# Impact of parametric seasonal variations on water quality in the Crocodile River and Inyaka Dam in the Mpumalanga Province, South Africa

**Supplementary Material**

By

Lazarus Katlego Mogane[1,*], Esper J. Ncube[3], Titus A.M. Msagati[2], and Tracy M. Masebe[1]

[1]College of Agriculture & Environmental Sciences, Department of Life and Consumer Sciences, University of South Africa, Roodepoort, Gauteng, South Africa, 1709.

[2]College of Science, Engineering & Technology, Institute for Nanotechnology and Water Sustainability, University of South Africa, Roodepoort, Gauteng, South Africa, 1709.

[3]School of Health Systems and Public Health, Faculty of Health Sciences, University of Pretoria, Tshwane, Gauteng, South Africa, 0001.

*Denotes corresponding author at moganelk@gmail.com

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**Fig. S1** Illegal waste disposal site near the Crocodile River in the City of Mbombela (Photo by LK Mogane, 2021).

The Maviljan wastewater treatment plant is currently not fully functional and only serves as a reservoir for domestic sewage. Frame A in Fig S2 shows the sewage stored in the ponds to settle the water. Frame B is supposed to be the treated effluent sampling point, while frame C shows an overflowing manhole of the untreated effluent which pours directly into the Inyaka Dam. Frame D shows the ongoing progress towards completion of the Maviljan wastewater treatment works. This risk highlights the significance of water quality monitoring in the Inyaka dam to aid in the mitigation of pollution strategies and provide interim alternative solutions

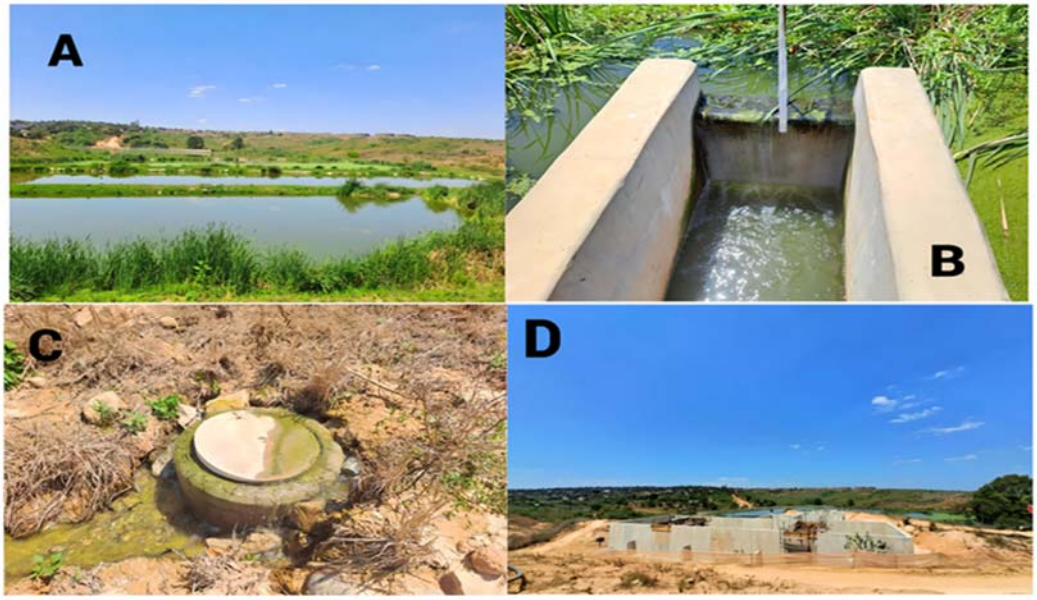


**Fig. S2** The Maviljan wastewater treatment plant in Bushbuckridge, Mpumalanga which discharges its effluent in the Inyaka dam (Photo by LK Mogane, 2021).

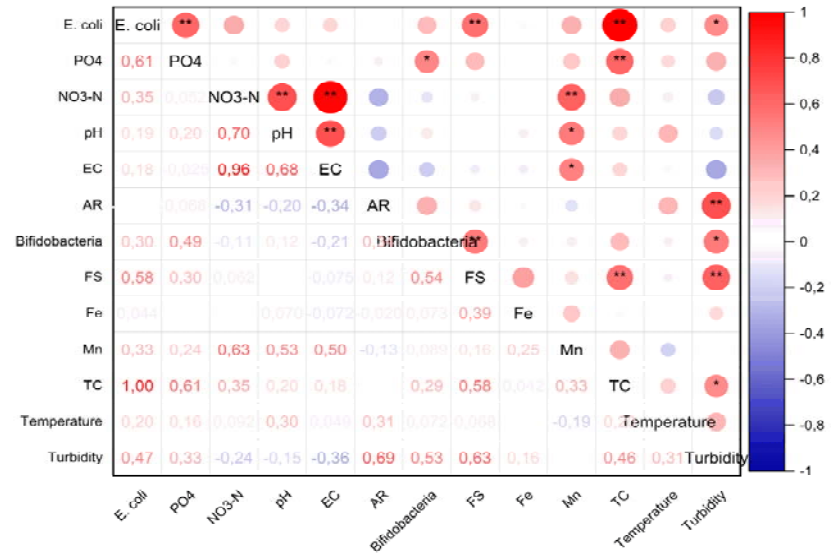


**Fig. S3** Correlation matrix for all measured parameters in the autumn season in the Inyaka Dam

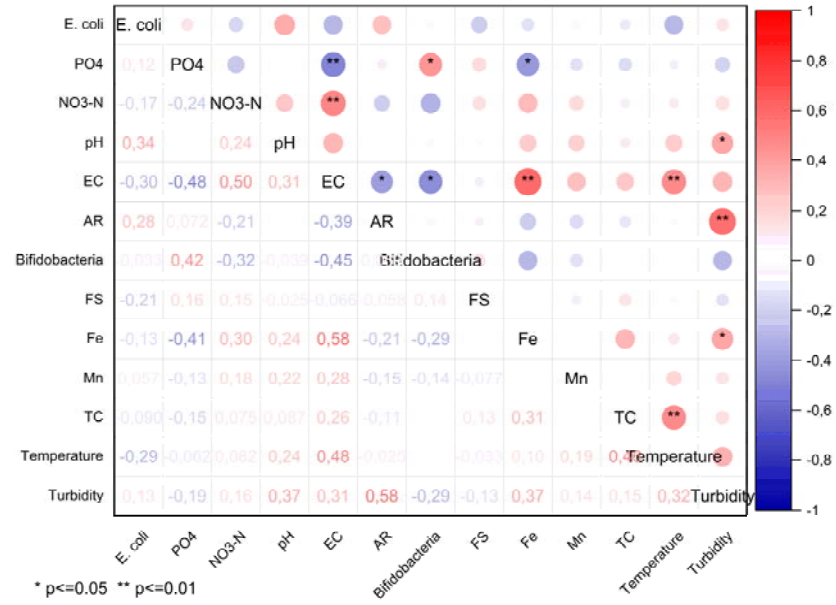


**Fig. S4** Correlation matrix for all measured parameters in the winter season in the Inyaka Dam

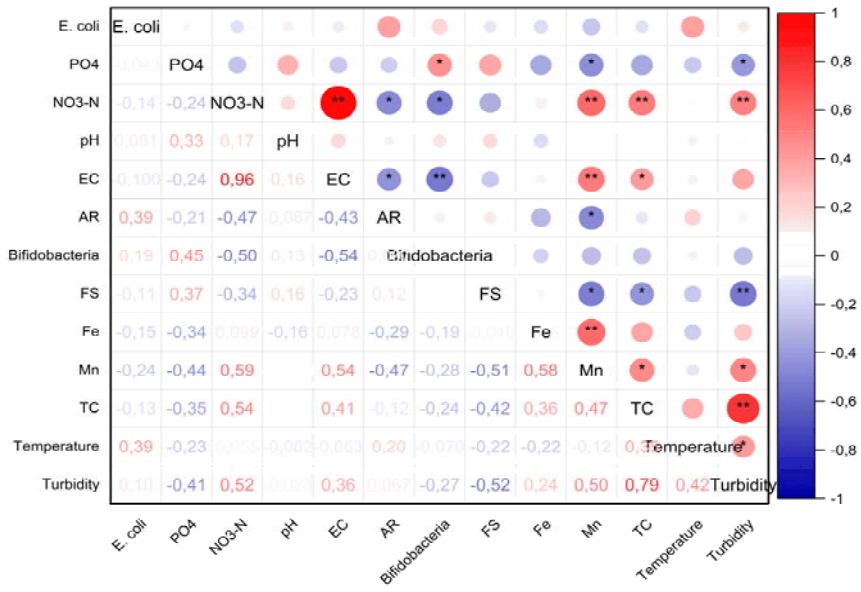


**Fig. S5** Correlation matrix for all measured parameters in the spring season in the Inyaka Dam

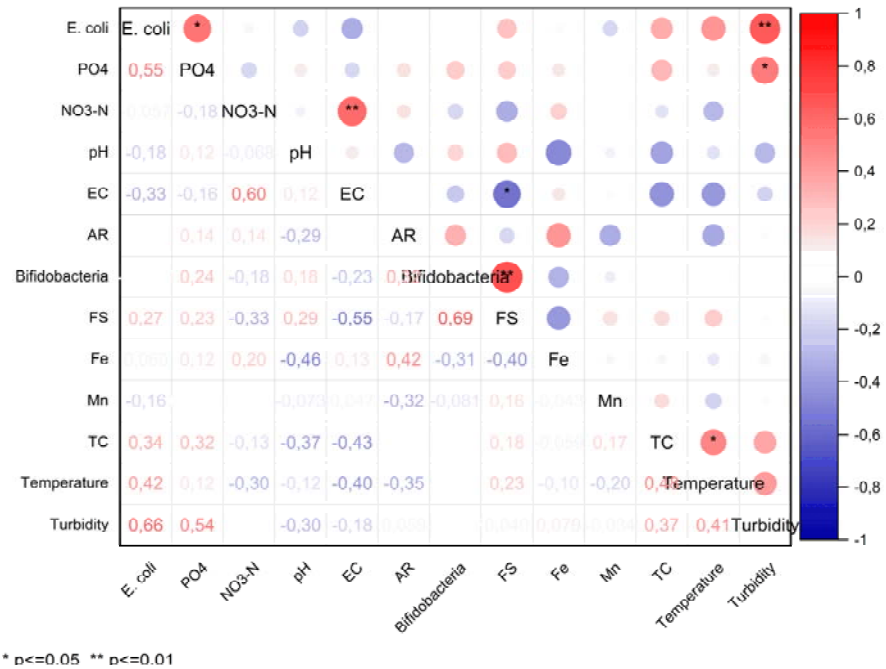


**Fig. S6** Correlation matrix for all measured parameters in the autumn season in the Crocodile River

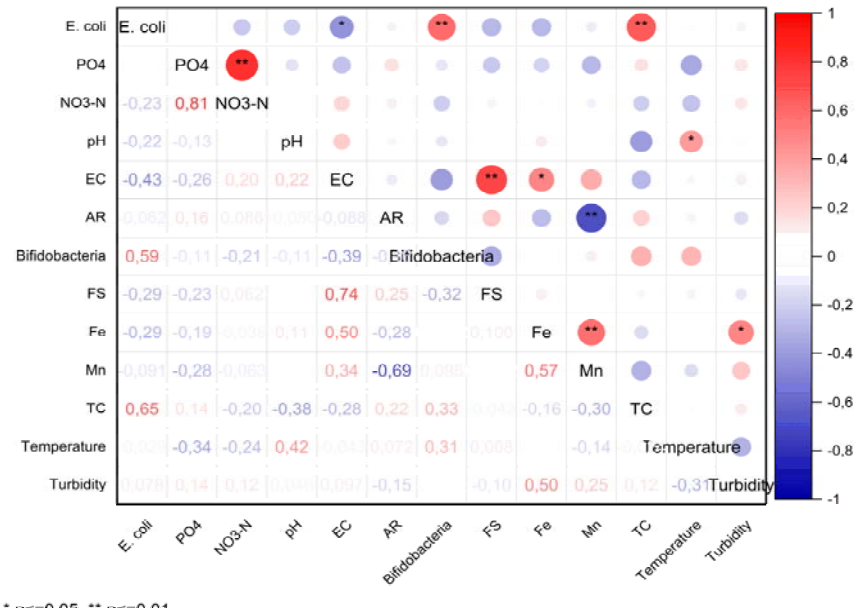


**Fig. S7** Correlation matrix for all measured parameters in the spring season in the Crocodile River

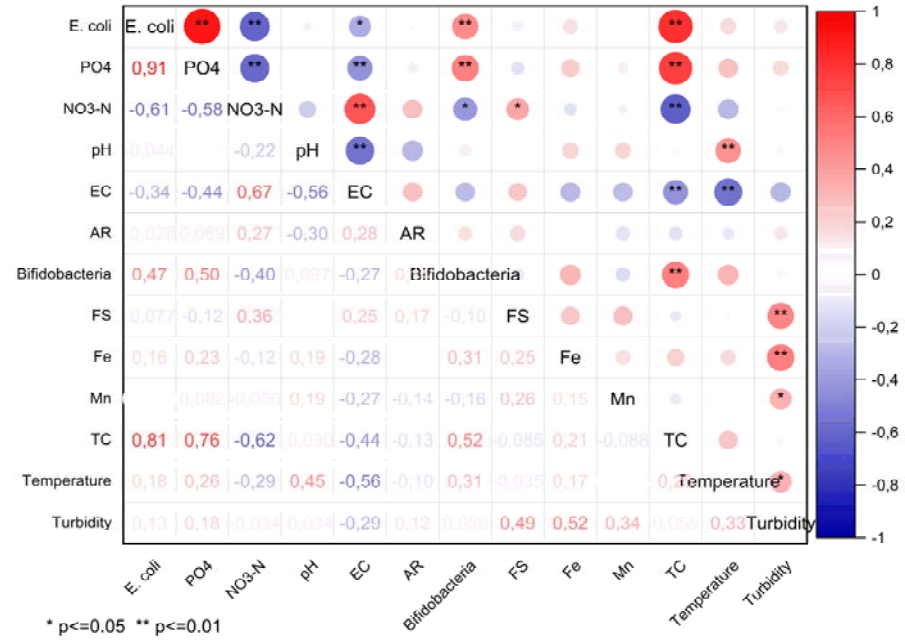


**Fig. S8** Correlation matrix for all measured parameters in the winter season in the Crocodile River.

**Table S1**: Correlation table of variables and main axes used to compute the PCA plots for the Inyaka Dam in summer

| | Components | | |
|---|---|---|---|
| Parameters | PC1 | PC2 | PC3 |
| Average Rainfall (mm) | **0.900** | -0.069 | -0.058 |
| *E. coli* | **0.844** | -0.022 | 0.227 |
| Turbidity | **0.747** | -0.029 | -0.242 |
| Faecal streptococci | **0.651** | -0.261 | 0.055 |
| Bifidobacteria | **0.566** | -0.276 | 0.292 |
| Total coliforms | **0.536** | 0.030 | -0.245 |
| Fe | -0.086 | **0.902** | -0.041 |
| Temperature | 0.020 | **-0.870** | -0.030 |
| $NO_3$-N | -0.215 | **0.736** | **0.570** |
| Electrical conductivity | -0.265 | **0.626** | **0.609** |
| $PO_4$ | 0.102 | 0.028 | **0.748** |
| Mn | 0.020 | -0.161 | -0.026 |
| pH | 0.024 | 0.221 | 0.396 |
| Initial eigenvalue | 3.72 | 2.53 | 1.60 |
| Percentage of variance (%) | 28.59 | 19.53 | 12.28 |
| Cumulative variance (%) | 28.59 | 48.12 | 60.40 |

Extraction method: Principal component analysis; Rotation method: Varimax with Kaiser Normalisation.

**Table S2**: Correlation table of variables and main axes used to compute the PCA plots for the Inyaka Dam in autumn

| | Components | | |
|---|---|---|---|
| Parameters | PC1 | PC2 | PC3 |
| Total coliforms | **0.934** | 0.219 | 0.022 |
| *E. coli* | **0.934** | 0.217 | 0.025 |
| $PO_4$ | **0.756** | 0.050 | 0.095 |
| Faecal streptococci | **0.629** | -0.059 | 0.120 |
| Bifidobacteria | 0.491 | -0.139 | 0.346 |
| $NO_3$-N | 0.147 | **0.938** | -0.124 |
| Electrical conductivity | -0.005 | **0.920** | -0.149 |
| pH | 0.054 | **0.865** | 0.170 |
| Mn | 0.235 | **0.647** | -0.204 |
| Temperature | 0.087 | 0.229 | **0.785** |
| Aver. rainfall | 0.033 | -0.296 | **0.781** |
| Turbidity | **0.530** | -0.285 | **0.615** |
| Fe | -0.049 | 0.072 | -0.010 |
| Initial eigenvalue | 4.00 | 3.36 | 1.37 |
| Percentage of variance (%) | 30.80 | 25.90 | 10.50 |
| Cumulative variance (%) | 30.80 | 56.60 | 67.20 |

Extraction method: Principal component analysis; Rotation method: Varimax with Kaiser Normalisation.

**Table S3**: Correlation table of variables and main axes used to compute the PCA plots for the Inyaka Dam in winter

| | Components | | |
|---|---|---|---|
| Parameters | PC1 | PC2 | PC3 |
| Bifidobacteria | **-0.755** | 0.197 | -0.064 |
| $PO_4$ | **-0.744** | -0.080 | 0.001 |
| Electrical conductivity | **0.728** | 0.444 | -0.232 |
| Fe | **0.690** | 0.247 | 0.078 |
| $NO_3$-N | **0.564** | 0.005 | -0.188 |
| Temperature | 0.015 | **0.884** | 0.021 |
| Total coliforms | 0.082 | **0.718** | 0.056 |
| Aver. rainfall | -0.175 | -0.075 | **0.892** |
| Turbidity | 0.375 | 0.282 | **0.758** |
| pH | 0.096 | 0.124 | 0.218 |
| Mn | 0.107 | 0.104 | -0.271 |
| *E. coli* | -0.190 | -0.443 | 0.408 |
| Faecal streptococci | -0.101 | 0.062 | -0.090 |
| Initial eigenvalue | 3.33 | 1.96 | 1,54 |
| Percentage of variance (%) | 25.60 | 15.05 | 11.84 |
| Cumulative variance (%) | 25.60 | 40.65 | 52.50 |

Extraction method: Principal component analysis; Rotation method: Varimax with Kaiser Normalisation.

**Table S4:** Correlation table of variables and main axes used to compute the PCA plots for the Inyaka Dam in spring

| | Components | | |
|---|---|---|---|
| Parameters | PC1 | PC2 | PC3 |
| Turbidity | **0.812** | 0.278 | 0.224 |
| Total coliforms | **0.777** | 0.288 | 0.018 |
| Faecal streptococci | **-0.770** | 0.020 | -0.062 |
| Mn | **0.682** | 0.284 | -0.521 |
| Electrical conductivity | 0.295 | **0.860** | -0.192 |
| $NO_3$-N | 0.451 | **0.818** | -0.167 |
| Bifidobacteria | 0.036 | **-0.816** | 0.038 |
| Temperature | 0.360 | 0.063 | **0.711** |
| Aver. rainfall | -0.184 | -0.235 | **0.696** |
| *E. coli* | 0.126 | -0.163 | **0.667** |
| Fe | 0.398 | -0.076 | **-0.576** |
| pH | 0.004 | 0.127 | 0.042 |
| $PO_4$ | -0.390 | -0.291 | -0.113 |
| Initial eigenvalue | 4.39 | 2.24 | 1.59 |
| Percentage of variance (%) | 33.74 | 17.23 | 12.22 |
| Cumulative variance (%) | 33.74 | 50.98 | 63.21 |

Extraction method: Principal component analysis; Rotation method: Varimax with Kaiser Normalisation.

**Table S5**: Correlation table of variables and main axes used to compute the PCA plots for the Crocodile River in summer

| | Components (Summer) | | |
|---|---|---|---|
| Parameters | PC1 | PC2 | PC3 |
| EC | **0.986** | -0.113 | -0.047 |
| Turbidity | **0.977** | -0.133 | -0.017 |
| Fe | **0.977** | -0.092 | -0.037 |
| Mn | **0.977** | -0.112 | -0.098 |
| $NO_3$-N | **0.900** | 0.094 | -0.155 |
| pH | **-0.737** | 0.048 | -0.450 |
| FS | **0.543** | -0.438 | -0.187 |
| AR | **0.527** | -0.191 | 0.019 |
| Temperature | 0.358 | -0.153 | -0.012 |
| Bifidobacteria | -0.096 | **0.938** | -0.011 |
| *E. coli* | -0.118 | **0.876** | 0.113 |
| $PO_4$ | 0.088 | 0.025 | **0.903** |
| TC | -0.222 | 0.124 | **0.805** |
| Initial eigenvalue | 6.23 | 1.96 | 1.52 |
| Variance explained (%) | 47.90 | 15.10 | 11.70 |
| Cumulative variance (%) | 47.90 | 63.00 | 74.70 |

Extraction method: Principal component analysis; Rotation method: Varimax with Kaiser Normalisation.

**Table S6:** Correlation table of variables and main axes used to compute the PCA plots for the Crocodile River in autumn

| | Components (Autumn) | | |
|---|---|---|---|
| Parameters | PC1 | PC2 | PC3 |
| *E. coli* | **0.778** | 0.045 | 0.178 |
| $PO_4$ | **0.542** | 0.193 | 0.397 |
| $NO_3$-N | -0.260 | **-0.530** | 0.142 |
| pH | -0.439 | **0.549** | -0.104 |
| Electrical conductivity | **-0.544** | **-0.508** | 0.015 |
| Average rainfall | -0.022 | -0.196 | **0.890** |
| Bifidobacteria | -0.033 | 0.716 | **0.519** |
| Faecal streptococcus | 0.210 | **0.859** | 0.052 |
| Fe | 0.136 | **-0.658** | 0.373 |
| Mn | -0.028 | 0.008 | -0.407 |
| Total coliforms | 0.719 | 0.046 | -0.131 |
| Temperature | **0.682** | 0.181 | -0.344 |
| Turbidity | **0.772** | -0.128 | 0.151 |
| Initial eigenvalue | 6.23 | 1.96 | 1.52 |
| Total variance explained (%) | 47.90 | 15.10 | 11.70 |
| Cumulative variance (%) | 47.90 | 63.00 | 74.70 |

Extraction method: Principal component analysis; Rotation method: Varimax with Kaiser Normalisation.

**Table S7**: Correlation table of variables and main axes used to compute the PCA plots for the Crocodile River in winter

| | Components (Winter) | | |
|---|---|---|---|
| Parameters | PC1 | PC2 | PC3 |
| *E. coli* | **0.939** | -0.040 | 0.063 |
| $PO_4$ | **0.917** | 0.055 | 0.126 |
| Total coliforms | **0.893** | 0.084 | -0.007 |
| $NO_3$-N | **-0.738** | -0.375 | 0.194 |
| Bifidobacteria | **0.564** | 0.294 | 0.065 |
| pH | -0.110 | **0.820** | -0.009 |
| Temperature | 0.171 | **0.767** | 0.164 |
| Electrical conductivity | -0.444 | **-0.743** | -0.070 |
| Turbidity | 0.106 | 0.155 | **0.854** |
| Faecal streptococcus | -0.196 | -0.198 | **0.766** |
| Fe | 0.190 | 0.305 | **0.627** |
| Mn | 0.016 | 0.037 | 0.465 |
| Average rainfall | -0.056 | -0.296 | 0.296 |
| Initial eigenvalue | 4.28 | 2.15 | 1.9 |
| Total variance explained (%) | 32.90 | 16.60 | 14.70 |
| Cumulative variance (%) | 32.90 | 49.50 | 64.20 |

Extraction method: Principal component analysis; Rotation method: Varimax with Kaiser Normalisation.

**Table S8:** Correlation table of variables and main axes used to compute the PCA plots for the Crocodile River in spring

| | Components (Spring) | | |
|---|---|---|---|
| Parameters | PC1 | PC2 | PC3 |
| *E. coli* | -0.044 | **0.771** | -0.357 |
| $PO_4$ | -0.184 | 0.031 | -0.216 |
| $NO_3$-N | -0.024 | -0.244 | 0.055 |
| pH | 0.106 | -0.271 | 0.024 |
| Electrical conductivity | 0.348 | -0.294 | **0.806** |
| Average rainfall | **-0.708** | 0.198 | 0.381 |
| Bifidobacteria | 0.146 | **0.600** | -0.437 |
| Faecal streptococcus | -0.108 | -0.099 | **0.884** |
| Fe | **0.786** | 0.028 | 0.352 |
| Mn | **0.854** | -0.203 | -0.037 |
| Total coliforms | -0.206 | **0.863** | 0.042 |
| Temperature | -0.191 | 0.078 | -0.016 |
| Turbidity | **0.612** | 0.351 | 0.144 |
| Initial eigenvalue | 3.14 | 2.40 | 2.10 |
| Total variance explained (%) | 24.10 | 18.50 | 16.2 |
| Cumulative variance (%) | 24.10 | 42.60 | 58.80 |

Extraction method: Principal component analysis; Rotation method: Varimax with Kaiser Normalisation