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Uses of Urban Sewer Water for Agriculture in Nanded City, Maharashtra, India

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Abstract: Estimating the effluent's quality is crucial for much wastewater research, as wastewater's chemical and physical characteristics influence its amount and usability. Field observations regarding the source or circumstances of wastewater occurring, the source of pollution, and other relevant factors that may impact wastewater quality are considered when assessing wastewater quality. The sustainability of wastewater for use is evaluated based on factors including pH, EC, TDS, hardness, total alkalinity, chloride, nitrate, sodium, and potassium. The assessment of sewer sustainability for irrigation is contingent upon its electrical conductivity and sodium content. These investigations were conducted in 2022 and 2023. Water samples gathered from industrial effluent, primarily used in farmlands and solely in the nearby areas, were examined in this study.
Keywords: Physico-chemical, Parameters, Permissible Limit, Chemical standards, Wastewater

I. INTRODUCTION

Population growth, urbanization, improved living standards, and economic development have led to increased volumes of wastewater across domestic, industrial, and commercial sectors (Asano et al., 2007; Lazarova & Bahri, 2005). According to the United Nations World Water Development Report, industry accounts for 22% of global water withdrawals, varying from 59% in high-income countries to 8% in low-income countries. In contrast, agriculture uses approximately 50% of freshwater (Brenda & Lee, 2009). In India, only 24% of the wastewater produced by households and industries is treated before being used for agriculture or discharged into rivers (Minhas & Samra, 2003). Although many sewage treatment plants manage some wastewater, they often need proper operation and maintenance. Globally, up to two-thirds of sewage is untreated, with fewer than 10% of existing treatment plants in Mexico operating satisfactorily (Mario & Boland, 1999). One environmental concern associated with wastewater use is groundwater contamination, which can lead to high concentrations of nitrates, salts, and microorganisms (USEPA, 1992).

Salinity from wastewater can hinder crop productivity by suppressing growth during the pre-seedling stage, causing nutritional imbalances, and introducing toxic ions (Kijne et al., 1998). Farmers growing exotic vegetables for the market, which they do not consume, might need to be aware of potential health risks associated with their practices (Drechsel et al., 2006). High nitrogen levels in wastewater can lead to nitrate contamination of groundwater sources used for drinking, posing health risks. Additionally, the accumulation of heavy metals in soils and their uptake by plants present significant risks with wastewater irrigation (Khouri et al., 1994). The improper disposal of domestic and industrial wastes, whether through land accumulation or river discharge, can lead to severe ecological issues (Eckenfelder, 2000). Wastewater often contains heavy metals, toxic chemicals, chlorides, and other pollutants, exacerbating these problems (Uberai, 2003).

In developing countries such as China, Mexico, Peru, Egypt, Lebanon, Morocco, India, and Vietnam, wastewater has long been a nutrient source for crops (AATSE, 2004; Jimenez & Asano, 2008). Using untreated wastewater for agriculture has been used for centuries (Keraita et al., 2008). Estimates suggest that over 4–6 million hectares of land are irrigated with wastewater or polluted water (Jimenez & Asano, 2008; Keraita et al., 2008; UNHSP, 2008), with some estimates reaching 20 million hectares, nearly 7% of the world's irrigated land (WHO, 2006). A review integrating data from Jiménez and Asano (2008) and UNHSP (2008) indicates that 46 countries use polluted water for irrigation. In West Africa, 50 to 90% of vegetables consumed in urban areas are grown locally with contaminated irrigation water (Drechsel et al., 2006). In Pakistan, about 26% of national vegetable production relies on wastewater for irrigation (Ensink et al., 2004).

This study aims to analyze and assess the suitability of industrial wastewater for agricultural practices, specifically for crop irrigation, in and around Nanded City.

II. MATERIALS AND METHODS

2.1 Study Area: Nanded is situated between 18°15' and 19°55' North latitude and 77°07' to 78°15' East longitude. The district spans a geographical area of 10,528 square kilometers. As one of Maharashtra's fastest-growing cities in the Marathwada region, Nanded has experienced significant development (Yannawar et al., 2013; Yannawar, 2015).

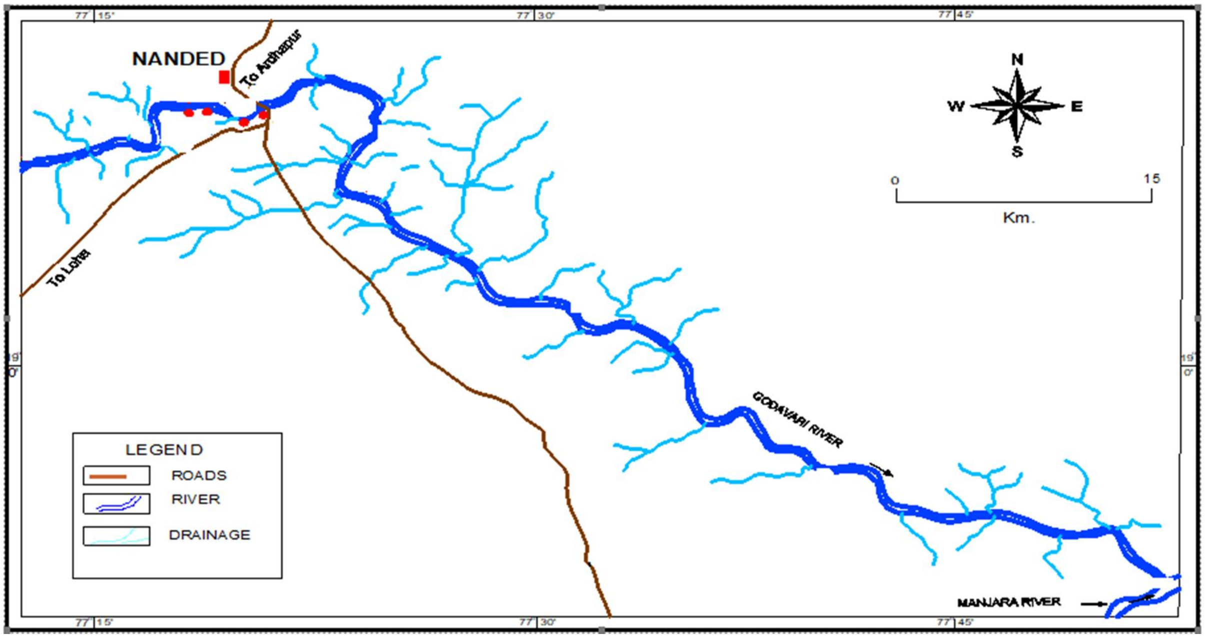

Fig.2.1: Showing selected sampling locations in the Godavari River of Nanded City, Maharashtra

2.2 Site and Field Selection: Two and three fields were chosen for monitoring irrigation practices, nutrient applications, and heavy metal accumulation. The wastewater from the oil and cattle feed industries is utilized in agricultural areas near Vasarni, Nanded. Central sewage has been supplied for over thirty years from the cattle feed industries in the Maharashtra Industrial Development Corporation (MIDC) and the City and Industrial Development Corporation (CIDCO) of New Nanded.

2.3 Sampling Methods: The effluent samples for this investigation were collected from local cattle feed industries in Nanded's MIDC. Physical and chemical parameters were analyzed following the Standard Methods for Examining Water and Wastewater, 17th edition, APHA (1998). Sampling was conducted three times each morning from 2022 to 2023. pH, temperature, dissolved oxygen, and total dissolved solids were measured immediately, while other parameters were analyzed later in the laboratory using standard methods. This descriptive cross-sectional study involved sampling raw urban wastewater from orchards and farms during the spring and summer months (May to August). The aim was to assess critical parameters relevant to crop irrigation in these areas. Sampling was carried out according to established standard methods.

III. RESULTS AND DISCUSSION

This study examined water samples from industrial wastewater collected between 2022 and 2023. Various physical parameters were measured, including total solids, total dissolved solids, electrical conductivity, and color. Additionally, estimated chemical parameters such as pH, carbon dioxide, total hardness, phenolphthalein alkalinity, total alkalinity, salinity, total acidity, oil, and grease were assessed. Ionic parameters, including chloride, phosphate, sulfate, calcium, magnesium, sodium, potassium, fluoride, iron, chromium, and manganese, were also analyzed. Biological properties such as the standard plate count and most probable count were determined. Color is typically the first noticeable contaminant in wastewater and impacts water bodies' aesthetics, transparency, and gas solubility (Yuxing & Jian, 1999). All discharge samples exhibited a blackish hue. The pH of the wastewater ranged from 6.9 to 8.7, with temperatures varying from 20°C to 30°C. Total dissolved solids ranged from 784 to 1730 µM, reflecting the water's varied dissolved and suspended component concentrations.

The data from this study revealed significant variations in water quality based on physicochemical properties. The accompanying graphs detail and illustrate average values for various wastewater quality parameters. This report highlights the strong relationship between wastewater use and management practices.

For farmers in this semi-arid region, a consistent wastewater supply is crucial for cultivating high-value vegetables and crops. The availability of wastewater continues throughout the year, allowing farmers to rotate its use and exchange resources to match crop water needs better. During dry periods or at the end of irrigation systems, wastewater may be the only available water source in regions like Haroonabad, Pakistan, and Hyderabad, India (Ensink et al., 2004; Ensink, 2006). All parameters, except electrical conductivity (EC) and pH, are reported in mg/L. These values are compared against limits for industrial effluent discharged into inland surface waters. Farmers often experiment to address production risks like pest infestations, water shortages, or diminishing availability of fertile land and labor (Mutsaers et al., 1997). While health risks are not a significant concern due to low awareness, poor water quality can still be problematic for farmers, even if its health impacts are not immediately recognized. Therefore, it is crucial to encourage farmers to seek their solutions, as several home remedies can unintentionally mitigate health risks (IWMI, 2008).

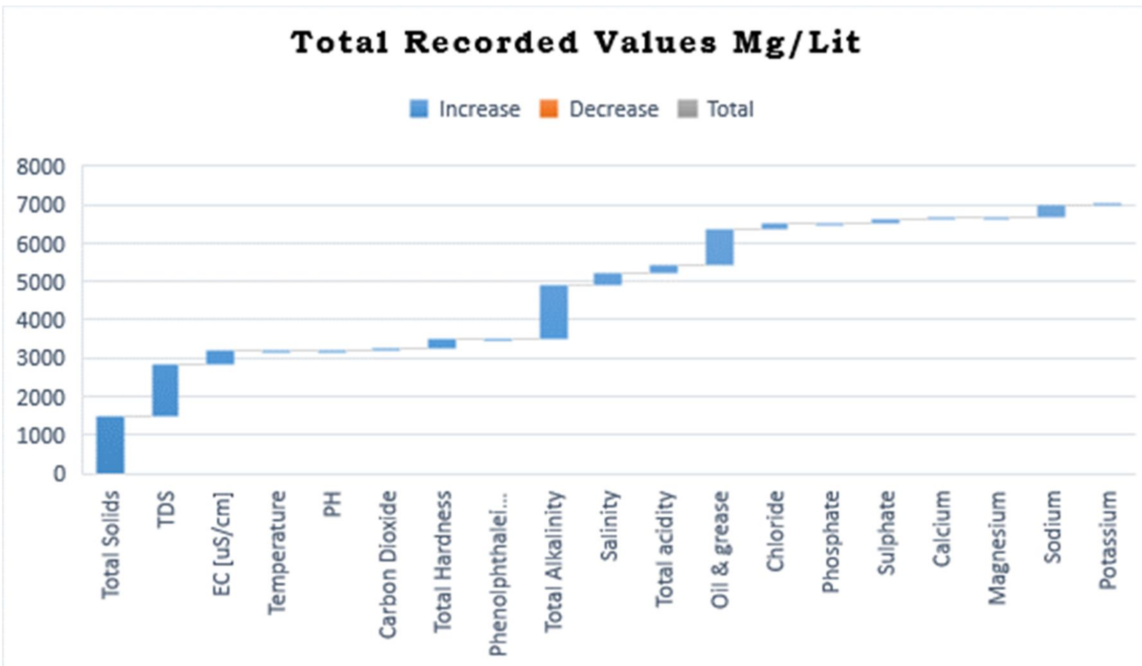

Fig.3.1: The total mean values observed of Physico-chemical parameters of industrial wastewater samples in mg/Lit.

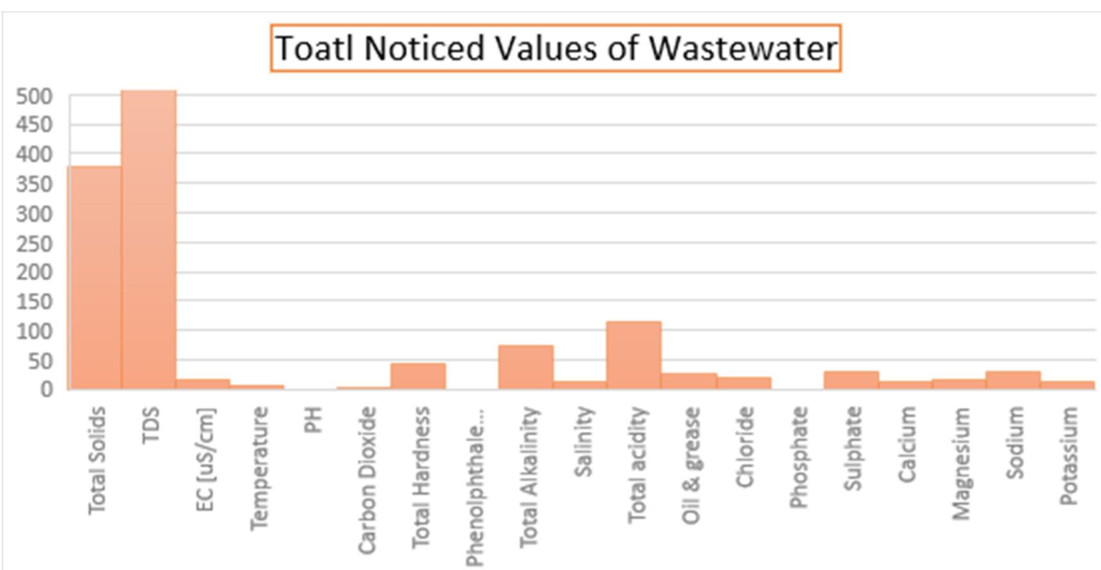

Fig.3.2: The total SD values observed of Physico-chemical parameters of industrial wastewater samples in mg/Lit.

Salinity from wastewater can negatively affect crop productivity by suppressing growth at the pre-seedling stage, causing nutritional imbalances, and introducing toxic ions (Kijne et al., 1998). Farmers growing exotic vegetables for the market, which they do not consume themselves, might need to consider the potential health impacts of their practices (Drechsel et al., 2006). Consequently, many farmers develop strategies and innovations to cope with declining water quality, aiming to sustain or boost yields while addressing negative trade-offs, including health concerns. Innovations such as labor-saving techniques and alternative irrigation methods, like furrow irrigation instead of overhead watering, can help mitigate health risks. Smallholder farmers in developing countries have various management options to handle the dangers of heavy metals or excess salts and nutrients in irrigation water, as noted by Yannawar et al. (2014) in Nanded and its surrounding areas.

IV. CONCLUSIONS

There is room for improvement in water and nutrients in Nanded, where there is a lack of industrial pollution, impoverished farmers use untreated water, and the economic benefits of wastewater use are maximized. Adequate controls should be put in place at the same time to manage different illnesses in populations that are exposed to wastewater. It is concluded that all of the norms specified by the Ministry of Environment Forest, New Delhi, and the Standards of Environmental Protection Act apply to the effluent discharged from the oil and cattle feed industry and adjacent industries, except oil and grease. Thus, environmental disposal should receive less consideration. Farmers and scientists need to identify areas of agreement and apply information to alter attitudes and actions. When improperly supervised, wastewater utilization presents severe health and environmental dangers to agriculture crops and human health.

V. RECOMMENDATIONS FOR IMPLEMENTATION

Recommended practices might need adjustments to keep efforts low and outputs high. These may not necessarily be the most effective measures in reducing health risks, but they are probably more sustainable. Policies and decisions on wastewater use in agriculture should generally be motivated locally, as the socioeconomic, health, and environmental conditions that vary across countries will dictate how far common recommendations are applicable. Nevertheless, the following general recommendations are made to guide decisions based on the findings of this study.

1) Prevent pollution rather than treating symptoms of pollution.
2) Use the precautionary principle.
3) About Regulation, Risk Reduction, and Safe Use of Wastewater
4) Cleaner Production: This principle is used by the industry
5) Apply the polluter-pays-principle.
6) Apply realistic standards and regulations.
7) Balance economic and regulatory instruments.
8) Apply water pollution control at the lowest appropriate level.
9) Establish mechanisms for cross-sectoral integration.
10) Give open access to information on water pollution.
11) Promote international cooperation on water pollution control.
12) Crop Selection: Some crops are more prone to contamination from pathogens than others.

Further studies must address other smallholder irrigation systems and crops to develop new measures.
Declaration: The authors of this manuscript do not oppose the interest.

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