land and water resources (Murtaza et al., 2010). Sewage, or wastewater consisting of water and suspended solid waste, is discharged from households, buildings, and factories, conveyed through large pipes known as sewers, and subsequently released into the environment (Palamuleni, 2002). A significant environmental issue is the release of wastewater into rivers or other aquatic systems. A segment of the water in wastewater flows evaporates upon release, while the residual untreated wastewater enters the aquatic system. This discharge may result in water contamination, harm to aquatic habitats, and deterioration of downstream water quality.

Addressing this issue is crucial for preventing ecological degradation and safeguarding the health and safety of those reliant on the river for water resources (Aziz et al., 2024).The majority of this sewage remains untreated, infiltrating groundwater and compromising aquifers, or being released into waterways. The disposal of this effluent is contingent upon the region and the availability of natural water in a certain site (Schwarzenbach, 2010). Chemical contaminants originate from stormwater, which transports developing pollutants, pharmaceuticals, fertilizers, and pathogens into lakes, rivers, and oceans designated for recreation and potable use (Petrie, 2015). The sewage disposal system employed in a residence or community affects its health status. In a developing nation such as Nigeria, sewage produced in both rural and urban regions is predominantly released into pit latrines, septic tanks, soakaways, and cesspools inside towns and municipalities (Ajibola, 2013). The table 1 shows the sewage disposal methods used in Nigeria and its negative implications (Fayomi et al., 2019). Septic tanks, pit latrines, sewer systems, earth pits, and excrement in vegetation are prevalent sewage disposal methods in urban regions. Maintaining a secure, sanitary, and hygienic workplace is essential in any enterprise. To do this, the following actions must be undertaken.

- Treating sewage mitigates the contamination of surface and groundwater, hence diminishing the transmission of waterborne diseases such as cholera and dysentery.
- Effective waste disposal mitigates interactions with insects, animals, and humans.
- Properly install and maintain septic tanks to prevent odors in the environment.
- Implement rules and regulations for appropriate waste disposal and inform individuals about the effects on health, the environment, and aquatic ecosystem remediation technology.

In biological treatment technology, microorganisms are utilized to consume wastewater discharge, which directly impacts humans, animals, and the environment adversely (Fayomi et al., 2019). Consequently, many projects are generating substantial runoff into valleys and depressions, resulting in: 1) the contamination of farmers' shallow wells utilized for irrigation and household purposes. 2) For irrigation purposes, the water is utilized in distinct segments via pumps, resulting in significant health issues. 3) The swampy landscape in the region contributes to the emergence of health issues. 4) Odor dispersion, which exacerbates air pollution; 5) affects the visual quality of the environment; and 6) contaminates surface water sources (Aziz and Fakhry 2016). The repercussions of this deterioration may result in reduced dissolved oxygen levels, changes in receiving waters, the discharge of toxic substances, bioaccumulation or biomagnification in aquatic species, and increased nutrient concentrations (Environmental Canada, 1997).

Wastewater is a complex resource, offering both advantages and disadvantages for its use. Wastewater and its nutrient components can be employed for agricultural production, hence providing significant benefits to farming communities and society as a whole. However, the use of wastewater can also have adverse consequences on communities and ecosystems. The widespread use of wastewater containing toxic compounds, along with inadequate funding for treatment, is expected to lead to an increase in wastewater-related diseases and expedited environmental deterioration (Akpor and Muchie, 2011). Although the use of contaminated wastewater effluents for intensive irrigation may lead to delayed adverse effect it adversely

Table 1
Characteristics of different types of wastewaters (Aziz and Ali, 2018)

		Type of Wastewater					
Analysis	**Unit**	**SWW**	**TWW**	**MWW**	**MLL**	**DWW**	**Standards**
Temperature	°C	22.6	18.86	21.86	12.58	21.53	<35*, 40**
pH	-	7.5	10.2	6.78	7.28	7.09	6-9.5*
Turbidity	FTU	174	289	19.77	9.87	504	
EC	μs/cm	1,793.5	12,500	582.6	800	800	
Total salts	mg/L	1,147.8	8,000	372.9	512	512	
Total acidity	mg/L	4,000	0	40	60	60	
Total alkalinity	mg/L	3,300	4,660	206	34.68	260	
Total hardness	mg/L	2,000	2,600	194	480	620	
Chloride	mg/L	800	6,938	30.5	209.9	70	750 **
BOD5	mg/L	400	320	44	273	650	<40*
COD	mg/L	600	1,207	-	-	951	<100
BOD5/COD	-	0.67	0.26	-	-	0.68	
Total solids	mg/L	2,000	13,200	10,000	1,200	1,200	
TSS	mg/L	1,200	2,000	1,800	600	600	60*, 35**
TDS	mg/L	800	11,200	8,200	600	600	

* Iraqi Environmental Standards, Contract No.: W3QR-50-M074, Revision No.: 03, October 2011.
** Environment Protection Agency (EPA), Standards for Effluent Discharge, Regulations, 2003, from Ali, 2017.

affects groundwater quality when nutrients seep through the soil (Mahmood and Maqbool, 2006).

Eutrophication caused by elevated nutrient concentrations results in diminished dissolved oxygen levels. Additional components of wastewater effluents substantially diminish dissolved oxygen (DO) levels. The bacterial breakdown of organic matter in wastewater and the oxidation of its components can substantially reduce the dissolved oxygen levels in the receiving water bodies (Borchardt and Statzner, 1990). The effects may be swift and temporary or may last for months or years due to the accumulation of oxygen-depleting chemicals in sediment layers (Environmental Canada, 1999). Reduced dissolved oxygen levels negatively impact fish life by increasing disease vulnerability, hindering growth, reducing swimming capacity, modifying feeding and migratory behaviors, and, in extreme instances, leading to rapid mortality. Extended reductions in dissolved oxygen concentrations can result in changes in species composition (Environmental Canada, 1997; Owhonka et al., 2021). Insufficiently treated wastewater effluent may cause physical changes to receiving water bodies. All aquatic creatures have certain temperature preferences and tolerance limits. An increase in the average temperature of a water body may result in biological repercussions. Municipal wastewater effluents, possessing higher temperatures than receiving water bodies, act as a source of thermal enhancement (Horner et al., 1994; Akpor and Muchie, 2011). The release of suspended solids into receiving waterways can cause numerous direct and indirect environmental effects, including reduced sunlight penetration (resulting in decreased photosynthesis), physical harm to fish, and toxic consequences from pollutants linked to suspended particles (Horner et al., 1994). An additional environmental consequence of untreated wastewater, sometimes linked to health problems, is the bioaccumulation and biomagnification of contaminants. Bioaccumulation can lead to specific substances, which may exist in low concentrations or be nearly undetectable in water, accumulating at elevated amounts within the tissues of flora and fauna. These chemicals demonstrate stability, display extended chemical durability, and are impervious to breakdown by digestive processes (Environmental Canada, 1997; 1999; Akpor and Muchie, 2011). In rare circumstances, biomagnification can markedly increase the concentrations of particular contaminants as they move up the food chain from prey to predators (Chambers and Mills, 1996). The processes of bioaccumulation and biomagnification make even trace quantities of certain chemicals in wastewater concerning. Such substances include organochlorine pesticides, mercury, and heavy metals. Although several sources of persistent bioaccumulative chemicals exist, such as industrial discharges and atmospheric deposition, municipal wastewater continues to be a primary contributor (Environmental Canada, 1997). The release of harmful substances from wastewater into receiving water bodies negatively impacts terrestrial flora and animals (Akpor and Muchie, 2011). The adverse consequences may be instantaneous or cumulative. The immediate consequences of wastewater effluents generally stem from heightened levels of ammonia and chlorine, significant quantities of oxygen-depleting chemicals, or perilous concentrations of heavy metals and organic contaminants. Cumulative effects arise from the progressive buildup of pollutants in receiving water, becoming apparent only when the specified threshold is

Table 2
Method of Sewage Disposal and its Implication (Fayomi et al., 2019)

Method of Sewage Disposal and its Implication	Negative implication
septic tank	pollution of soil and water environment
sewage flow into stormwater	air pollution, risk of causing flooding
sewage into ponds	stagnant water which is breeding area for vector diseases
direct dumping of untreated wastewater in rivers	Presence of toxic substances in the flood chain, via the plant and animals that feed on it directly or indirectly

surpassed (Akpor and Muchie, 2011). Moreover, Eutrophication of aquatic systems may lead to repercussions of nutrient enrichment. The nutrient-triggered proliferation of aquatic plants in receiving water bodies results in several adverse effects (Akpor and Muchie, 2011; Owhonka et al., 2021):

- Algal aggregates, malodorous emissions, and water discolouration, thereby obstructing recreational and aesthetic utilization of water.
- Proliferation of rooted aquatic vegetation obstructs navigation, aeration, and channel capacity.
- Decomposing macrophytes and phytoplankton accumulate at the bottom of a water body, initiating microbial degradation processes that necessitate oxygen, hence resulting in oxygen depletion.
- Severe oxygen depletion can result in the mortality of beneficial aquatic organisms.
- Siliceous diatoms and filamentous algae can obstruct water treatment plant filters, leading to diminished backwashing efficiency.
- Algal blooms can obscure submerged aquatic plants, so diminishing or ceasing photosynthesis and productivity (McCasland et al., 2008).

Nitrogen and phosphorus are beneficial to aquatic species in small amounts; however, their overabundance results in eutrophication. Eutrophication leads to algal blooms and heightened vegetation in streams, ponds, lakes, reservoirs, estuaries, and coastal shorelines (Eynard et al., 2000; Owhonka et al., 2021). In aquatic ecosystems like lakes, rivers, streams, and coastal waters, massive algal blooms can lead to the death of significant amounts of phytoplankton, potentially asphyxiating the lakebed with organic debris. The breakdown of this material might diminish the dissolved oxygen in the adjacent water, hence threatening the existence of certain fish species and other aquatic animals (Environmental Canada, 2003; Owhonka et al., 2021). Eutrophication generally leads to an increase in specific plant species while diminishing the diversity and population of other plant and animal species in the ecosystem (Environmental Canada, 2003; Owhonka et al., 2021). Concentrations of total ammonia beyond 2 mg/L in the majority of surface waters are harmful to aquatic creatures, however the degree of toxicity differs among species and developmental stages. Studies on ammonia's toxicity to freshwater vegetation demonstrate that levels exceeding 2.4 mg/L hinder photosynthesis (Chambers et al., 1997; WHO, 2006; Owhonka et al., 2021). Nitrate is believed to lead to a decrease in amphibian populations. Negative consequences encompass insufficient larval development, reduced body size, and impaired swimming capability (Environmental Canada, 1999; Akpor and Muchie, 2011; Owhonka et al., 2021).

5. Reuse of Wastewater for Different Purposes

The quality of raw industrial wastewater varies according to its source; for instance, the effluent from dairy, steel, slaughterhouses, tanneries, yeast production, and paper manufacturing differs significantly. Various treatment techniques are necessitated by the specific contaminants present in wastewater, which must be treated to a standard suitable for different categories of irrigation, whether regulated or unrestricted (e.g., forestry, greenbelts, wheat, fruits, vegetables, etc.) (Metcalf and Eddy, 2014; Aziz et al., 2017; Aziz and Ali, 2018). Based on the parameters of BOD5, COD, TSS, DO, pH, turbidity, and NO_3-N for treated EMWW (Erbil municipal wastewater), it is suitable for irrigation of prepared vegetables, maintenance of parking areas, playgrounds, and roadside landscaping within urban environments (WHO, 2006). In light of drought, declining groundwater levels in metropolitan regions, and the utilization of potable water for irrigation, it is advisable to employ treated wastewater for irrigation purposes. Based on the acquired EC and total salts measurements, fresh TWW is unsuitable for irrigation. MWW possesses high quality for irrigation purposes (Amin and Aziz, 2005). Depending on chloride values, all kinds of raw wastewaters (SWW, TWW, MWW, MLL, and DWW) cannot be reused for irrigation purpose (Aziz and Ali, 2018). In metropolitan regions, reclaimed wastewater has primarily been utilized for non-potable purposes (Crook et al., 1992; Odigie, 2014):

- Irrigation of public parks, recreational centers, sporting fields, schoolyards, playing fields, and the margins and central reservations of highways;

- Irrigation of landscaped areas surrounding public, residential, commercial and industrial buildings;
- Courses on Irrigation;
- Ornamental landscapes and decorative water features, such as fountains, reflecting pools and waterfalls;
- Fire protection and
- Toilet and urinal flushing in commercial and industrial buildings.

Furthermore, the drawbacks of urban non-potable reuse often pertain to the substantial expenses associated with the establishment of dual water-distribution systems, operational challenges, and the possible hazard of cross-connection.

Costs must be weighed against the advantages of preserving potable water and ultimately deferring or obviating the necessity for developing additional water supply sources. Potable urban reuse can occur either directly or indirectly.

Indirect potable reuse entails the retention and dilution of reclaimed water, or sometimes raw wastewater, in surface or groundwater prior to its collection and treatment for human use. Unplanned and indirect potable reuse occurs extensively when cities are sourced from areas receiving significant quantities of wastewater in numerous developing nations (Crook et al., 2004; Odigie, 2014).

Typically, only standard treatment methods (coagulation-flocculation clarity, filtration, and disinfection) are employed, resulting in potential long-term health consequences from organic and inorganic trace contaminants that persist in the supplied water. Direct potable reuse occurs when the effluent from a wastewater reclamation facility is integrated into a drinking water distribution system.

The expenses for treatment are substantial due to the necessity for water to comply with severe rules that are becoming progressively more restrictive, both for the number of monitored variables and acceptable contamination thresholds.

Currently, only Windhoek, Namibia is engaged in direct potable reuse under arid conditions. The Goreangab Reclamation Plant, established in 1968, is presently undergoing expansion to process around 14,000 m^3/d by 1997 to enhance water supplies for the city of Windhoek (Van der Merwe et al., 1994; Odigie, 2014).

In specific nations, wastewater is extensively utilized for irrigation; for instance, 67 % of Israel's total effluent, 25 % in India, and 24 % in South Africa is repurposed for irrigation through deliberate planning, but unintentional reuse is significantly higher. Water scarcity is escalating in arid places, such as Africa and South Asia, with notable political ramifications in areas like the Middle East (Murakami, 1995; Odigie, 2014).

Table 3
Reclaimed water standards for unrestricted irrigation

Parameters	**Maximum concentration**
Physical characteristics	
Floating material	Nil
TSS	10.0
pH(SU)	10.0
Chemical characteristics - organic	
BOD5	10.0
Turbidity (NTU)	5.0
FOG	Nil
phenol	0.002
Chemical characteristics	
Al	5.0
As	0.1
Be	0.1
B	0.5
Ba	1.0
Cd	0.01
Cl_2	0.2
Cr	0.1
Co	0.05
Cu	0.4
Cn	0.05
F	1.0
Fe	2.0
Pb	0.1
Ag	0.5
Li	0.07
Mn	0.2
Hg	0.001
Mo	0.01
Ni	0.2
Se	0.02
Va	0.1
Zn	2.0
NO_3	10.0
Cl	100.0
SO_4	600.0
NH_3	5.0
Microbiological characteristic	
TTCC (MPN/100ml)	2.2
Living intestinal nematodes (no/litre)	1.0

6. Conclusions

The rise in wastewater due to population development and industrialization, which exerts pressure on land and water resources, necessitates the utilization of wastewater for suitable applications. Wastewater must be processed to establish a secure environment for humans, animals, and other organisms. The existence of excessive physicochemical characteristics in wastewater that beyond statutory limitations signifies inadequate treatment of the effluent. To adhere to wastewater regulations and standards, wastewater must undergo treatment before to discharge. This can be achieved by implementing appropriate treatment protocols that mitigate threats to public health and the environment.

Meticulous planning, suitable and permissible treatment, consistent monitoring, and proper laws are crucial for ensuring the pristine discharge of wastewater into receiving waterways and the ecosystem. This will enhance scientific decision-making while preserving environmental sustainability and the health of flora and fauna. It is essential to ensure compliance with effluent standards and limitations established by regulatory agencies.

References

Ajibola A. S., Development of analytical methods for the determination of emerging contaminants in the aquatic environment by liquid chromatography-tandem mass spectrometry, (PhD Thesis), University of Athens, Greece, 2013, 99–105,

Akpor O. B., Muchie M., Environmental and public health implications of wastewater quality, African Journal of Biotechnology, 10 (13), 2011, 2379-2387,

Ali S. M., Treatment of Erbil Municipal and Dairy Wastewater Using Activated Carbon Added to Biological Filtration Process, (M.Sc. Thesis), Department of Dams and Water Resources Engineering, College of Engineering, Salahaddin University-Erbil, Iraq, 2017, 87–95,

Amin K. A., Aziz S. Q., Feasibility of Erbil Wastewater Reuse for Irrigation, ZANCO Journal of Pure and Applied Sciences, Salahaddin University-Erbil, 17 (2), 2005, 63-77,

Ayboga E., Policy and Impacts of Dams in the Euphrates and Tigris Basin, In Mesopotamia Water Forum, Sulaymaniyah, Kurdistan Region of Iraq, April 2019, 6-8,

Aziz S. Q., Ali S. M., Performance of Biological Filtration Process for Wastewater Treatment: A review, ZANCO Journal of Pure and Applied Sciences, 28 (2), 2016, 554-563,

Aziz S. Q., Ali, S. M., Characteristics and potential treatment technologies for different kinds of wastewaters, ZANCO Journal of Pure and Applied Sciences, 30, S1, 2018, 122-134,

Aziz S. Q., Fakhrey E. S., The effect of Kawergosk oil refinery wastewater on surrounding water resources, ZANCO Journal of Pure and Applied Sciences, 28 (2), 2016, 656-667,

Aziz S. Q., Mustafa J. S., Mamand B. S., Dawood A. H., Ali S. M., Ameen Z. A. M., Assessment of Sewerage System and Impacts of Wastewater on the Environment and Reusing in Erbil City, Recycling and Sustainable Development, 17, 2024, 63-75,

Aziz S. Q., Slewa E. O., Abdullah W. A., Evaluation of Lesser-Zab River Water for Various Applications, Kirkuk University Journal-Scientific Studies,12 (4), 2017, 1-23,

Borchardt D., Statzner B., Ecological impact of urban stormwater runoff studied in experimental flumes: population loss by drift and availability of refugial space, Aquatic Sciences, 52, 1990, 299-314,

Britannica, Wastewater treatment, Written by Nathanson J. A., Ambulkar A., 2005, https://www.britannica.com/technology/wastewater-treatment, Accessed 11.9.2024.,

Chambers P. A., Allard M., Walker S. L., Marsalek J., Lawrence J., Servos M., Busnarda J., Munger K. S., Adare K., Jefferson C., Kent R. A., Search and menus, Water Quality Research Journal of Canada, 32 (4), 1997, 659-713,

Crook J., Guidelines for Water Reuse, Camp Dresser & McKee, 1992, 254,

Crook J., Water reclamation and reuse criteria: in Advances in Water and Wastewater Treatment, Surampalli R. Y., Tyagi K. D., Eds., American Society of Civil Engineers, 2004, 303-329,

Dewalkar S. V., Shastri S. S., Environmental Impact Assessment of Wastewater Treatment Systems: State of the Art, International Journal of Advance and Innovative Research, 8, (1 (IV)), 2021, 307-314,

Environment Canada 1997, Review of the impacts of municipal wastewater effluents on Canadian waters and human health, Ecosystem Science Directorate, Environmental Conservation Service, Environment Canada, Prepared for the Canadian Council of Ministers of the Environment, 25,

Environmental Canada 1999, State of the Great Lakes 1999, Environmental Canada and the US Environmental Protection Agency, 8,

Environmental Canada 2003, Environmental signals: Canada's national environmental indicator series 2003 / Prepared by the National Indicators and Reporting Office, 78, Available from http://www.ec.gc.ca/soer.ree, Accessed 12.12.2007.,

Eynard F., Mez K., Walther J. L., Risk of cyanobacterial toxins in Riga waters (Latvia), Water Research, 34 (11), 2000, 2979-2988,

Fayomi G. U., Mini S. E., Fayomi O. S. I., Owodolu T., Ayoola A. A., Wusu O., A Mini Review on the Impact of Sewage Disposal on Environment and Ecosystem, IOP Conference Series: Earth and

Environmental Science, 331, International Conference on Energy and Sustainable Environment, 18-20 June 2019, Covenant University, Nigeria, 012040,

Horner R. R., Skupien J. J., Livingston E. H., Shaver H. E., Fundamentals of Urban Runoff Management: Technical and Institutional Issues, Terrence Institute and United States Environmental Protection Agency, Washington, DC, USA, 1994,

Huntington T. G., Evidence for intensification of the global water cycle: Review and synthesis, Journal of Hydrology, 319 (1-4), 2006, 83-95,

Islam S. M. F., Karim Z., World's Demand for Food and Water: The Consequences of Climate Change, In Desalination-Challenges and Opportunities, M. H. D. A., Vatanpour V., Taheri A. H., Eds., IntechOpen, 2019, 1-27,

Jyotsana, M., Maan, N.S., Kumar, A. and Maan, S., 2023. Effects of dietary supplementation of different herbs on relative expression of Toll-like Receptors (TLRs) in poultry. The Indian Journal of Animal Sciences, 93(4), 2023, 323–330.

Maura J., Atreya S., Arshi A., The Treatment of Wastewater, Recycling and Reuse - Past, Present, and in the Future, International Journal of Science and Research (IJSR), 12 (11), 2023, 210-222,

Mahmood S., Maqbool A., Impacts of wastewater irrigation on water quality and on the health of local community in Faisalabad (Pakistan), Pakistan Journal of Water Resources, 10 (2), 2006, 19-22,

Mahvi A. H., Mesdaghinia A. R., Karakani F., Nitrogen removal from wastewater in a continuous flow sequencing batch reactor, Pakistan Journal of Biological Sciences, 7 (11), 2004, 1880-1883,

McCasland M., Trautmann N. M., Porter K. S., Wagenet R. J., Nitrate: Health effects in drinking water, Cornell Cooperative Extension, Ithaca, NY, 1985,

Mehtab H., Muhammad F. M., Asma J., Sidra A., Nayab A., Sharon Z., Hanif J., Water pollution and human health, Environmental Risk Assessment and Remediation, 1 (3), 2017, 16-19,

Metcalf L., Eddy H., Wastewater Engineering: Treatment and Resource Recovery, 5th ed., New York: McGraw-Hill Education, 2014, 2048,

Murakami M., Managing water for peace in the Middle East: Alternative strategies, United Nations University Press, 1995, 309,

Murtaza G., Ghafoor A., Qadir M., Owens G., Aziz M. A., Zia M. H., Saifullah, Disposal and use of sewage on agricultural lands in Pakistan: A review, Pedosphere, 20 (1), 2010, 23-34,

Odigie J.O., Harmful effects of wastewater disposal into water bodies: a case review of the Ikpoba River, Benin city, Nigeria, Tropical Freshwater Biology, 23 (2014) 87 – 101,

Owhonka A., Fubara E. F., Justice O. B., Wastewater Quality-It's Impact on the Environment and Human Physiology: A Review, International Journal of Advance Research and Innovation, 9 (4), 2021, 43-58,

Palamuleni L. G., Effect of sanitation facilities, domestic solid waste disposal and hygiene practices on water quality in Malawi's urban poor areas: a case study of South Lunzu Township in the city of Blantyre, Physics and Chemistry of the Earth, Parts A/B/C, 27 (11-22), 2002, 845-850,

Petrie B., Barden R., Kasprzyk-Hordern B., 2015. A review on emerging contaminants in wastewaters and the environment: current knowledge, understudied areas and recommendations for future monitoring, Water research, 72, 2015, 3-27,

Schwarzenbach R. P., Egli T., Hofstetter T. B., Von Gunten U., Wehrli B., Global water pollution and human health, Annual review of environment and resources, 35, 2010, 109-136,

Soni R., Pal A. K., Tripathi P., Lal J. A., Kesari K., Tripathi V., An overview of nanoscale materials on the removal of wastewater contaminants, Applied water science, 10 (8), 2020, 189,

Van der Merwe B., Peters I., Menge J., Namibia case study. In: Health, Agricultural and Environmental Aspects of Wastewater and Excreta Use, Report of a joint WHO/FAO/UNEP/UNCHS Regional Workshop, Harare, Zimbabwe, 31 October to 4 November, Geneva, Switzerland, 1994, 63,

World Health Organization (WHO), United Nations Environment Programme, WHO Guidelines for the Safe use of Wastewater, Excreta and Greywater, (Volume IV: Excreta and Greywater use in Agriculture), WHO Library Cataloguing-in-Publication Data, 2006, 182, https://www.who.int/publications/i/item/9241546859, Accessed 12.9.2024.

Uticaj kvaliteta otpadnih voda na životnu sredinu: pregled

Shuokr Qarani Aziz [a], Enzar Khaleel Mahmood [a], Sazan Mohammed Ali [b, #]

[a] Salahadin univerzitet u Erbilu, Fakultet inženjerskih nauka, Odsek za građevinarstvo, okrug Kurdistan-Irak
[b] Privatni institut Noble, Odsek za geodeziju, Erbil, Irak

INFORMACIJE O RADU

Primljen 15 novembar 2024
Prihvaćen 26 mart 2025

Pregledni rad

Ključne reči:
Životna sredina
Zagađenje
Tretman
Urbanizacija
Kvalitet otpadnih voda

I Z V O D

Ponovna upotreba prečišćenih otpadnih voda (za poljoprivredu i kao dopuna potrebama za pijaćom vodom) postaje sve popularnija kao pouzdan izvor vode. Ova studija ispituje uticaj neprečišćene ili nedovoljno prečišćene otpadne vode na životnu sredinu. Kvalitet otpadnih voda doprinosi degradaciji recipijenata, pri čemu su otpadne vode jedan od glavnih faktora različitih problema zagađenja voda. Loš kvalitet ispuštenih otpadnih voda doprinosi pogoršanju ekološkog statusa vodotokova. Mikroorganizmi prisutni u otpadnim vodama obavljaju niz korisnih funkcija u ekosistemima, ali mnogi od njih su istovremeno glavni uzročnici različitih bolesti koje se prenose vodom.
Stoga je neophodno temeljno prečišćavanje otpadnih voda pre njihovog ispuštanja, kako bi se izbegli patofiziološki rizici za korisnike i vodene ekosisteme. Ispuštanje sirovih i nedovoljno tretiranih otpadnih voda u vodene tokove ima i trenutne i dugoročne posledice po ekosistem i ljudsko zdravlje. Jedini način da se umanji negativan uticaj otpadnih voda na životnu sredinu, ljudsku fiziologiju i javno zdravlje jeste dosledna primena zakona o zaštiti voda i životne sredine u ruralnim i urbanim sredinama, kao i adekvatan tretman otpadnih voda pre njihovog ispuštanja. Ovo se može postići primenom odgovarajućih tehnika prečišćavanja koje smanjuju rizike po životnu sredinu i zdravlje ljudi. Postizanje ispuštanja otpadnih voda bez zagađenja recipijenata zahteva pažljivo planiranje, odgovarajući tretman, redovno praćenje i poštovanje zakonskih propisa.