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Temporal Variability of Water Quality Parameters: Surface and Groundwater Contamination

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Abstract

Temporal variability of water quality parameters provides essential information about surface and groundwater contamination dynamics. Seasonal and event-based fluctuations, driven by both natural and anthropogenic processes, are found consistent by long-term monitoring of various regions. Statistical analyses in groundwater (PCA, PCA-MLR, clustering) indicate high variability of parameters such as nitrate (NO_3^-), total dissolved solids (TDS), electrical conductivity (EC), hardness and heavy metals Fe and Mg due to seasonal recharge, water–rock interaction, dilution during wet months, and introduction of agricultural fertilizer and domestic or industrial wastewater. Redox-sensitive constituents such as arsenic have quantifiable seasonal variations associated with water-table processes, pumping and recharge cycles. Surface water quality follows similar patterns: dilution of parameters such as EC and nutrients by wet-season dilution, and concentration of solutes and increases in biochemical oxygen demand (BOD), nitrogen (total N), and phosphorus (TP) during dry seasons. Multivariate analysis commonly indicates common sources of contamination—e.g., municipal sewage, agriculture, industrial effluent—with spatial distribution related to urban or agricultural land use. In controlled systems, like aquifer storage and recovery (ASR), temporal variability of treated surface water stored underground affects disinfection byproduct (DBP) formation. Groundwater-influenced zones generally exhibit lower organic loading and DBPs, but seasonal quality fluctuations and storage period increase these risks.

Keywords; Temporal variability, Water quality parameters, Surface water, Groundwater, Seasonal variation, anthropogenic activities.

INTRODUCTION

Water is an essential resource that plays a pivotal role in sustaining life, ecological balance, and socioeconomic development. But the fast rate of urbanization, industrialization, and agricultural intensification has ended up affecting greatly the quality of surface and groundwater resources globally. The degradation of water quality presents serious threats to public health, biodiversity, and sustainable water management. Of all the concerns, temporal variability of water quality parameters has become a key research area, since changing concentrations of pollutants can impact treatment demands, ecological impacts, and policy measures.

Surface water bodies like rivers, lakes, and reservoirs are most susceptible to point and nonpoint source contamination by domestic sewage, industrial effluent, and agricultural runoff. At the same time, groundwater, which is traditionally perceived as more safeguarded, comes under rising influence of leaching of pollutants, over-pumping, and mismanagement of wastes. These alterations tend to follow time patterns because of seasonal patterns, hydrological cycles, and land use changes, requiring permanent surveillance and observation.

Objectives of the Study

This research seeks to examine the temporal dynamics of major water quality parameters within surface and groundwater systems. Through the examination of data for a specified duration, the study aims to detect patterns of pollution, determine the underlying factors, and assess the extent of water quality deterioration.

Understanding this is crucial in formulating effective water resource management policies, guaranteeing safe drinking water supply, and compliance with statutory requirements.

The research also focuses on the use of physicochemical and biological indicators that are integrated to evaluate water quality dynamics, while offering information on natural and anthropogenic factors. The results are likely to add to the expanding literature on water quality monitoring and enable sustainable water governance at the local and regional levels.

REVIEW OF LITERATURE

Castro et al. (2017) in their research established a method that utilized hierarchical cluster analysis to examine the spatial and temporal dynamics of water quality controlling processes. Outcomes of this research enhance understanding of the influence of precipitation and human pollution on groundwater quality. Temporal variability results from the alteration of the quantity and distribution of precipitation, diluting groundwater within the aquifer. Spatial areas affected by seawater intrusion, rock contact, rainfall, and local pollution were distinguished. Temporally, precipitation changes impacted groundwater dilution was seen.

Ayotte et al. (2014) examined the prevalence of arsenic in groundwater and its temporal variation is one of them, nationwide in U.S. covering 1,245 public and private wells. There was Significant seasonality of arsenic in New England, co-varying with groundwater table fluctuations and no measureable seasonality in California's Central Valley. They concluded that monitoring programs need to consider seasonality to prevent under/overestimation of toxic contaminant concentrations.

Uddin et al. (2009) examined the groundwater samples in order to investigate the temporal and seasonal variation of Arsenic in drinking water wells and found that overall there is a reduction in arsenic in the study period, although variable trends were seen for the wells. More contaminated wells (>50 µg/L) showed more intense fluctuations.John, C. K., et al. (2021) evaluated rainwater collected through serial filtration (1.5 µm to 500 µm) to determine turbidity, TSS, conductivity, pH, E. coli, and total coliform after 20 days following rainfall events and noted that sedimentation reduced suspended solids and microbial contamination substantially over time and concluded that storage depth and sediment retention is essential for water quality.

Osuagwu, J. C et al. (2014) examined how soil erosion and sediment deposition contribute to increasing turbidity, lower dissolved oxygen, compromise aquatic habitats, clog fish spawning substrates, and transport toxins/metals into river water. Sediment was said to act as a vector of nutrients, pesticides, and metals—undermining water quality and biodiversity. Sultana (2017) investigated the influence of land use and land cover processes in the watershed that impact sedimentation transport to the river. Sultana & Naik (2016) focused on reservoir sedimentation prediction towards sustainable future planning.

Samad & Al-Zahrani. (2018) assessed how sedimentation along the Chakbandi–Chenab continuum attenuates some pollutants, but heavy metals and physico-chemical parameters frequently surpass WHO levels as a consequence of uncontrolled effluent release. It was found that sediment can remove certain pollutants but is defeated by continuous pollution loads. Empirical approaches, data-driven methods like ANN, and Fuzzy logic were utilized to evaluate reservoir water storage capacity loss due to sedimentation (Sultana & Naik, 2015; Sultana & Naik, 2016; Sultana & Naik, 2017; Sultana & Naik, 2023). The efficiency of the trapped sediment of the reservoir was evaluated by Sultana & Naik (2019), Sultana & Sultana (2019), Sultana & Naik (2015) and Sultana & Naik (2017) using different methods. Sultana & Sultana (2019) compared the diverse empirical methods to evaluate the trap efficiency of reservoirs.

Geng M., et al. (2023) discussed the correlation between anoxia duration, sediment oxygen demand, and P release in river-lake systems, particularly Dongting Lake, illustrating how changed sediment dynamics dictate eutrophication and water quality. Sediments were found to function both as sinks and sources of N and P, and hydrological changes are responsible for spatial-temporal water quality heterogeneity.

Lifeng Chang et al. (2023) investigated 31 years of observations in Dongting Lake to evaluate the effect of water–sediment processes on water quality. It revealed that total nitrogen has risen with time, whereas total phosphorus initially increased and then decreased. Since the operation of the Three Gorges Dam, the role of water discharge and sediment in controlling nutrient concentrations reduced. Internal feedback processes currently prevail in changing water quality. The research emphasizes integrated long-term management of river–lake systems. Physico-chemical parameters and quality evaluation were conducted by Sultana & Sultana (2019) for Hyderabad city and reported that all the parameters were well above the permissible limit. ANN method was used to forecast the ground water quality index by Sultana (2020) to comprehend the ground water quality degradation in the basin.

Lalehzari & Tabatabaei (2015) simulated nitrate transport prior to and following subsurface (underground) dam construction in the Shahrekord plain, Iran.

Nitrate values for 15 months were calibrated monthly to assess dam impact on hydraulic regimes and contaminant spreading. The subsurface dam was found to raise groundwater levels upstream (~4.5 km upstream), but had little impact on nitrate concentration distribution. This research demonstrates the hydrologic effect of subsurface dams and offers a framework for solute transport modeling in nitrate-affected aquifers. Sultana & Sultana (2019) employed EPANET in the design of the water supply distribution system of Hyderabad City.

Qin, L., et al. (2020) investigated how dam-created reservoir sedimentation modifies phosphorus forms in sediments of an important drinking-water source.

It was discovered that dam construction greatly changed sediment phosphorus fractions—particularly bioavailable inorganic ones—revealing implications for nutrient cycling and eutrophication potential. It was declared that it is Significant for reservoir management, since changes in phosphorus forms may impact water treatment, algal blooms, and general water quality. Sultana & Sultana (2021) have discussed the encroachments that have occurred along River Musi, which passes through Hyderabad city of Telangana State, which itself is a tributary to River Krishna. It was seen that encroachments were leading to gradual shrinkage of the river, and the river is also becoming severely polluted due to the discharge of harmful chemical waste from industries into it. This causes inundation of the city during rains and contamination of streams and groundwater. Sultana & Sultana (2021) elaborated on the restoration of lakes in Hyderabad city.

Zakwan et al. (2022) compared the significant changes in sediment concentrations which indicate that various parameters influence the silt transported by the streams as well as the volume of sediment in alluvial streams, which is influenced by hydrological as well as hydraulic properties. Sultana et al. (2023) determined and examined land use and land cover dynamics of the Godavari middle sub-basin, and graphed changes in the water spread area of Sriram Sagar reservoir within the basin. Sultana & Sultana (2019) designed water supply distribution systems.

Da Silva, G.C.X., et al., (2020) examined seasonal dynamics of physical and chemical parameters during the filling of reservoirs. It was found that temperature rose (25–32.5 °C), dissolved oxygen (DO) fluctuation increased, turbidity reduced with time (2–10.5 NTU), and total suspended solids (TSS) was moderate (~4 mg/L).

Electrical conductivity and total dissolved solids (TDS) were variable, indicating leaching of ions from soils. The paper brings forth the influence of reservoir filling on thermal stratification, DO concentration, and initial water chemistry which is vital for aquatic ecosystem condition. Sultana & Sultana (2024), Sultana et al. (2019), Sultana & Sultana (2019) reviewed the different studies on groundwater contamination and kinds of contaminations created, and the impact of groundwater pollution and contamination on human health. Ara et al. (2025) carried out SWAT modelling with remote sensing and GIS assistance to evaluate water availability within the command area of the Gandak River basin.

Chowdhury, S., & Al Zahrani, M. (2014) examined 15 water-quality variables between April 2010 and February 2012 in a Saudi Arabian dam reservoir and neighboring aquifer using multivariate and principal component analyses. The reservoir and groundwater groups indicated significant correlations among sulfate, hardness, fluoride, TDS, chlorides, and turbidity. Factor analysis accounted for >80% variance, indicating potential data dimension reduction. This research illustrates quantitative water quality changes as a result of reservoir-aquifer interaction—valuable for drinking water safety and monitoring design. Dong, S., et al. (2014) evaluated the impact of rubber weir dams on groundwater recharge and quality within the Luohe River. It was determined that following dam building, there was a strengthening in the river-to-groundwater recharge, that modified aquifer water quality—TH, TDS, nitrate, and NH_4-N altered due to mixing, evaporation, and hydrogeological conditions. This research demonstrated anthropogenic alteration of groundwater chemistry through surface water impoundments. Tundu, C., et al., (2018) approximated a potential 39% reduction in dam storage capacity through an annual sediment accumulation of ~330 t in Chimhanda Dam via RUSLE and bathymetry.

There was a significant positive correlation between turbidity ($r = 0.63$) and TDS ($r = 0.64$) with sediment yield by the authors, reflecting compromised water quality through sedimentation.

The research demonstrated how reservoir sediment accumulation quantities directly impair essential water quality parameters. Sultana (2017), Sultana & Sultana (2019), Sultana & Naik (2019), Sultana & Sultana (2021) analyzed the impact of land use and land cover activities of the watershed that influence sediment transport to the river. Sultana & Sultana (2021), Sultana (2020) and Sultana & Naik (2019) measured sediment load through sediment loading curve. Estigoni, M. V., et al., (2015) undertook bathymetric surveys over 10 years and conducted sediment-core analyses that revealed clay-rich sediment accumulation in upstream areas that sequestered nutrients and efficiently mitigated nutrient loads in the water column thus enhancing the quality of downstream water. This research demonstrates the potential of sedimentation to function as a nutrient sink, with beneficial side-effects for downstream quality.

Sultana & Naik (2015) employed empirical approaches and Sultana & Naik (2015) used the machine learning methods to find the sediment accumulation in reservoirs.

Ammar et al. (2017) tested samples and reported that in wet-fill stages, sediments draw down nutrients; in dry-spill stages, sediments discharge chemicals to surface and groundwater. Bidirectional flux impacts the quality of water—particularly in spill stages.This work illustrated sediment's dual function and its pivotal connection between surface reservoir waters and underlying aquifers. Ali & Shakir (2018) laid down rates of sedimentation and control measures (e.g., flushing, dredging), acknowledging sediment buildup as a serious threat to reservoir capacity and flow regulation downstream. This paper gave pragmatic insight into how sediment dynamics influence storage, reliability of water supply, and flow regimes.

Bhattacharyya & Singh (2019) specified sediment sources, transport processes, effects on water quality (e.g., nutrient retention, turbidity), and management methods such as dredging, flushing, and catchment erosion control. Such a review presented a seminal source that integrated worldwide evidence regarding the role of sedimentation in reservoir water resources.

Mohammed, O. A. et al., (2019) mapped and determined areas probably suitable for natural aquifer recharge in Iraq's Western Desert, utilizing the synergy of remote sensing, GIS, and geospatial analysis to address groundwater scarcity and recharge management. The research proved an effective, replicable geoinformatics workflow integration of RS, GIS, hydrology, and field measurements for mapping recharge sites.

Abdulhameed, I. M. et al., (2021) assessed the reusing of treated urban wastewater in Ramadi City (Anbar Province, Western Iraq) for irrigation of green belts for dust storm mitigation and water resources conservation using the WEAP simulation tool.

Sulaiman, S. O. et al., (2021) tested and improved the operational behavior of Dokan Dam reservoir through a simulation model, with emphasis on evaluating how good the model is in simulating actual reservoir inflows and outflows and providing a tool for optimal water resource management. Empirical formula and verified model performance facilitate reservoir management in changing hydrological conditions, with improved readiness and optimization potential.

Aude, S. A. et al., (2022) in this research, analyzed the static and seismic stability and liquefaction susceptibility of Al Adhaim Dam (Iraq), and critiqued a geotextile reinforcement system to minimize liquefaction hazards in earthquakes. Eryiğit, M., & Sulaiman, S. O. (2022) optimized the water supply pipeline selection and operation for Rutba City with equal costs and revenues, through a heuristic algorithm that was inspired by the natural immune system.

METHODOLOGY

Overview of methodologies generally employed in researches pertaining to the temporal variability of water quality of surface and ground systems are:

1. **Field Sampling & Monitoring**
   - Seasonal/Temporal Sampling Campaigns (Several passes over seasons or years.)
     - E.g., groundwater sampling in 1990 & 2012 during summer, processed through Piper & USSL diagrams, EC, SAR, RSC, etc.
     - Surface water of Jakara River sampled on a daily basis during dry/mixed seasons for 15 parameters Groundwater/surface water in India monthly/bi-monthly samples with GPS location, on-site EC/pH, laboratory assays for ions
     - Post- and pre-monsoon sampling for streams and groundwater in Gujarat for seasonal fluoride/nitrate analysis

2. **Automated & Discrete Sensor Measurements**
   - Soil grain-size testing in conjunction with hydraulic head monitoring using piezometers.
   - Rain gauges to determine timing and amounts of precipitation.

- High-frequency in-situ sensors are used by some studies with autoregressive models

3. Multivariate & Statistical Analysis

- Cluster Analysis (CA): Hierarchical and agglomerative clustering (e.g., Ward's method) find seasonal/spatial clusters in water chemistry.
- Principal Component Analysis & Factor Analysis (PCA/FA): Applied to compress data and expose dominant pollutant sources. Frequently integrated with multiple linear regression such as APCS MLR.
- Discriminant Analysis & ANOVA: DA (standard/stepwise) and ANOVA distinguish between seasons. E.g., utilized in Kano River and Bystrzyca studies to separate dominant parameters.
- Correlation & Regression: Pearson/partial correlation and MLR measure relationships between parameters
- Trend & Non-parametric Tests: Seasonal Kendall, Mann-Kendall, QWTREND detect seasonal and long-term trends

4. Spatial Analysis & GIS Integration

- Geostatistics (Kriging/Semivariogram): Ordinary kriging maps spatial distribution of indices such as EC, SAR
- GIS Mapping & Vulnerability Indices: Mapping sample points and spatial interpolation. Use of DRASTIC index to evaluate aquifer contamination vulnerability.

5. Hydraulic & Hydro chemical Techniques

- Piezometer Installation & Hydraulic Head Monitoring Devices installed at varied depths to measure groundwater level relative to river stage 5–6 days/month
- Water Table & River Stage Comparison Simultaneous hydraulic and chemical sampling explains GW–SW interaction dynamics.
- Reactive Transport & Simulation Models MODFLOW simulations model flow and chemistry Reactive transport models enable contaminant fate modeling

6. Spatio-Temporal Modeling Tools

- GWSDAT (Ground Water Spatiotemporal Data Analysis Tool): Times-series and spatial trends combined for contaminant plume monitoring
- Bayesian & Mixed-Effect Models: Poisson/Gamma hierarchical model for spatial count data Bayesian spatio-temporal regression in stream networks
- Generalized Additive Mixed Models (GAMMs): Model nonlinear effects of temporal variables (e.g. conductivity, turbidity) on nitrate.

7. Hybrid Method Integration

- Combined Approaches: Numerous studies combine sensor data, hydrochemical assays, spatial modeling, and statistical tools. E.g., surface-groundwater interactions through sensors, chemistry, hydraulic data Multivariate statistics + GIS mapping using Piper, Gibbs, cluster, PCA/FA, kriging

Table 1 Summary of the methods

Method	Purpose	Examples
Sampling Design	Capture seasonal/temporal variability	Seasonal/planned campaigns, continuous sensors
Statistical Analysis	Identify trends & controlling factors	PCA/FA, CA, DA, trend analysis, correlation/regression
Spatial Modeling	Visualize parameter distribution	Ordinary kriging, GIS vulnerability mapping
Hydraulic Monitoring	Track GW/SW interactions	Head measurements, piezometers, river stage data
Modeling Tools	Predict and simulate dynamics	MODFLOW, reactive transport, Bayesian & GAMM models

Hierarchical Cluster Analysis on combined time–location samples were utilized to determine patterns and Principal Component Analysis (PCA) was applied for cluster validation and to indicate important influencing variables to investigate the Groundwater Quality: Analysis of Its Temporal and Spatial Variability.

Temporal variability was measured and correlated it with geochemical, redox, seasonal, and anthropogenic factors to investigate the factors influencing the temporal variability of arsenic in Groundwater Used for Drinking Water Supply. Obtained water samples from different depths (free phase vs. sediment layer) and tested for turbidity, total suspended solids (TSS), and E. coli through serial filtration (500 µm → 1.5 µm filters) to investigate the Impacts of sedimentation on rainwater quality.

The technique employed to analyze the impact of soil erosion and sedimentation on the quality of surface water is the collection of samples from the upstream (A) and downstream (B) points during run-off events and measurement of physico chemical parameters: pH, hardness, iron, chloride, BOD, TSS, TDS, etc.

FINDINGS

Enumerated clusters reflecting water quality changes; cluster maps revealed spatial–temporal pattern. PCA reaffirmed key drivers: seawater intrusion, rock–water interaction, rainfall infiltration, and human pollution. Temporal variability is chiefly attributed to precipitation fluctuations—wetter periods diluted groundwater pollutants.

Observed close association between arsenic variations and variations in redox conditions, pH, and major-ion chemistry. Observed seasonal influences: in New England, arsenic was lower Jan–Jun compared to Jul–Dec ($p < 0.0001$); in California Central Valley, seasonal variations were not significant statistically. Seasonal cycles of arsenic reflected water-level fluctuations—caused by pumping, evapotranspiration, or recharge mixing.

From the research of the impact of soil erosion and sedimentation on surface water quality it is apparent that the downstream samples indicated 30–176 % increments in pollutants (e.g., hardness, BOD, TSS) relative to upstream and pollution index: upstream = 1.22 (moderately polluted), downstream = 2.43 (heavily polluted). From the analysis of the Impacts of sedimentation on rainwater quality, the free-phase water (surface layer) was always of higher quality than the lower sediment zone. 70 % of the TSS had settled within 36 hours after rainfall and there is close correlation ($r \approx 0.9$–1) between turbidity, TSS, and E. coli

Limitations Identified

Although many methods have been used to measure emporal variability in water quality, there are a number of limitations that continue across studies. Most depend on episodic seasonal sampling, which can be missing short-term oscillations or contamination peaks associated with rainfall, runoff, or human discharge, producing an incomplete record of swift changes. Low spatial and temporal resolution of monitoring networks, particularly in the developing world, limits reliable interpolation and trend detection. Sensor-based continuous monitoring is effective but tends to be prohibitively costly and prone to calibration error or biofouling in distant locations. Statistical methods such as PCA and cluster analysis, although effective in pattern recognition, are vulnerable to the quality of data, scaling, and interpretation subjectivity. Groundwater research is usually based on static water level measurements and grab sampling with no integrated hydrodynamic modeling to evaluate flow paths or recharge impacts. In addition, models like MODFLOW or GIS tools necessitate rigorous calibration, trustworthy input information, and assumptions that might not apply uniformly in heterogeneous aquifer systems. Lastly, insufficient socio-economic and land use data integration limits causative activity contamination trend linkage, declining the strength of source apportionment and policy implications.

DISCUSSIONS

Investigations in various geographical contexts have always reported that water quality parameters display tremendous temporal variability as a result of seasonal variations, hydrological cycles, and anthropogenic stresses. In surface waters, metrics like electrical conductivity (EC), total dissolved solids (TDS), biochemical oxygen demand (BOD), nitrates, phosphates, and coliform count were typically greater during dry periods because of decreased dilution and increased levels of pollutants, whereas wet periods had dilution impacts but also elevated microbial loads due to runoff. Seasonal grouping and variability analyses in rivers such as Bystrzyca (Poland), and lakes such as Ziway (Ethiopia) verified wet and dry season water quality regimes consistently. Groundwater investigations in India, Ethiopia, and Bangladesh provided information on seasonal variations of crucial parameters such as arsenic, nitrate, chloride, and salinity—often highest during dry months as a result of evapotranspiration and reduced recharge, and post-monsoon months had better quality in most places.

Multivariate methods (PCA, cluster analysis, trend analysis) accounted for variations in terms of both natural processes (geochemistry, redox reactions, dilution) and anthropogenic factors (agricultural runoff, industrial discharge, sewage infiltration). In the majority of regions, moderate to high seasonal threat to drinking and irrigation suitability was reported, emphasizing the importance of frequent, seasonally-timed monitoring to support effective water resource management.

From the research into the Impacts of sedimentation on rainwater quality, it is observed that sedimentation is effective in lowering microbial and turbidity loads in rainwater storage. Fast settling indicates that temporary storage enhances safety without the use of chemicals. From the research into the effects of soil erosion and sedimentation on surface water quality it is observed that gully erosion and sedimentation considerably degrade the water quality. This research focuses on the urban environment–runoff–river pollution connection.

CONCLUSIONS

The brief conclusions from selected research articles are:

1. Groundwater quality parameters vary widely in time, mostly because of hydrological (recharge, dilution), geochemical (water–rock interactions, redox processes), and anthropogenic influences (agricultural runoff, sewage, industrial discharge).
2. Surface waters exhibit strong seasonality, with dry seasons increasing concentrations of nutrients, organics, and contaminants.
3. A combined temporal-spatial framework, utilizing multivariate statistical methods, is required to detect the sources of pollution, quantify dynamic water quality change, and guide water management for sustainability.

Temporal water quality variation is ubiquitous—due to hydrological seasonality, geological conditions and redox states, and anthropogenic activity. Study-specific findings emphasize the importance of multi-season monitoring, seasonal modeling of contaminant dynamics, and dynamic water-quality management in relation to seasonal changes.

Research invariably finds that temporal variability is a key determinant of the quality of surface and groundwater systems, and that seasonal variations are controlled by hydrological processes, land use practices, and human activities. Dry seasons typically have higher dissolved solid, nutrient, and heavy metal concentrations because of less dilution, evaporation, and greater buildup of pollutants, whereas wet seasons have dilution but increased microbial contamination from surface runoff. Groundwater systems, especially, exhibit seasonally strong responses in parameters like nitrate, arsenic, chloride, and salinity, due to recharge, water–rock interactions, and variable water tables. Multivariate analyses (PCA, cluster, and trend analysis) confirm that both natural and anthropogenic factors control these changes. The conclusions emphasize the need for the implementation of seasonally adaptive water quality monitoring systems, incorporating high-frequency temporal information, and the use of strong statistical and geospatial analysis for better water resource management. Seasonal and long-term interventions are required for providing safe drinking water, sustainable irrigation, and conserving aquatic ecosystems.

By the research of the Impacts of sedimentation on rainwater quality it is observed that natural sedimentation greatly enhances rainwater quality—physical removal supports microbial reductions. It is a valuable baseline-level treatment for rural storage, but additional research is required for wider application. From the research on the Impacts of sedimentation on rainwater quality it can be deduced that erosion of soil is a significant contributor to surface water deterioration in Otamiri River. There is a need for erosion controls and land-use policy to safeguard the watershed.

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