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A Multivariate Evaluation of Water Quality and Regulatory Compliance from Diverse Sources

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INTRODUCTION & AIM

"In rapidly industrializing regions, water quality often becomes the invisible victim of economic growth, with consequences that flow directly into public health."

THE PROBLEM

Kano State, an industrial hub (textiles, tanneries, plastics)

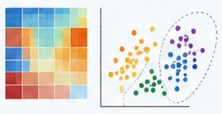
No prior multivariate assessment linking source pollution to regulatory compliance

SOURCE POLLUTION → WATER CONTAMINATION → PUBLIC HEALTH IMPACTS → ECONOMIC & SOCIAL CONSEQUENCES

THE AIM

1. **Evaluate water quality across 4 source types**

2. **Identify pollution patterns** and inter parameter dependencies



3. **Quantify compliance** with NSDWQ standards

To generate robust, data-driven evidence that supports effective water quality management and protects public health in Kano State.

EVIDENCE-BASED DECISIONS | REGULATORY COMPLIANCE | HEALTHIER COMMUNITIES | SUSTAINABLE ENVIRONMENT

METHOD

Total samples 33

Total locations 11

6 physicochemical parameters

Source Types

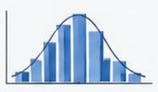
- Drinking Water (n = 11)
- Groundwater (n = 8)
- Industrial Wastewater (n = 7)
- Surface Water (n = 7)

PARAMETERS

pH	EC	DO	TDS	Turbidity	TSS
Acidity / Alkalinity	Electrical Conductivity	Dissolved Oxygen	Total Dissolved Solids	Water Clarity	Total Suspended Solids

ANALYTICAL TOOLKIT

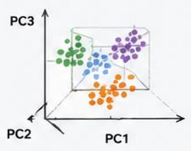
Descriptive stats — Summarize and describe data



One way ANOVA — Compare means across groups

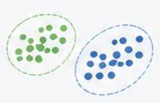
Pearson correlation — Assess linear relationships

Principal Component Analysis (PCA)



Reduce dimensionality and uncover patterns

k means clustering — Group samples with similar characteristics



Water Quality Index (WQI) — Aggregate multiple parameters into a single index

COMPLIANCE CHECK

Compare results with NSDWQ standards → Assess compliance for each parameter → Identify exceedances and risks → **COMPLIANT**

Meets NSDWQ Standards
Safe for public health

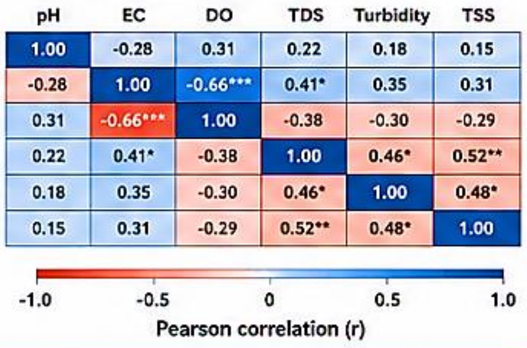
Comprehensive Assessment | Robust Statistical Analysis | Evidence-Based Decisions | Protects Public Health | Supports Sustainable Water Management

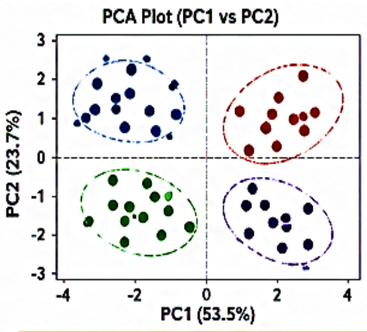
RESULTS & DISCUSSION

Surface water showed the highest overall quality (mean WQI = 88.4) and industrial wastewater the lowest (mean WQI = 56.6).

Compliance with drinking water standards was highest for TDS (90.9%) and lowest for turbidity (39.4%).

	pH	EC	DO	TDS	Turbidity	TSS
pH	1.00	-0.28	0.31	0.22	0.18	0.15
EC	-0.28	1.00	-0.66***	0.41*	0.35	0.31
DO	0.31	-0.66***	1.00	-0.38	-0.30	-0.29
TDS	0.22	0.41*	-0.38	1.00	0.46*	0.52**
Turbidity	0.18	0.35	-0.30	0.46*	1.00	0.48*
TSS	0.15	0.31	-0.29	0.52**	0.48*	1.00

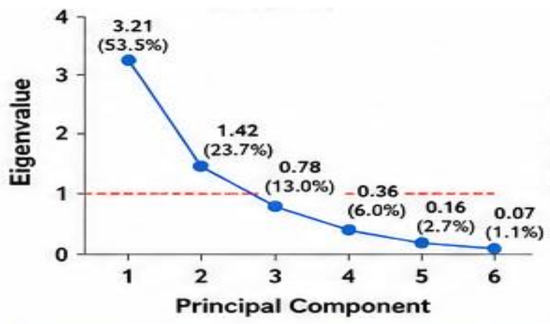


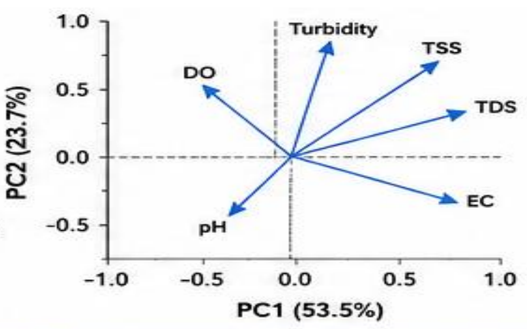


Significant moderate correlations: EC & DO ($r = -0.66$, $p < 0.001$) and TDS & TSS ($r = 0.52$, $p = 0.002$).

Four distinct water quality groups identified. Industrial wastewater samples (Cluster 1) form an isolated cluster, indicating higher pollution levels.

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$





The first two components explain 77.2% of the total variance.

TDS, EC, TSS and turbidity load positively on PC1; DO and pH load negatively.

CONCLUSION

Pronounced differences in water quality across source types.

Surface water has the best quality (WQI = 88.4); industrial wastewater the worst (WQI = 56.6).

Highest compliance: TDS (90.9%).

Lowest compliance: Turbidity (39.4%).

Significant correlations: EC & DO ($r = -0.66$**, $p < 0.001$) and TDS & TSS ($r = 0.52$**, $p = 0.002$).

Four clusters identified; industrial wastewater forms isolated cluster with poor quality.

Key Implications

Urgent need for improved industrial wastewater treatment and strengthened monitoring of groundwater resources to safeguard public health and water sustainability in Kano State, Nigeria.

FUTURE WORK / REFERENCES

NSDWQ, (2007). Nigerian Standard for Drinking Water. Nigerian Industrial Standard, NIS: 554, 13-14.