



# A MULTIVARIATE STATISTICAL APPROACH FOR PROCESS MONITORING AND PARAMETER INTERDEPENDENCY IN TEXTILE WASTEWATER TREATMENT

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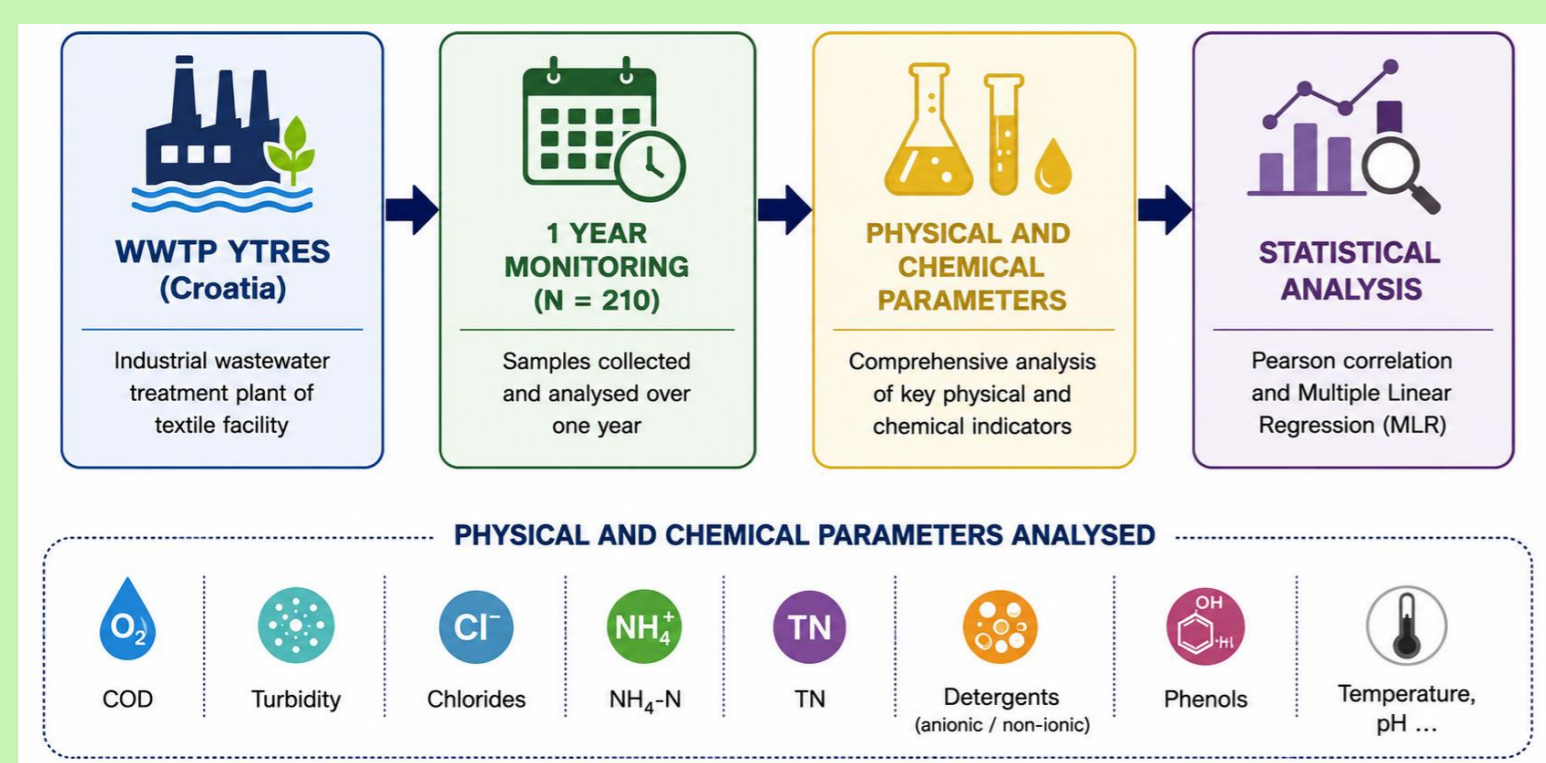
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## INTRODUCTION

This study explores how multivariate statistical methods can be used to better understand and monitor textile wastewater treatment. The research was carried out using wastewater samples collected over one year from an industrial treatment plant connected to a textile facility. Several important water quality parameters were monitored, including chemical oxygen demand (COD), turbidity, chlorides, sulphates, nitrogen compounds, phosphates, phenols, and detergents. Pearson correlation analysis and multiple linear regression were used to examine how these parameters are related and whether some of them could help estimate organic load more quickly. The results show that statistical analysis can provide useful insight into the behavior of textile wastewater and support more effective process monitoring. This approach may help operators detect changes in wastewater quality earlier, improve treatment performance and manage industrial wastewater in a more sustainable way.

## MATERIALS AND METHODS



## RESULTS

Table 1. Characterization of Influent and Effluent Wastewater Parameters (n=210)

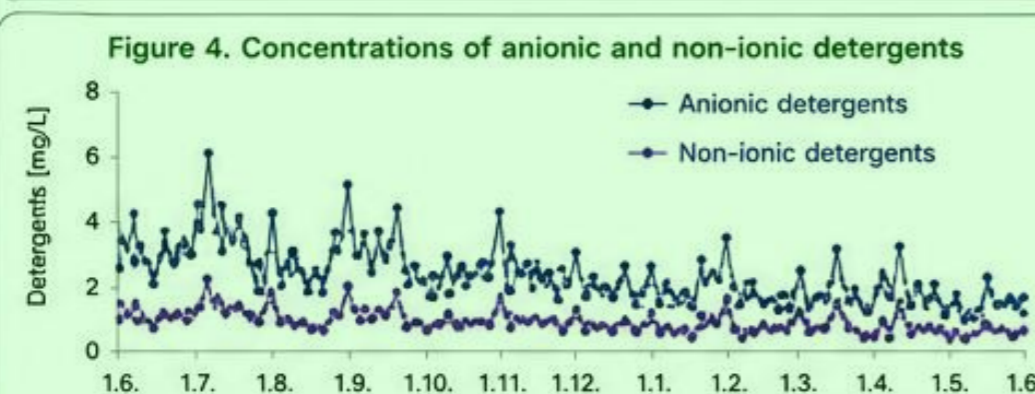
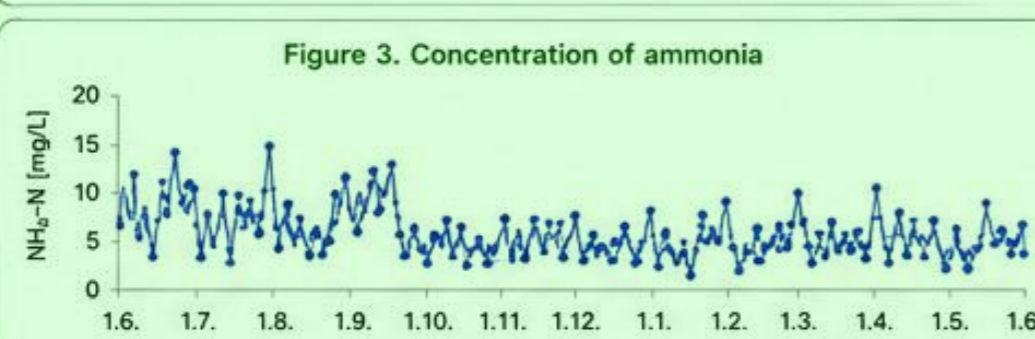
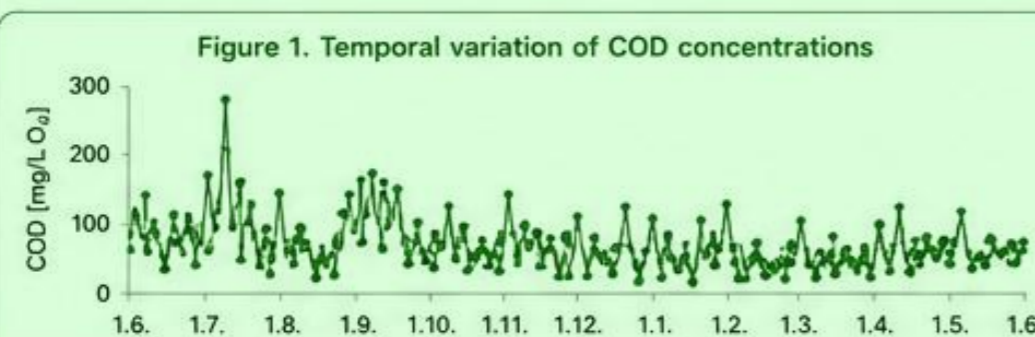
Parameter	Unit	Influent (Mean ± SD)	Influent (Range)	Effluent (Mean ± SD)	Effluent (Range)
pH	-	7.82 ± 0.28	7.50 – 9.02	7.58 ± 0.12	7.30 – 7.76
Temperature	°C	29.80 ± 1.45	26.70 – 32.70	18.20 ± 1.30	16.00 – 21.50
COD	mg/L	115.4 ± 32.1	68.0 – 280.0	38.5 ± 6.4	15.0 – 52.7
Turbidity	-	17.5 ± 5.8	6.0 – 28.0	2.8 ± 1.2	1.0 – 6.0
Susp. Solids	mg/L	82.5 ± 25.4	45.0 – 165.0	42.0 ± 30.9	5.0 – 135.0
Chlorides	mg/L	1285 ± 142.5	1062 – 1672	980 ± 165.2	654 – 1345
Sulphates	mg/L	78.5 ± 12.3	37.3 – 97.9	62.4 ± 10.8	31.0 – 85.0
Ammonia	mg/L	8.45 ± 4.12	1.05 – 18.0	1.25 ± 0.85	0.15 – 4.50
Nitrates	mg/L	14.2 ± 5.10	5.20 – 28.5	9.68 ± 6.10	0.33 – 25.0
Nitrites	mg/L	0.45 ± 0.18	0.12 – 0.95	0.31 ± 0.24	0.07 – 0.69
Phosphates	mg/L	0.85 ± 0.32	0.25 – 1.85	0.12 ± 0.09	0.001 – 0.59
Total Nitrogen	mg/L	28.1 ± 10.4	15.2 – 53.6	11.2 ± 3.40	6.24 – 18.5
Detergents	mg/L	3.25 ± 1.85	1.06 – 7.87	1.15 ± 0.35	0.40 – 1.69
Phenols	mg/L	0.42 ± 0.25	0.13 – 1.60	0.18 ± 0.08	0.05 – 0.35

### A) TREATMENT PERFORMANCE

Key treatment indicators (mean values)

Parameter	Influent (mean)	Effluent (mean)	Reduction
COD (mg/L)	115.4	38.5	↓ 66.6 %
NH <sub>4</sub> -N (mg/L)	8.45	1.25	↓ 85 %
Phosphates (mg/L)	0.85	0.12	↓ 86 %
Detergents (mg/L)	3.25	1.15	↓ 65 %

**Main outcome:**  
Stable pollutant removal and compliant effluent quality.

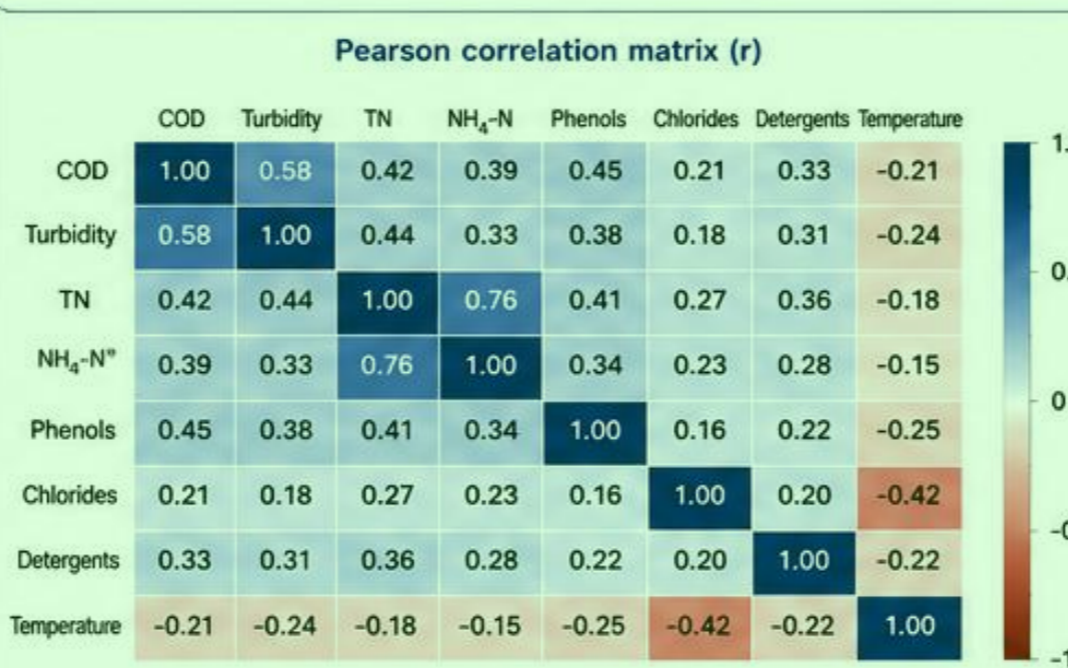
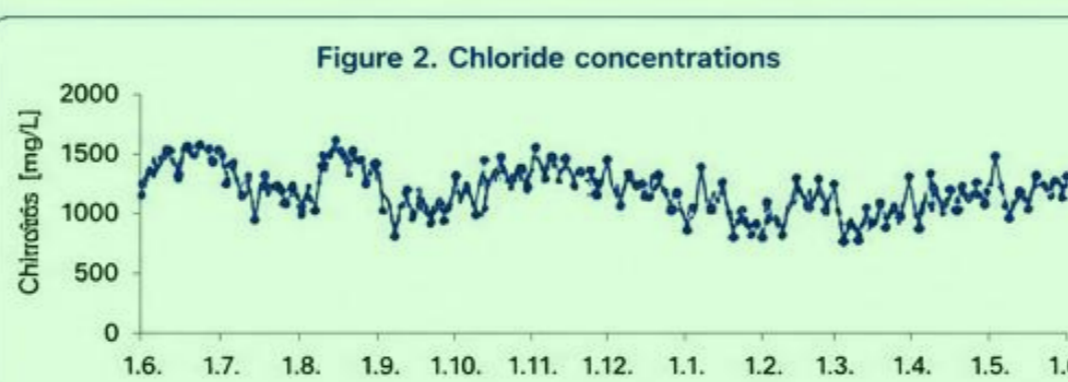


### B) CORRELATION ANALYSIS

Key Pearson correlations (p < 0.05)

Relationship	Pearson coefficient (r)
COD ↔ Turbidity	0.58*
TN ↔ NH <sub>4</sub> -N	0.76
COD ↔ TN	0.42
COD ↔ Phenols	0.45
Temperature ↔ Chlorides	-0.42

**Key finding:**  
Turbidity emerged as the strongest real-time proxy for COD monitoring.



### C) COD PREDICTION MODEL

Multiple linear regression model

$$\text{COD} = 35.12 + 3.08 (\text{Turbidity}) + 0.018 (\text{Chlorides}) + 2.38 (\text{Detergents}) + 0.42 (\text{Temperature})$$

Model performance

Metric	Value
R <sup>2</sup>	0.54
Prediction error	0.52 %
Significant predictors	Turbidity, chlorides, detergents

**Outcome:**  
Rapid estimation of organic load using easier-to-measure parameters.

Abbreviations / Notes

COD – Chemical Oxygen Demand  
TN – Total Nitrogen  
NH<sub>4</sub>-N – Ammonia nitrogen  
Cl<sup>-</sup> – Chlorides  
PO<sub>4</sub><sup>3-</sup> – Phosphates  
Detergents – Total surfactants (anionic and non-ionic)  
Turbidity – Water turbidity  
Temperature – Wastewater temperature

N = 210 (1-year monitoring period)