Abstract of the Thesis

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Abstract

The water quality of the Sabarmati River is substantially influenced by various anthropogenic sources. This study provides a framework for preserving the health of the river by examining 17 water quality parameters across 11 monitoring sites (upstream US-1 to US-4, middle stream MS-1 to MS-3 and downstream DS-1 to DS-4), through the application of multivariate statistical analysis methods and water quality modeling.

Multivariate statistical analysis helps identify significant water quality variables and determine pollution sources. The box-whisker plots illustrated the spatial and temporal variations in water quality. Pre-monsoon and winter seasons were found to be critical due to higher chemical loads. The plots revealed that water quality deteriorates with increasing distance downstream. It showed the highest chemical pollution in the downstream stretch, largely due to wastewater discharges. Cluster analysis (CA) categorized the sites into three groups: sites US-1 to US-4 and MS-1 as less polluted (LP) sites, sites MS-2, MS-3, and DS-1 as moderately polluted (MP) sites, and Sites DS-2 to DS-4 as highly polluted (HP). Principal component analysis (PCA) / factor analysis (FA) highlights the significance of water quality parameters across spatially distinguished sites. TDS, Cl, COD, DO, sulphate, and nitrate were significant for all sites, indicating the influence of runoff and anthropogenic activities. Sample temperature predominated at LP and MP sites, while pH and NH_3-N were more prevalent at MP and HP sites, underscoring the sources of contamination at the respective locations. The higher levels of chemical pollution at HP sites indicate wastewater discharges.

QUAL2Kw proved effective in determining river's carrying capacity and establishing water quality management scenarios. The model was applied to the individual stretch for six identified water quality parameters: inorganic suspended solids (ISS), dissolved oxygen (DO), CBOD slow (CBODs), CBOD fast (CBODf), ammonia N (NH_3-N), and pH. The sensitivity analysis, conducted through upstream stretch water quality simulation, revealed that the model is sensitive to headwater flow, hydrolysis rate for CBODs, oxidation rate for CBODf, and depth coefficient. The water quality simulated for the middle

and downstream stretches for the critical period of winter and pre-monsoon seasons depicted the self-purification capacity and water quality management scenarios. The simulation results showed that a minimum flow of 10 m^3/s during winter and 13.11 m^3/s during pre-monsoon is required to maintain the water quality of the middle stream stretch for outdoor bathing water quality Class B with the existing pollution load. It can be improved further by reducing the existing pollution load by 20% or by increasing river inflow by 50% (29.85 m^3/s for winter and 28.10 m^3/s for pre-monsoon). Downstream stretch water quality simulations revealed that with a river inflow of 235.93 m^3/s and a 50% reduction in the current pollution load, the discharge standard requirement can be met. The subsequent simulation showed that a DO of 4.0 mg/L can be maintained by reducing the existing wastewater flow and pollution load by 50% with a river inflow of 377.50 m^3/s during winter and 353.90 m^3/s during summer.

The study finds that combining multivariate statistical analysis techniques with QUAL2Kw modeling has been highly effective in assessing and maintaining the health of the river. The methods, ANOVA, box-whisker plots, CA and PCA analysis, clearly demonstrate water quality variations and depict variables that significantly affect water quality. Water quality simulations by QUAL2Kw provide the best management scenarios to maintain assimilative capacity and pristine river sources. The study provides a robust framework that can be applied to other studies for restoring and maintaining river health.

This PhD Thesis will help in: This research work provides a basis to ascertain the river's water quality for its intended use. It helps restore and maintain the pristine condition of the Sabarmati River. The recommendations of the study support future scopes and ensure the long-term sustainability of the river. It will serve as a scientific basis for researchers, water quality managers, policy makers, and environmental regulatory authorities to design effective water quality management programs. The proposed water quality modeling framework can be applied to other river systems and is useful to researchers and water quality managers to restore and maintain the water quality of the river.

List of Publication(s):

1) Darji, J., Lodha, P., & Tyagi, S. (2022). Assimilative capacity and water quality modeling of rivers: a review. Aqua Water Infrastructure, Ecosystems and Society, 71(10), 1127–1147. https://doi.org/10.2166/aqua.2022.063

2) Darji, J., & Lodha, P. (2025). Analyzing Spatial and Temporal Variations in Water Quality and Identifying Key Influencing Factors in the Sabarmati River System, Western India. Water Conservation Science and Engineering, 10(6). https://doi.org/10.1007/s41101-024-00335-y

3) Darji, J. S., & Lodha, P. P. (2025). QUAL2Kw–A Water Quality Modeling Tool for Rivers and Streams: A Review. IJSAT-International Journal on Science and Technology, 16(3). https://doi.org/10.71097/IJSAT.v16.i3.7594