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ASSESSMENT OF WATER QUALITY OF KAVERI RIVER IN ERODE DISTRICT, TAMIL NADU BY A VARIANCE VARIABLE TECHNIQUE

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Abstract: In this study, multiple water quality parameters of the river Kaveri observed at the station Erode for six years were collected and analyzed using principal component analysis. A dedicated computational program was prepared and the data were fed into it in order to process and understand the data as a cluster. The output graphs were analyzed for both linear and or non-linear relationships between the variables such as water quality parameters and the constants such as the years. The results indicated the linear relationship between the chloride and coli and other interesting correlations between the variables and constants.

Keywords: Principal component analysis, water quality, Kaveri, Erode, chloride, fecal coli.

Introduction

Rivers are important resources for drinking water. Periodical assessment of river water quality and interpretation of the results are very much important for sustainable development of the society. However, extraction of information from complex data is rather difficult. Preceding researches reported several mathematical assessment models such as Bayesian models [1], fuzzy index model [2], and principal component analysis [3-11].

Among the techniques, it has been demonstrated that principal component analysis (PCA), a variance variable technique, is one of the best technique for reducing the dimensions of the data. PCA is successfully used for several analyses including quasi-harmonic analysis in protein research, performance evaluation of corrosion inhibitors, and for analyzing metabolomic data of NMR [12-15].

In this study, the water quality of Kaveri river at Erode station, Tamil Nadu was subjected to PCA in view of extraction of information about linear and non-linear correlations among the data collected at different years.

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Experimental

In this study, the water quality parameters such as pH, dissolved oxygen (DO), biological oxygen demand (BOD), chloride, sulphate, nitrate, total hardness, fecal coli, and total coli (Table 1) present in the sample were obtained from the Government of Tamil Nadu database [16] for the district of Erode. The data were subjected to PCA using Scilab software using a dedicated program. There were some parameters without the corresponding data for certain years. In those cases, arbitrary values were taken into account. Then the data were fed into the program and run using Scilab to get output.

Table 1. Water quality parameters observed at Erode, Tamil Nadu, India

Year	pH	D.O mg/l	B.O.D mg/l	Chloride mg/l	Sulphate mg/l	Nitrate mg/l	Total hardness mg/l	Fecal coli MPN/100ml	Total coli MPN/100ml	DBU Rank
2004-2005	8.00	5.10	3.90	50	20	0.34	150	1918	6257	3
2005-2006	8.00	5.60	3.20	165	59	0.25	232	809	2183	3
2006-2007	7.30	4.50	6.70	53	21	0.19	164	503	1413	2
2008-2009	7.44	5.30	1.44	84	43	0.21	150	607	967	3
2009-2010	7.88	3.60	7.60	0.11	28	0.21	150	1019	2215	4
2010-2011	7.84	3.60	7.60	0.24	28	0.21	168	1019	430	2

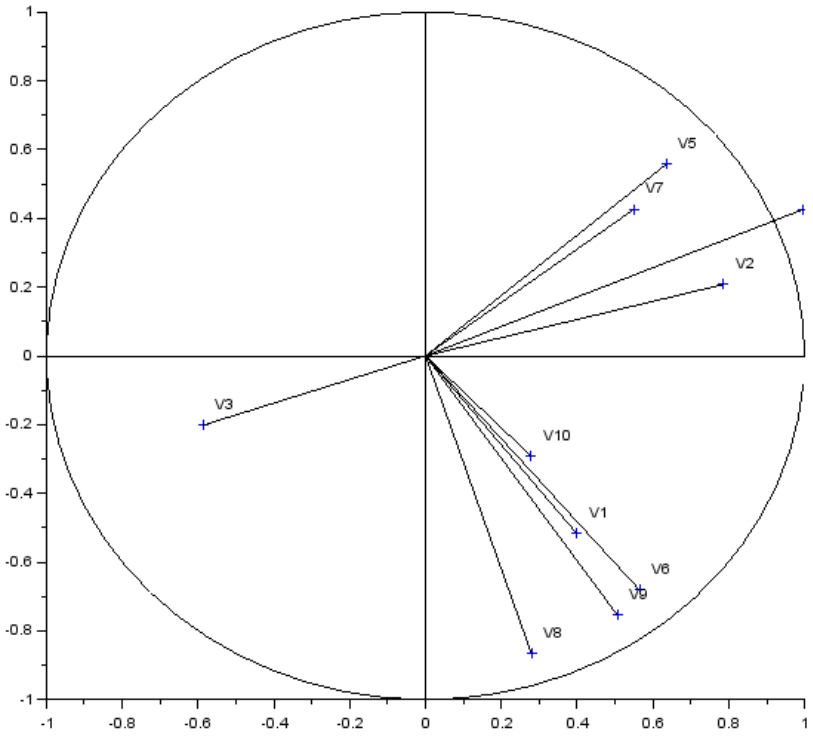
Results and Discussion

In this study, the water quality parameters along with the rank were considered as variables (V1 to V10). Similarly, the years were considered as constants. The parameters shown in Table 1 were input to the Scilab program. And the Figures 1(a) & (b) represent the output from the program.

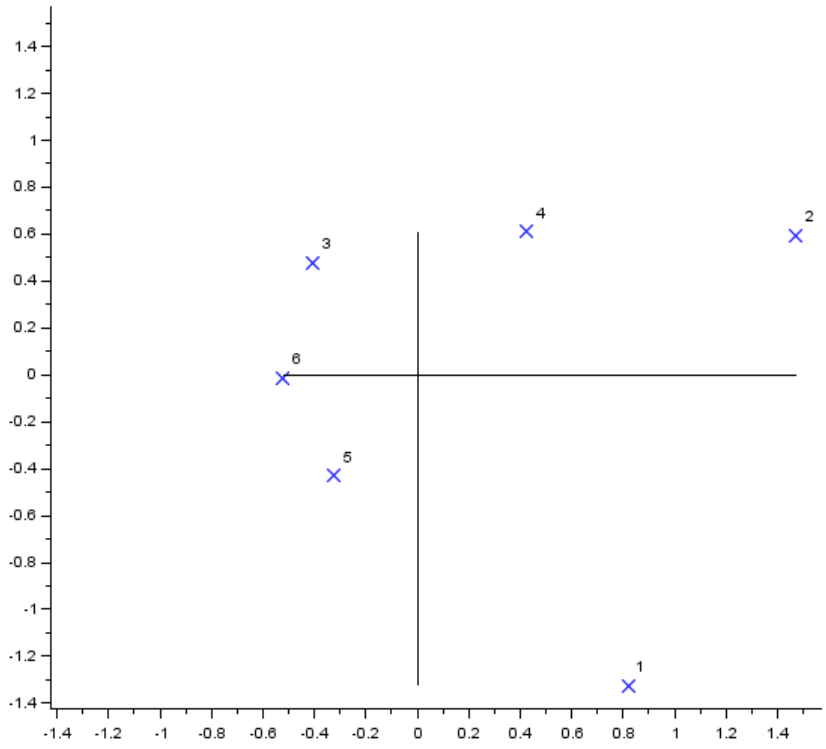
Based on the results, the characteristics of the variables are categorized into 3 groups as follows (Figure 1a): group 1 (V2, V4, V5, V7), group 2 (V1, V6, V8, V9, V10), and group 3 (V3). In most cases, the variables present in the group 1 are nearly perpendicular (90^o) to the variables of group 2. Further, V3 and variables of group 2 is also perpendicular to each other. This is attributed to the non-linear relationship between these variables. Apparently, the concentration of chloride (V3) will have effect on the total coli (V10) present in the

water. Meanwhile, the angles between (V3, V4) and (V2, V3) are close to 180^{o}. This characteristic behavior is due to the linear relationship between them.

In contrary to the previous study on river water quality [5], in this study the overall water quality of Kaveri at Erode could not be grouped since the scores of each year at far from each other (Figure 1b). The water quality observed during 2004–2005 and 2005-2006 are different and specific among other years. From the plot, it is easy to identify that the quality of water observed during 2004–2005 and 2005-2006 were better than others due to their high scores on the X-axis. Whereas, the quality of water observed during 2010–2011 is more polluted than other years. It is interesting to note that the quality of water during 2008-2009 is better than 2006–2007. This may be attributed to the lesser total coli counts and better BOD levels in the water during 2008 – 2009.



(a)



(b)

Figure 1. Scores and relationship plots of (a) variables – water quality parameters and (b) constants - overall quality of river water over the years for water quality observed at Erode, Tamil Nadu, India.

Conclusion

Principal component analysis is one of the best techniques for dimension reduction of complex data. In the present study the water samples of Kaveri river collected at Erode, Tamil Nadu, India over 6 years were subjected to principal component analysis using Scilab software. The results suggested that the quality of water in 2010 – 2011 is the most polluted one than the other samples collected at different years. The results also suggested for direct relationship between the chloride and the total coli present in the river water. Similar to the present study, the water quality data with many other parameters observed over a long term can also be subjected to principal component analysis for understanding of the trend of water pollution and to create a database.

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References

[1] M.E. Borsuk and C. A. Stow, "Bayesian parameter estimation in a mixed-order model of BOD decay," Water Research, 2000, 34, 1830-1836.

[2] Y.T. Liou and S.L. Lo, "A fuzzy index model for trophic status evaluation of reservoir waters," Water Re-search, 2003, 39, 7, 1415-1423.

[3] Y. Li, L. Xu, S. Li, "Water quality analysis of Songhua River Basin using Multivariate Techniques", J. Water Resource and Production, 2009, 2, 110-121.

[4] J. Femila Mercy Rani, D. Ramya, "Determination of principal component for selection of corrosion inhibition using principal component analysis", Chemical Science Review and Letters, 2014, 2, 526-530.

[5] M. Sukumaran, K. Devarayan, "Evaluation of water quality of Kaveri river in Tiruchirappalli District, Tamil Nadu by Principal Component Analysis", Current World Environment, 2016, 11, 89-95.

[6] M. Sukumaran, K. Devarayan, "Interpretation of water quality of Kaveri river in Mohanur, Tamil Nadu by multivariate technique", International Journal of Science, Environment and Technology, Accepted, 2016, 5(4).

[7] J. Jing, C. Yufei, "Assessment of groundwater quality based on Principal Component Analysis Method", International Journal of Civil and Structural Engineering, 2011, 2, 661-666.

[8] I.T. Jolliffe, "Principal Component Analysis", 2nd Edition, *Springer Verlag*, New York, 1986, 1-20.

[9] S. Salman, S. Abolfazl, S. Bahram, M.B. Sayed, "Modeling spatial pattern of salinity using MIKE21 and principal component analysis technique in Urmia lake", Current World Environment, 2015, 10, 626-633.

[10] O. Sanaa, "Cluster and Factor Analysis of Groundwater in Mafraq Area, Jordan", Current World Environment, 2015, 10, 422-431.

[11] D. Majid, S. Bahram, R. Firoozeh, K. Ahmad, "Uncertainty analysis of monthly stream flow forecasting. Current World Environment, 2014, 9, 894-902.

[12] W. Petersen, L. Bertino, U. Callies, E. Zorita, "Process identification by principal component analysis of river water-quality data", Ecological Modelling 2001, 138, 193-213.

[13] J.K. Nicholson, J.C. Lindon, E. Holmes, "Metabonomics: understanding the metabolic responses of living systems to pathophysiological stimuli via multivariate statistical analysis of biological NMR spectroscopic data", Xenobiotica 1999, 29, 1181–1189.

[14] R. Stoyanova, T.R. Brown, “NMR spectral quantitation by principal component analysis”, NMR in Biomedicine, 2001, 14, 271–277.

[15] J.C. Lindon, E. Holmes, J.K. Nicholson, “Pattern recognition methods and applications in biomedical magnetic resonance”, Progress in Nuclear Magnetic Resonance Spectroscopy, 2001, 39, 1–40.

[16] Pollution database for Tamil Nadu, April 2014.