

## EVALUATION OF GROUND WATER QUALITY USING MULTIPLE LINEAR REGRESSION AND MATHEMATICAL EQUATION MODELING

**Hemant PATHAK\***

Indira Gandhi Govt. Engineering College, Department of Chemistry, Sagar, (M.P.), India  
E-mail: [hemantp1981@yahoo.co.in](mailto:hemantp1981@yahoo.co.in)

**Abstract:** A methodology for characterizing ground water quality of Bhainsa village, Sagar city, India using physico-chemical data that include multiple regression and mathematical equation modeling. The aim of this research to collect physico-chemical data in order to explore the composition of groundwater samples using mathematical equation modeling. Multiple regression analysis is used to determine the sources of variation between parameters. Thus, an equation is explored for the sampled ground water. Using software, the Mathematical equation modeling allows, testing in simultaneous analysis the entire system of variables in order to determine the extent to which it is consistent with the data. For this purpose, it should investigate simultaneously the interactions between the different components of ground water and their relationship with DO. The integrated result provides a method to characterize ground water quality using statistical analyses and modeling of physico-chemical data in Bhainsa village to explain the ground water chemistry of that area.

**Key words:** Ground water quality, Mathematical equation modeling

\* \* \* \* \*

### INTRODUCTION

In recent decades, multivariate statistical methods have been employed to extract significant information from physico-chemical datasets in compound systems. The present study attempts to establish a mathematical water quality model. Since the data obtained in this study had multivariate nature and several of the variables were correlated, multiple regression analysis methods were used for the interpretation of the data. Multiple linear regression (MLR) is an accurate tool to evaluate ground water quality, since it generates a minimum data set of indicators. Then, all the variables would be included simultaneously into single model in order to test the potential interactions between the independents variables using the Mathematical equation modeling (SEM).

### MATERIALS AND METHODS

The study site covers entire area of Bhainsa village, Sagar city, India. In this total of 57 water samples were collected from 05 sampling station during Sep. 2007 to Sep. 2011. All the

---

\* Corresponding Author

samples, collected in tight capped high quality polyethylene bottles, were immediately transported to the laboratory under low temperature conditions in ice-box and stored in the laboratory at 4 °C until processed analyses. Hemant et al. Studied Sagar region from many years (Pathak, 2012; Pathak & Limaye, 2008a, b, c; Pathak & Limaye, 2011a, b, c, d; Pathak & Limaye, 2012a, b, c, d, Pathak et al., 2011, Pathak et al., 2012).

All the chemicals used were of AR grade. Analysis was carried out for various water quality parameters were measured by using Standard methods (APHA, 2005). Results obtained were subjected to multivariate statistical analysis using SPSS. 11<sup>1</sup>, Winks SDA 6.0.5<sup>2</sup>, multivariate statistical analysis has been performed using standard methods. Test results compare to IS : 10500 Standards (Indian standard drinking water, 1991). Hydrochemistry of the of Bhainsa village, Sagar city was summarized through the statistical analysis and mathematical modeling of ground water properties. The general purpose of multiple linear regressions is to quantify the relationship between several independent or predictor variables and a dependant variable.

MLR method provides equation linking a dependant variable  $V_d$  to the independent variable  $V_i$  using the MLR regression analyses, Investigate the relationships between DO and physico-chemical properties.  $V_d = \beta_0 + \beta_1 V_{i1} + \dots + \beta_n V_{in}$

When the intercept  $\beta_0$  and the regression coefficients of descriptors ( $\beta_i$ ) are determined by least square method.

$V_i$  descriptors are used to describe water quality and cation dependence.

(n) is the number of water samples.

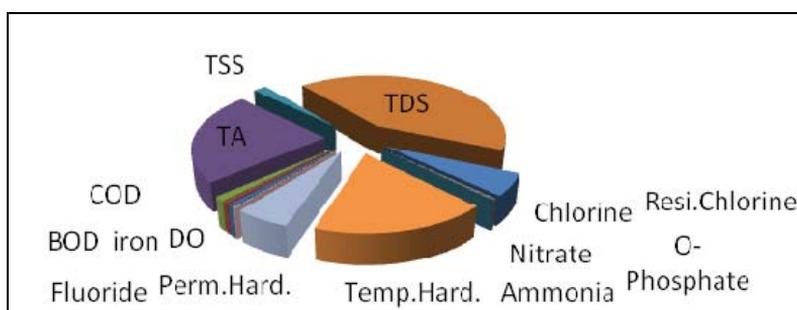
The reduction in the number of descriptors (variables) is included in the study to minimize the information overlap in variables. The best equation is selected while being based on the highest multiple correlation coefficients (R), lowest standard deviation (SD). Relationships between variables were established using the forward stepwise regression method. The MLR modeling method was performed by the SPSS statistical program.

## RESULTS AND DISCUSSION

Regression analysis was conducted to investigate the relationships between DO and physico-chemical properties. 20 physico-chemical were considered as independent variables and DO as a dependent variable.

After obtaining various equations with ground water samples. An analysis of residuals was developed and  $R^2$  values were studied. The multiple R coefficients indicate that the correlation between physico-chemical properties and DO is moderate. The positive sign of the beta coefficients pertaining to these variables indicates that there is a positive relationship between DO and physico-chemical properties.

The selected MLR equation for ground water in Bhainsa village, Sagar city is:



**Figure 1.** Ground Water

<sup>1</sup> <http://www.spss.com>

<sup>2</sup> [www.texasoft.com](http://www.texasoft.com)



of the of Bhainsa village, Sagar city showed that water chemistry is related to water rock interaction and/or dissolution of evaporitic formation from where dominance of  $[SO_4]$ . Although, the illustrated approach exhibits the limitation that results of the study only verify that the proposed relationships among variables in the conceptual model were supported by the sample data collection. Goodness of fit of this model can be worked by multiplying water sample and analyzed parameters. Sampling places has intensive agriculture areas. It was reported that groundwater was contaminated from nitrate fertilizers and manures used in agriculture. Furthermore, nitrate is used by microorganisms as food resources. In addition, high nitrate levels are often accompanied by bacterial and pesticide contamination. The water quality parameter of the Bhainsa village clearly indicates that the water samples are highly polluted. This area situated nearer to the higher traffic area.

## REFERENCES

- Pathak H. (2012), Doctoral thesis (awarded), Dr. H. S. Gour central university, Sagar, M.P., India.
- Pathak H., Limaye S. N. (2008a), A mathematical modeling for environmentally polluted water soluble impurities: A case study (Proceedings of the 45th Annual convention of chemists and international conference on recent advances in *chemistry*, Organised by, Indian chemical society Hosted by, Karnataka university, Dharwad November 23-27, 2008).
- Pathak H., Limaye S. N. (2008b), Physico-chemical Analysis of Ground Water Samples of Sagar city with respect to water soluble pollutants, National Seminar, Bina, Sponsored by, U.G.C., New Delhi.
- Pathak H., Limaye S. N. (2008c), Statistical Study on Physico-Chemical Parameters and Water Quality assessment of *Lakha banzara pond, Sagar (M.P.)*, National Seminar of Environment Safety and solid waste management, Sagar, Sponsored by, U.G.C., New Delhi.
- Pathak H. (2012), *J Environ Anal Toxicol*, 2(5), 01-05
- Pathak H., Limaye S. N. (2011a), Interdependency between Physicochemical Water Pollution Indicators: A Case Study of River Babus, Sagar, M.P., India *analele Universității din Oradea – Seria Geografie*, 1, 23-29.
- Pathak H., Limaye S. N. (2011b), Study of seasonal variation in ground Water quality Chemical parameters of Sagar city (M.P.) by principal component analysis and evaluation, *E- Journal of chemistry*, 8(4), 2000-2009;
- Pathak H., Limaye S. N. (2011c), *The Green Pages: Directory for Environmental Technology*, <http://www.eco-web.com/edi/110128.html>
- Pathak H., Limaye S. N. (2011d), A mathematical modeling with respect to DO for environmentally contaminated drinkingwater sources of Makronia sub-urban area, India: A case study, *Ovidius University Annals of Chemistry*, Vol.22(2), 2011. ISSN-1223-7221.
- Pathak H., Limaye S. N. (2012a), Assessment of Physico-Chemical Quality of Municipal Water Samples of Makronia Sub-Urban Area of Bundel Khand Region, India, *Analele Universității din Oradea – Seria Geografie*, 2, 122-127.
- Pathak H., Limaye S. N. (2012b), An water quality index mathematical modeling of water samples of Rajghat, water supply reservoir Sagar (M.P.) with respect to total dissolved solids: A regression analysis, *The Polytechnic Institute of Iasi*, 2012, vol.1. ISSN: 0254 - 7104.
- Pathak H., Limaye S. N. (2012c), *Assessment of Physico-Chemical Quality of Groundwater in rural area nearby Sagar city,MP, India*, *Advances in Applied Science Research (Pelagia Research Library)*, 2012, vol. 3 (1), pp. 555-562, ISSN: 0976-8610.
- Pathak H., Limaye S. N. (2012d), *Ground and Tap water Quality assessment of Sagar city especially in terms of saturation index*, *The Polytechnic Institute of Iasi*, 2012, vol.2, ISSN: 0254 - 7104.
- Pathak H., Pathak D., Limaye S. N. (2011), Seasonal Study with Interpretation of the Chemical Characteristics of Water Pond in Reference to Quality Assessment: A Case Study, *Analele Universității din Oradea – Seria Geografie*, 2, 233-238
- Pathak H., Pathak D., Limaye S. N. (2012), *Studies on the physico-chemical status of two water bodies at Sagar city under anthropogenic Influences*, *Advances in Applied Science Research (Pelagia Research Library)*, 2012, vol. 3 (1), pp. 31-44, ISSN: 0976-8610.
- \*\*\* (2005), APHA, "Standard methods for the examination of water and waste water", 21st edition, American Public Health Association, Washington, DC., USA.
- \*\*\* (1991), Indian standard drinking water, Specification (First Revision) IS-10500:1991. BIS, New Delhi, India
- \*\*\* (1999), A water handbook United Nations Children's Fund (UNICEF) Water, Environment and Sanitation Technical Guidelines- No.2.
- \*\*\* (2009), USEPA, National Drinking water standards. United States Environmental Protection Agency, <http://www.epa.gov/safewater/>
- \*\*\* (2012), Official website of Madhya Pradesh pollution control board, Bhopal, [www.mppcb.nic.in](http://www.mppcb.nic.in)
- \*\*\* (2012), SPSS Advanced Models™ 11.0 Web site at <http://www.spss.com>
- \*\*\* (2012), WINKS SDA software, Version 6, Web site at [www.texasoft.com](http://www.texasoft.com)

Submitted:  
September 17, 2012

Revised:  
October 19, 2012

Accepted and published online  
November 02, 2012