Spatio-temporal patterns of river water quality in the klang river basin, malaysia: a functional data analysis approach to detect pre- and post-pandemic shifts

By Ali, NFM (Ali, Nur Fatihah Mohd) ; Mohamed, I (Mohamed, Ibrahim) ; Yunus, RM (Yunus, Rossita Mohamad) ; Othman, F (Othman, Faridah)

Source ENVIRONMENTAL MONITORING AND ASSESSMENT
Volume: 197 Issue: 11
DOI: 10.1007/s10661-025-14644-9

Article Number 1198

Published OCT 11 2025

Indexed 2025-10-16

Document Type Article

Abstract Understanding spatial and temporal patterns of river water quality over a multi-year period is crucial for effective basin management and pollution control. This study applies functional data analysis (FDA) to evaluate monthly water quality index (WQI) data from 16 monitoring stations across the Klang River Basin, Malaysia, covering the period from 2020 to 2023, which spans both pre- and post-pandemic conditions. By treating water

quality index (WQI) measurements as smooth functions over time, FDA captures underlying trends and variations that are not readily detected using classical statistical techniques. Functional principal component analysis (FPCA) reveals that the first component accounts for 97% of the total variation, reflecting the dominant pattern in water quality over time, which is characterized by relatively stable upstream conditions and gradual deterioration downstream. The second and third components capture seasonal fluctuations and short-term disturbances, potentially linked to monsoonal cycles and shifts in human activities during the pandemic. Functional clustering based on FPCA scores groups stations according to their temporal behavior, distinguishing upstream areas with stable conditions from downstream areas experiencing greater variability. Spatial interpretation of these clusters offers additional insight into localized pollution sources and environmental stressors. Compared to classical PCA, FDA provides a more detailed, curve-based understanding of time-dependent and location-specific changes in water quality. The result underscore the value of FDA in environmental monitoring, particularly for detecting pre- and post-pandemic shifts, and support its application in guiding adaptive and spatially targeted management strategies for river basins.

Keywords

Author Keywords: Functional principal component analysis; Spatio-temporal clustering; Water quality trends; Monsoonal influence; River basin monitoring

Keywords Plus: OUTLIERS

Addresses

[1] Int Islamic Univ Malaysia, Dept Computat & Theoret & Sci, Kulliyyah Sci, Kuantan 25200, Malaysia

[2] Univ Malaya, Inst Math Sci, Fac Sci, Kuala Lumpur 50603, Malaysia

[3] Univ Malaya, Fac Engn, Dept Civil Engn, Kuala Lumpur 50603, Malaysia

Categories/ Classification

Research Areas: Environmental Sciences & Ecology

Web of Science Categories

Environmental Sciences

+ See more data fields

Citation Network

In Web of Science Core Collection

0 Citations

42
Cited References

Use in Web of Science

0
Last 180 Days

0
Since 2013

This record is from:

Web of Science Core Collection

- Science Citation Index Expanded (SCI-EXPANDED)

Suggest a correction
If you would like to improve the quality of the data in this record, please Suggest a correction