ISSN: 2583-7354

International Journal of Emerging Knowledge Studies
Publisher's Home Page: https://www.ijeks.com/
Fully Open Access
Research Paper

Suitability of Hebbal-Nagawara Valley Wastewater for Irrigation in Chickballapur District: An Over View

Shivaraj Kumar M[1], Dr. Lokesh M U[2]
[1]Research Scholar, Department of Social Work, Davanagere University, India.
[2]Head of the Department and Professor, Department of Social Work, Davanagere University, India.
DOI: https://doi.org/10.70333/ijeks-03-12-020
*Corresponding Author: shivarajkumar1234@gmail.com

Article Info: - Received : 26 November 2024 Accepted : 25 December 2024 Published : 30 December 2024

Abstract

Chikkaballapur district is home to numerous artificial lakes originally constructed for agricultural use, domestic water supply, and recreational purposes. However, these lakes are increasingly drying up due to prolonged drought conditions and decreased rainfall. In light of stringent regulations on wastewater discharge and the ongoing decline in freshwater availability, there is an urgent need to explore the expanded utilization and reuse of marginal quality water for irrigation and related purposes. The effectiveness of using marginal quality water for irrigation depends on several factors, including the water's specific chemical properties, the type of crops grown, soil characteristics, and prevailing climatic conditions. While the use of such water presents viable opportunities, it demands more intensive management and continuous monitoring compared to high-quality water sources. This study aims to evaluate the physicochemical and biological characteristics of water from the H-N Valley at various sampling points. Laboratory analyses were conducted to measure parameters such as pH, electrical conductivity, total dissolved solids (TDS), hardness, calcium, magnesium, chloride, biological oxygen demand (BOD), and nitrates. Notably, BOD levels exceeded the maximum permissible limit of 6 mg/L as prescribed by BIS standards. The findings indicate that H-N Valley water is generally suitable for irrigation and groundwater recharge. The study also provides a qualitative assessment and suggests remedial measures to mitigate the ongoing water crisis in Chikkaballapur district.

Keywords: *Chikkaballapur District, H-N Valley Water, Physico-Chemical Parameters, Water Quality Assessment.*

1. INTRODUCTION

Sewage is a form of wastewater produced by communities, characterized by its volume, flow rate, physical composition, and the presence of chemical and hazardous substances. Utilizing sewage water for irrigation is considered an effective strategy for wastewater management. In countries that frequently experience drought, this method not only disposes of wastewater sustainably but also contributes significantly to agricultural productivity and economic stability. According to the Food and Agriculture

Organization **(FAO, 1992)**, domestic wastewater can potentially supply most of the essential nutrients required for agricultural crop production.

A notable example is found in the hyper-arid Fezzan region of Libya, situated in the central Sahara Desert, where groundwater is the only naturally available water source. The increasing demand for water has necessitated the reuse of treated municipal wastewater for irrigating sandy soils **(UNESCO, 1997)**. Such sewage water generally contains permissible levels of essential nutrients like total nitrogen (N), phosphorus (P), and potassium (K), which enhance soil fertility. Studies have shown that irrigation with sewage water leads to a reduction in soil pH and an increase in electrical conductivity (EC). Additionally, there is a marked increase in concentrations of major soil nutrients such as N, P, K, calcium (Ca), magnesium (Mg), and sulfur (S).

In many rural and urban areas of developing countries, the use of sewage and wastewater for irrigation is a widespread and long-standing practice. In these regions, polluted water is often the only reliable source for agricultural use. Small-scale and marginal farmers tend to prefer wastewater—even when alternative water sources are available—due to its high nutrient content, which reduces or even eliminates the need for expensive chemical fertilizers. This traditional practice, common in many arid and semi-arid zones across the globe, remains prevalent due to the absence of organized wastewater treatment infrastructure and the unaffordability of clean freshwater sources.

Despite the advantages, the use of untreated or inadequately treated wastewater poses considerable risks. Chemical pollutants, heavy metals, and microbial contaminants present in sewage can adversely affect human health, crop safety, and environmental quality. There is also the potential for long-term ecological damage, such as soil degradation and groundwater contamination. However, when wastewater irrigation is well-planned and effectively managed, it can offer numerous environmental and economic benefits.

Many wastewater users are landless individuals or small-scale farmers who lease small plots to cultivate high-value, fast-growing crops like vegetables that thrive in nutrient-rich sewage. Across regions in Africa, Asia, and Latin America, these sewage-based agricultural micro-economies support the livelihoods of countless low-income families. Over-regulating or banning such practices without offering viable alternatives may strip these communities of their only source of income.

In contrast, developed nations have made substantial investments in wastewater treatment technologies over the past four to five decades. In countries such as the United States and Canada, most municipal sewage is treated to secondary or even tertiary standards, effectively removing harmful substances before discharge or reuse. These advanced treatment facilities employ a combination of physical, chemical, and biological processes to ensure the safe reuse of wastewater. Nonetheless, untreated or partially treated sewage that flows into natural streams poses a risk to downstream communities and aquatic ecosystems.

Therefore, integrating treated sewage water into agricultural practices—particularly in water-scarce regions—offers a sustainable solution. However, its success depends on rigorous quality control, community awareness, and the implementation of safe reuse protocols to protect both human and environmental health.

2. ADVANTAGES OF WASTEWATER REUSE

- Enhances the economic efficiency of investments made in wastewater disposal and irrigation infrastructure, providing a cost-effective solution for water-scarce regions.
- Reduces the dependency on freshwater sources by offering an alternative and sustainable source for agricultural irrigation.
- Facilitates aquifer recharge through infiltration and natural filtration processes, helping to restore groundwater levels in drought-prone areas.
- Promotes the recycling of nutrients such as nitrogen and phosphorus present in wastewater, thereby decreasing the need for synthetic fertilizers and improving soil properties and fertility.

3. DISADVANTAGES OF WASTEWATER REUSE

- Wastewater is typically generated continuously throughout the year, whereas irrigation needs are largely seasonal, leading to potential mismatches in availability and demand.

- Certain toxic substances present in untreated or inadequately treated wastewater can harm plant growth and may lead to long-term environmental damage, including soil contamination and groundwater pollution.

4. SCOPE OF THE STUDY

- Effective management of water resources has become increasingly challenging in developing countries, where infrastructure development has not kept pace with rapid population growth and urbanization. In this context, the reuse of treated wastewater offers a viable solution to water scarcity, particularly in the agricultural sector.
- This study focuses on the reuse of secondary-treated domestic sewage water from Bangalore City to the drought-affected Chikkaballapur district through the Hebbal-Nagawara Valley Project. The project represents a practical model for transferring treated wastewater over long distances to restore dried-up lakes and support irrigation needs in regions facing acute water shortages.
- The study aims to assess the suitability of this treated wastewater for irrigation, based on detailed analysis of its physicochemical and biological properties, and to provide scientific insights that could guide sustainable water resource planning and policy-making.

5. OBJECTIVES OF THE STUDY

- To analyze the physicochemical and biological characteristics of treated wastewater from the Hebbal-Nagawara Valley at various sampling points.
- To collect water samples from three major lakes in Chikkaballapur district: Kandavara Lake, Mustoor Lake, and Gopalkrishna Lake.
- To evaluate the water quality parameters—such as pH, EC, TDS, hardness, calcium, magnesium, chloride, BOD, and nitrates—of these lakes.
- To visually represent and compare the collected data through appropriate graphs and charts.
- To compare the analyzed results with national and international standards using the Water Quality Index (WQI) for determining suitability for irrigation purposes.

6. NECESSITY OF THE STUDY

Wastewater contains naturally high levels of essential nutrients such as nitrogen, phosphorus, and potassium. This nutrient richness significantly reduces, and in some cases eliminates, the need for expensive chemical fertilizers. As a result, it helps lower the input costs for agriculture, particularly benefiting small-scale and marginal farmers in economically disadvantaged communities.

Utilizing wastewater for irrigating crops and farmland is a sustainable and environmentally responsible practice. It promotes the conservation of freshwater resources and minimizes water wastage, making it a viable solution in regions facing acute water scarcity.

Wastewater irrigation enhances the quality of crops and pastures by providing a reliable and consistent water source, especially during periods of water stress. Water shortages can drastically affect crop growth and quality, whereas access to wastewater for irrigation ensures improved agricultural output.

Regular access to wastewater enables farmers to expand their cultivation by growing more crops and pastures even in dry or otherwise uncultivable areas. It also extends the growing season, allowing for multiple cropping cycles throughout the year. This extended availability of water acts as a form of agricultural insurance against the uncertainties of seasonal rainfall and recurring droughts.

7. LITERATURE REVIEW

Poojashri R. Naik, Sankalpasri S. S., Bhavya B. S., & Reshma T. V. (2019) conducted a study titled "Water Quality Assessment of Hebbal Lake in Bangalore City" published in the International Journal of Innovative Technology and Exploring Engineering (IJITEE). The study highlights that Bangalore hosts several artificial lakes originally constructed for domestic water supply, industrial use, agriculture, and recreational purposes. However, due to rapid population growth, urbanization, and increased pollution, the water quality of these lakes is deteriorating steadily.

C. V. Varun, V. Sampath Kumar, & M. Pallavi (2019), in their study "Studies of Water Quality Assessment of Hebbal Lake" published in IJESC, describe the geographical and environmental characteristics of Hebbal Lake. The lake, which is not fed by any river, depends on catchment runoff and drainage. While many lakes in the Bangalore region were managed by the Public Works Department, Hebbal Lake is under the jurisdiction of the Karnataka State Forest Department. Their study emphasizes the need for continued monitoring to ensure its ecological balance.

K. K. Tanji (2017), in the article "Irrigation with Marginal Quality Waters: Issues" from the Journal of Irrigation and Drainage Engineering, discusses the increasing need to reuse marginal quality water due to strict wastewater discharge regulations and declining freshwater resources. The paper explores various sources of such water, including treated municipal wastewater, effluents from food processing units, lagoon water from animal farms, and saline irrigation drainage water. It highlights both the challenges and potential benefits of using these resources for crop irrigation and agroforestry systems.

Ramesh N. & Krishnaiah S. (2013), in their case study titled "Scenario of Water Bodies (Lakes) in Urban Areas – A Case Study on Bellandur Lake of Bangalore Metropolitan City", published in the IOSR Journal of Mechanical and Civil Engineering, examine the impact of urbanization on water bodies. The authors argue that India faces a severe water scarcity crisis, which has been exacerbated by population growth, industrialization, and urban sprawl. The study underscores the deterioration of surface water quality and the shrinking availability of potable water due to increased pollution.

Maria Fernanda Jaramillo & Ines Restrepo (2017), in their article "Wastewater Reuse in Agriculture: A Review about its Limitations and Benefits", provide a comprehensive review of how wastewater reuse affects soil characteristics, particularly texture, biomass, and microbial communities. While treated wastewater supports environmental sustainability and improves agricultural productivity, the authors stress the importance of evaluating microbiological risks, especially helminth concentrations, before implementing large-scale reuse practices.

Mohamed Elsayed Gabr, Hoda Ussa, & Ehab Fattouh (2020), in their study "Groundwater Quality Evaluation for Drinking and Irrigation Uses in Dayrout City, Upper Egypt" published by Elsevier, analyze groundwater using water quality indices (WQI), Gibbs diagrams, and Piper plots. Data from 30 boreholes were analyzed over a period from January to August 2016. The findings revealed significant seasonal fluctuations (approximately 2.3 meters) in groundwater levels and low-quality drinking water in urban areas west of the Ibrahimmia Canal, though the water was considered moderately suitable for irrigation.

Anupam Khajuria (2000.), in the paper "Application on Reuse of Wastewater to Enhance Irrigation Purposes", highlights the challenges of water resource management in developing countries like India. The reuse of wastewater is proposed as a key strategy to address water shortages. The author discusses the potential for innovation and policy development in the safe reuse of wastewater and emphasizes the role of modern technologies and public awareness in promoting sustainable irrigation practices.

8. DETAILS OF THE STUDY AREA

A lake is a naturally or artificially formed inland water body, typically larger and deeper than ponds, and surrounded by land. Lakes play a vital role in regional ecosystems and water management, particularly in areas prone to drought. One such region is the Chikkaballapur district in Karnataka, India, which has experienced persistent water scarcity over the years due to erratic rainfall, overexploitation of groundwater, and inadequate water resource management.

Kandavara Lake, once the largest lake in Chikkaballapur, covered approximately 330 acres and served as a significant source of water for agriculture and local needs. However, over the past 25 years, the lake has dried up completely and is now overrun with weeds and encroachments, reflecting the broader environmental degradation in the region.

To address this water crisis, the Government of Karnataka has initiated a rejuvenation program under the second phase of the Hebbal-Nagawara Valley Project. This ambitious project aims to revive 44 irrigation tanks across the Chikkaballapur district by supplying them with 210 million liters per day (MLD) of treated sewage water from Bangalore's

Hebbal and Nagawara sewage treatment plants. The rejuvenation initiative is expected to deliver 2.7 TMCFT (thousand million cubic feet) of water annually. The overarching goal is to restore dried-up water bodies and enhance groundwater recharge, thereby supporting sustainable agriculture and improving the overall water availability in the district.

Wastewater, also referred to as used or grey water, is any water that has been contaminated through human activities. This includes water from domestic, industrial, commercial, and agricultural sources, as well as surface runoff, stormwater, and sewage inflows. Due to increasingly strict regulations on wastewater discharge and the declining availability of freshwater, there is a growing need to explore the reuse of marginal-quality water—such as treated wastewater—for irrigation and other non-potable applications.

The long-term efficiency of irrigation using marginal-quality water depends on various factors. These include the chemical and biological composition of the water, the type of crops grown, the soil characteristics, and the local climatic conditions. By implementing advanced sewage treatment and distribution infrastructure, the Hebbal-Nagawara Valley Project demonstrates a model for integrating wastewater reuse into broader water resource planning. This project highlights how treated wastewater can be a reliable and sustainable water source in regions facing acute water shortages, ultimately supporting ecological restoration and agricultural resilience in Chikkaballapur and similar drought-prone districts.

Fig-1: Kandavara lake before filling with H-N valley water

Fig-2: Kandavara lake after filling with H-N valley water

9. METHODOLOGY

9.1. Selection of the Study Area

The lakes Kandavara Kere, Gopal Krishna Kere, and Mustoor Kere were selected as the primary study sites for assessing and analyzing water quality in the Chikkaballapur district. These lakes collectively cover an area of approximately 150 acres and play a significant role in supporting local agriculture and groundwater recharge.

The selected lakes receive water primarily from seasonal rainfall that drains from surrounding catchment areas, including the Nandi Valley region, Sankadagiri mountain ranges, and various rural and urban localities within Chikkaballapur town. In addition to natural runoff, these lakes are also replenished with treated wastewater from the Hebbal-Nagawara Valley Project, which channels secondary-treated domestic sewage water from Bangalore to the drought-prone areas of Chikkaballapur.

The combination of natural catchment inflows and treated wastewater makes these lakes ideal for studying the impacts of mixed-source water inputs on overall water quality, suitability for irrigation, and environmental sustainability.

Fig-3: Kandavara Lake

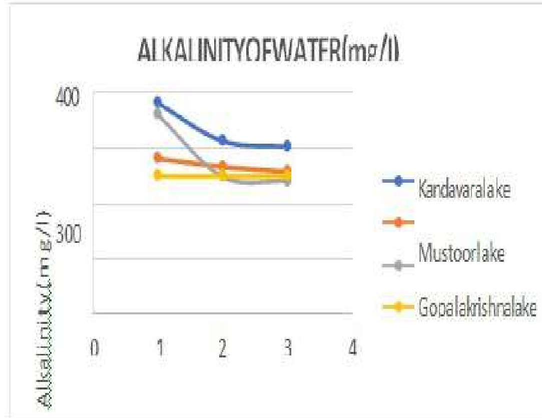
ISSN: 2583-7354

Fig-4: Mustoor Lake

Fig-5: Gopal Krishna Lake

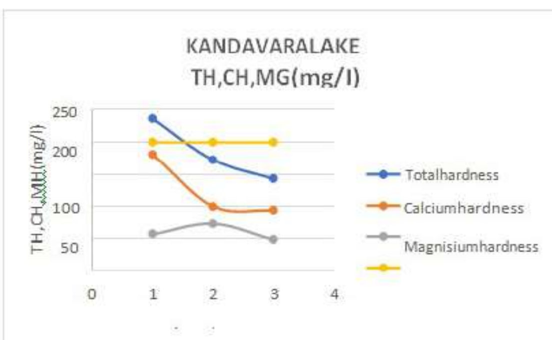
10. RESULTS AND DISCUSSIONS

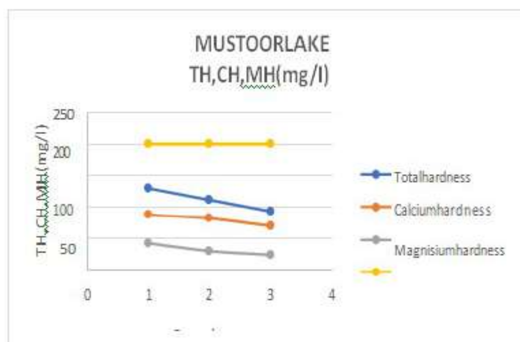
10.1. ALKALINITY

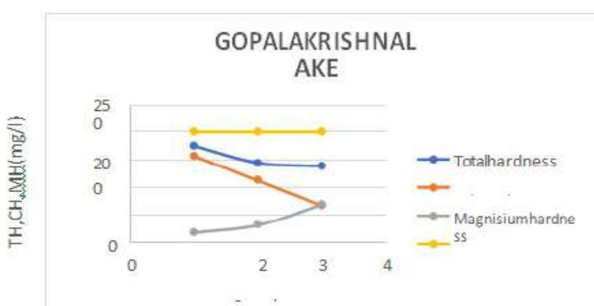


It was found that the alkalinity levels of water samples from Gopalkrishna Lake, Kandavara Lake, and Mustoor Lake varied, as shown in the figure. The increased alkalinity in the samples was attributed to the higher presence of dissolved minerals.

10.2. HARDNESS







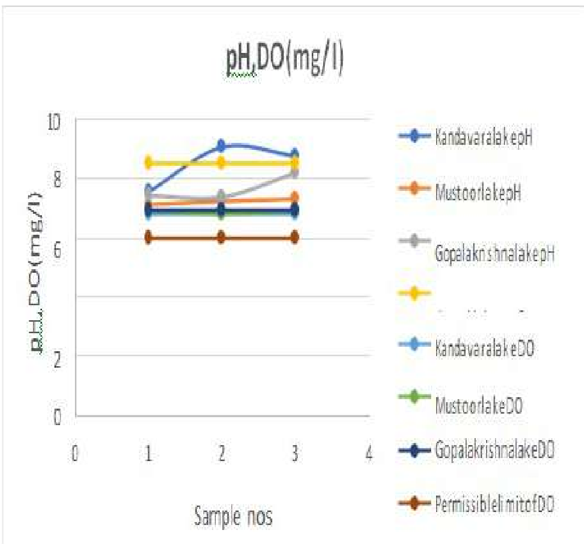
The above figure illustrates the experimental analysis conducted on Total Hardness (TH), Calcium Hardness (CH), and Magnesium Hardness (MH) through graphical representation. According to standard guidelines, the desirable limit for total hardness in water is

ISSN: 2583-7354

200 mg/L, calcium hardness is 75 mg/L, and magnesium hardness is 30 mg/L. All the water samples collected in the month of June were found to be within the permissible limits.

In lake ecosystems, calcium is added to the water through various natural processes such as plant decomposition, bone deposition, and shell formation. The concentration of magnesium is generally lower than that of calcium and is typically associated with calcium due to their chemical similarity and combined geochemical behavior.

10.3. pH and DO



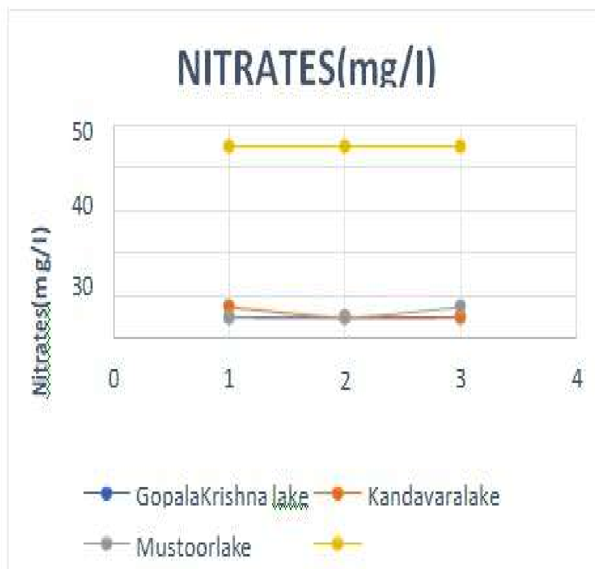
The figure shows the variation of pH and Dissolved Oxygen (DO) levels in the month of June. Generally, as the pH decreases, the concentration or activity of hydrogen ions (H^+) increases. Hydrogen ions and oxygen interact with water, which can result in a decrease in dissolved oxygen. Conversely, an increase in pH can shift the redox reactions toward the left, thereby influencing DO levels.

For almost all the samples, the DO values ranged between 6–7 mg/L, indicating a healthy environment within the lake ecosystem. Additionally, the pH values of the samples were also found to be within the desirable limits, supporting favorable aquatic conditions.

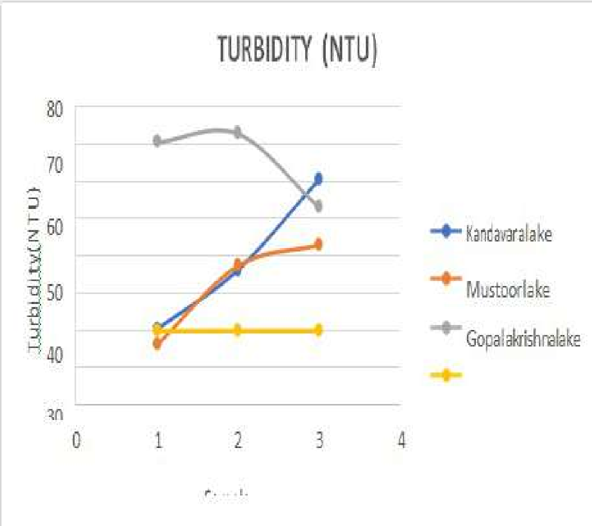
10.4. CHLORIDES

The figure presents a graphical representation of chloride concentrations in water samples collected during the month of June. According to water quality standards, the desirable range for chloride levels is above 250 mg/L and below 600 mg/L. All the samples collected were found to be within this desirable range, indicating acceptable water quality in terms of chloride content.

10.5. NITRITES

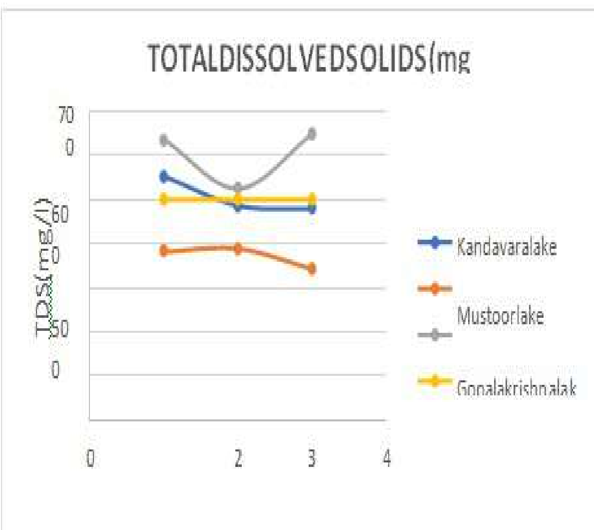


10.6. TURBIDITY



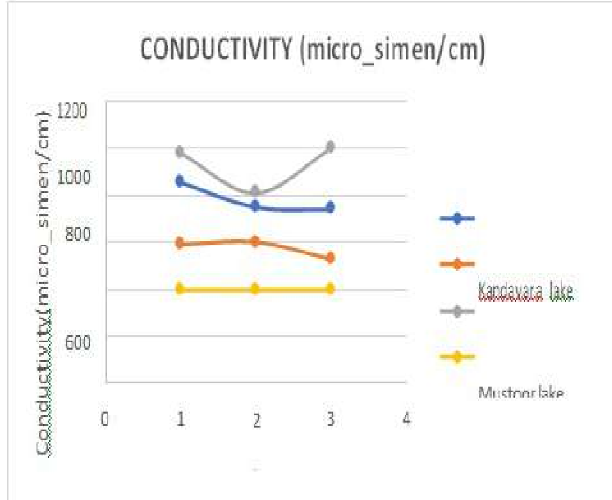
The above figure presents a graphical representation of turbidity levels in water samples collected during the month of June. The desirable limit for turbidity is 6 NTU. The observed turbidity levels exceeded this permissible limit, likely due to the presence of colloidal particles and suspended matter in the water.

10.7. TOTAL DISSOLVED SOLID



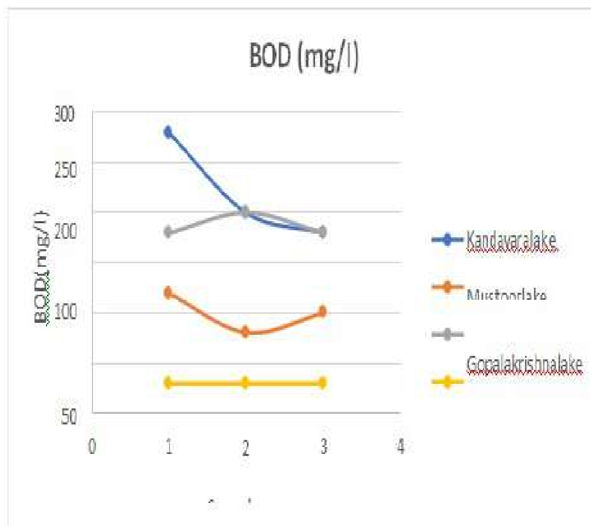
The above figure presents the experimental study on Total Dissolved Solids (TDS) using graphical representation. The desirable range for TDS is 200–500 mg/L. All the water samples collected in the month of June were found to be within this acceptable limit, indicating good water quality with respect to dissolved solids.

10.8. ELECTRICAL CONDUCTIVITY



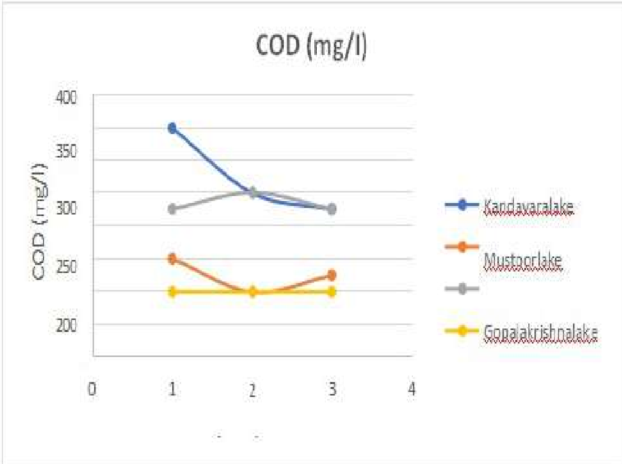
The desirable limit for electrical conductivity (EC) in water is 400 µS/cm (microsiemens per centimeter). From the graph above, it is observed that the electrical conductivity values exceed the desirable limit, indicating a higher concentration of dissolved ions in the water samples.

10.9. BOD



From the above graph, it is observed that the Biochemical Oxygen Demand (BOD) levels in all the lakes exceed the desirable limits, indicating a higher level of organic pollution in the water.

10.10. COD



From the above graph, it is evident that the Chemical Oxygen Demand (COD) levels in all the lakes exceed the desirable limit, indicating an elevated load of organic and inorganic pollutants in the water.

11. FINDINGS

- It was observed that the alkalinity levels in the water samples collected from Gopalkrishna Lake, Kandavara Lake, and Mustoor Lake varied across the sites.
- The desirable limit for total hardness is 200 mg/L, with calcium hardness recommended at 75 mg/L and magnesium hardness at 30 mg/L. All samples collected were within these prescribed limits.
- For almost all the samples, dissolved oxygen (DO) levels ranged between 6–7 mg/L, indicating a healthy aquatic environment. Additionally, pH values were found to be within desirable limits.
- The chloride concentration in the samples was within the desirable range of 250–600 mg/L.
- Turbidity levels in the water exceeded the permissible limit of 6 NTU, primarily due to the presence of colloidal and suspended particles.
- The desirable limit for electrical conductivity (EC) is 400 µS/cm. The observed EC levels were found to be higher than this limit, suggesting a high concentration of dissolved salts.
- The desirable range for Total Dissolved Solids (TDS) is 200–500 mg/L. The TDS levels in the samples were found to be within this acceptable range.
- The Biochemical Oxygen Demand (BOD) levels in all the lakes were above the desirable limit, indicating the presence of organic pollution.
- The Chemical Oxygen Demand (COD) levels were also observed to be higher than the permissible limits, suggesting the presence of both biodegradable and non-biodegradable pollutants in the lake water.

12. SUGGESTIONS

- Similar studies can be conducted in other nearby areas to identify regions vulnerable to water pollution, enabling more comprehensive water resource management.
- Based on the findings, it is advisable for farmers to rely more on groundwater or filtered lake water for irrigation purposes to ensure crop safety.
- After comparing the results with the Water Quality Index (WQI), it is evident that the current lake water is unsuitable for direct domestic or irrigation use. However, with proper filtration and treatment, the water can be made suitable for various non-potable purposes.
- The physico-chemical analysis highlights the potential of these lakes as a supplementary water source, provided they are properly maintained, restored, and protected. These findings serve as a crucial warning for addressing the growing water crisis in Chikkaballapur city.

13. CONCLUSION

The study examined various physico-chemical parameters such as pH, electrical conductivity, turbidity, alkalinity, chlorides, total hardness, calcium hardness, magnesium hardness, nitrates, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), and total dissolved solids (TDS) in the water samples collected from Kandavara Lake, Mustoor Lake, and Gopalkrishna Lake.

Upon comparing the results with the standard Water Quality Index, the samples were found to be unfit for domestic use. However, in light of the ongoing water crisis in Chikkaballapur, the study recommends that, following appropriate filtration and treatment, lake water may be used for irrigation and other non-domestic purposes. These findings underscore the importance of restoring and conserving local water bodies as part of an integrated water resource management strategy.

References

Naik, P. R., Sankalpasri, S. S., Bhavya, B. S., & Reshma, T. V. (2019). Water quality assessment of Hebbal lake in Bangalore city. International Journal of Innovative Technology and Exploring Engineering (IJITEE), 8(11), 2278–3075.

Varun, C. V., SampathKumar, V., & Pallavi, M. (2019). Studies of water quality assessment of Hebbal Lake. International Journal of Engineering Science and Computing (IJESC), 9(6).

Tanji, K. K. (2017). Irrigation with marginal quality waters: Issues. Journal of Irrigation and Drainage Engineering, 67(02976), 2017/165.

Gabr, M. E., Ussa, H., & Fattouh, E. (2020). Groundwater quality evaluation for drinking and irrigation uses in Dayrout City, Upper Egypt. Elsevier Journal.

Ramesh, N., & Krishnaiah, S. (2013). Scenario of water bodies (lakes) in urban areas: A case study on Bellandur Lake of Bangalore metropolitan city. IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), 7, 1–6.

Ganoulis, J. (2012). Risk analysis of wastewater reuse in agriculture. Springer Open Journal, 1(3).

Saber, M., Abdelshafy, M., et al. (2013). Hydrochemical and bacteriological analyses of groundwater and its suitability for drinking and agricultural uses at Manfault District, Assuit, Egypt. Springer Journal, ISSN 1866-7511.

Ramesh, N., & Krishnaiah, S. (2013). Scenario of water bodies (lakes) in urban areas: A case study on Bellandur Lake of Bangalore metropolitan city. IOSR Journal of Mechanical and Civil Engineering, 7.

Jaramillo, M. F., & Restrepo, I. (2017). Wastewater reuse in agriculture: A review about its limitations and benefits. Volume, 9(10).

Gurjar, O. P., Meena, R., Latare, A. M., Rai, S., Kant, S., Kumar, A., Kumar, A., & Sheshama, M. K. (2020). Effects of sewage wastewater irrigation compared to groundwater irrigation on soil physiochemical properties. Ain Shams Engineering Journal.

Cite this article as: Shivaraj Kumar M and Dr. Lokesh M U, (2024). Suitability of Hebbal-Nagawara Valley Wastewater for Irrigation in Chickballapur District: An Over View, International Journal of Emerging Knowledge Studies. 3(12), pp.1065-1074. https://doi.org/10.70333/ijeks-03-12-020