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Identifying the Most Critical Season for Variation in Water Quality by using Principal Component Analysis

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ABSTRACT

Multivariate statistical techniques, including Seasonal Indices and principal component analysis (PCA) were used to evaluate the seasonal variations and to interpret a critical season which is responsible for the variation in water quality data sets collected from the Wular Lake in Kashmir. The data sets, which contained 10 parameters for the four seasons Winter, Spring, Summer & Autumn were collected during a year monitoring program at 5 different sites along the Lake. Variation were found for the four season by Seasonal Indices and by the PCA the season spring is highly processed and value added for the variation in the quality of water whereas the summer & Autumn is moderately responsible for the changes in the water quality and winter are not value added. Furthermore, this study revealed that the major cause of water quality changes is due to Season.

Keywords: *Seasonal Indices, Principal Component Analysis, Seasons*

1. INTRODUCTION

Lakes are among the most vulnerable water bodies to pollution because of their role in carrying domestic and industrial wastes and run-offs from agricultural lands in their vast drainage basins. Detailed hydro chemical re-search is needed to evaluate the different processes and mechanisms involved in polluting water. Furthermore, due to seasonal variations in water qualities, monitoring programs that involve a large number of physicochemical parameters and frequent water samplings at various sites are mandatory to produce reliable estimated topographies of water qualities. The results are usually compiled into a large data matrix, which requires sophisticated data interpretations.

A variety of Statistical assessment models, including seasonal water quality index model and PCA has been used to study the physicochemical interrelationships and processes. The multivariate statistical analysis methods have the advantage of explaining complex water quality monitoring data to get a better understanding of the ecological status of the studied systems. The multivariate statistical analysis has been successfully applied in a number of hydrogeo-chemical studies. All the studies show that multivariate statistical analysis can help to interpret the complex data sets and assess the water quality, and it is useful in verifying variations caused by natural and anthropogenic factors linked to seasonality.

In the study the large data base analyzed, which contained 10 parameters for the four seasons Winter, Spring, Summer & Autumn were collected during a year monitoring program at 5 different sites along the Lake. It was subjected to different multivariate

statistical techniques (Seasonal Indices, principal components analysis (PCA)) with a view to extract information about the similarities or dissimilarities among the seasonal water quality. Variation were found for the four season by Seasonal Indices and by the PCA the season spring is highly processed and value added for the variation in the quality of water whereas the summer & autumn is moderately responsible for the changes in the water quality and winter is not value added.

2. MATERIAL AND METHODS

Five different Stations at Wular Lake in Kashmir were selected in order to study the Physicochemical Characteristics of lake water samples for the years. The study based on secondary data collected from various relevant government departments, published and unpublished reports.

For the seasonal indices data were collected for the ten parameters of the lake such as Dissolved Oxygen (mg/l), pH, Alkalinity (mg/l), Chloride (mg/l), Total hardness (mg/l), Conductivity (us/cm.), Total solids(mg/l), TDS (mg/l), TSS (mg/l) and Nitrate (mg/l), for the four seasons Winter, Spring ,Summer & Autumn. Software Minitab is used to evaluate the seasonal indices for the different parameters.
After that we apply the Principal Component Analysis (with the help of Minitab) on the seasonal indices for the four seasons to identify the critical season for the variation in water quality.

3. RESULTS

The analysis of the Table: 1 shows the seasonal indices for the different seasons.

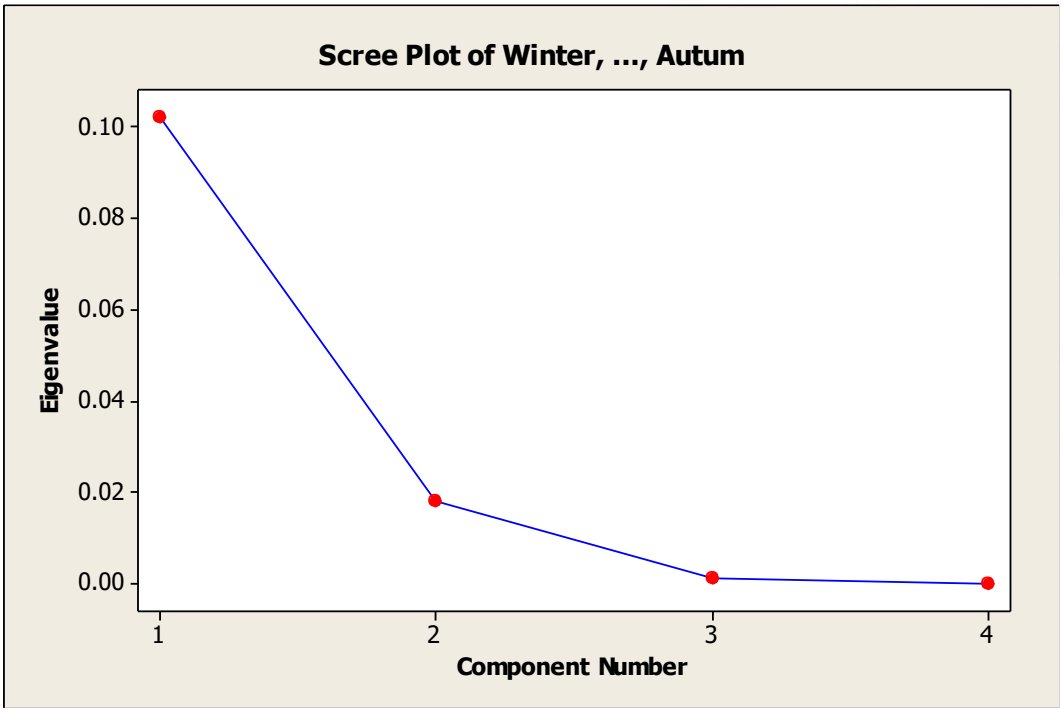
Parameters	Winter	Spring	Summer	Autumn
D.O.	1.159	1.007	0.821	1.013
Ph.	1.004	0.995	0.995	1.006
Alkalinity	0.782	1.004	1.223	0.991
Chloride	0.977	1.083	1.002	0.938
Conductivity	0.95	1.169	0.918	0.964
Total Hardness	0.891	1.354	0.883	0.872
Total Solids	0.713	1.447	0.928	0.912
TDS	0.793	1.274	0.957	0.975
TSS	0.503	1.857	0.89	0.751
Nitrate	0.864	1.249	0.97	0.921

Table: 1

The Principal Component Analysis by the four components is represented by the following tables:

Eigen analysis of the Covariance Matrix

Eiganvalues	.10203	0.01795	0.00116	.000
Proportion	0.842	0.148	0.010	.000
Cumulative	0.842	0.990	1.000	1.000



Principal Component Analysis

Variables	PC1	PC2	PC3	PC4
Winter	-0.507	-0.580	-0.398	-0.498
Spring	**0.826**	-0.254	-0.058	-0.499
Summer	-0.091	**0.771**	-0.386	-0.498
Autumn	-0.227	0.063	**0.830**	-0.505

4. DISCUSSION AND CONCLUSION

On the basis of the above study we conclude that all the parameters showing the seasonal indices greater than one in the spring season and in summer & autumn the values of the indices is almost one and for some parameters it's one. It reveals that there is a variation in the water quality of the lake due to season.

PCA helped to identify that the Season responsible for water quality variations and the principal components revealed that the season spring is highly processed and value added in the variation in the quality of water whereas the summer & autumn is moderately responsible for the changes in the water quality and winter is not value added.

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