Journal of Research in Biology

An International Scientific Research Journal

ISSN No: Print: 2231 –6280; Online: 2231- 6299

Short Communication

Classification of surface water quality in the rural areas of Meshginshahr using cluster analysis

Author:
Mohsen Hedarogle

Institution:
Department of Environmental Sciences, Ardabil Branch, Islamic Azad University, Ardabil, Iran.

Corresponding author:
Mohsen Hedarogle

ABSTRACT:

This study was conducted to classify the water quality of the rivers in north-western Iran, in Meshginshahr. Amount of heavy metals were measured at five stations in two high and low water season during 2012. Sampling and measurement of samples were done based on the standard method and by atomic absorption spectrometry (model Perkin Elmer 2380). For categorizing the quality of stations in terms of heavy metals in the environment, cluster analysis was used in Minitab software. The results showed that among the stations, Kangarlou and Tazekand were the most infected stations. Then, the average emission was for Khyavchai stations and the stations *viz* Gharesou and Ghasabeh were in low emission class. The results showed that the cluster analysis could classify the surface water quality based on the classification of heavy metals.

Keywords:

Surface water, Heavy metals, Multivariate statistical analysis, Meshginshahr, Iran.

Article Citation:
Mohsen Hedarogle
Classification of surface water quality in the rural areas of Meshginshahr using cluster analysis
Journal of Research in Biology (2020) 10(5): 2842-2846

Dates:
Received: 18 May 2020 **Accepted:** 25 June 2020 **Published:** 12 July 2020

This article is governed by the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which gives permission for unrestricted use, non-commercial, distribution and reproduction in all medium, provided the original work is properly cited.

Journal of Research in Biology

INTRODUCTION

Water is indeed the natural resource, the most important gift of all economic activities, from agriculture to manufacturing, for sustaining life and wealth. Water quality plays an important role in human, animal and plant health (Pejman *et al*., 2009; Zhao *et al*., 2012). Rivers are really the primary residential, industrial and agricultural inland water body and also contain significant urban sewage, industrial waste and water discharges from houses and agriculture fields (Juahir *et al*., 2011; Pradhan *et al*., 2009; Hu *et al*., 2012). Natural processes and anthropogenic effects affect surface water and impede its use for residential, commercial, agricultural and recreational purposes (Qadir *et al*., 2007; Sayadi *et al*., 2010; Sayyed and Sayadi, 2011; Sayadi and Sayyed, 2011; Sayadi and Rezaei, 2014).

Water pollution in the local areas is detrimental not only to marine life and agricultural practises, but also to public health (Adebola *et al*., 2013). In addition, untreated sewage and waste from factories, the issue of toxic algal blooms, depletion of biodiversity, and loss of oxygen due to high concentrations of toxic chemicals and biological nutrients have been observed worldwide and are the main pollutants affecting rivers in different countries (Abbas *et al*., 2013; Singh *et al*., 2005). Rising river pollution weakens, threatens human prosperity and also imbalances the ecosystem. It is therefore important to recognise these sources and their contribution to the total contamination of a region from an environmental and/or social point of view (Tobiszewski *et al*., 2010) and to regulate water pollution, to track water quality in the river basin (Singh *et al*., 2004).

In recent years, there has been growing awareness and concern about surface water pollution all over the world, and new approaches have been established towards the sources of contaminants, in addition to achieving feasible misuse of water properties. For example, multivariate statistical techniques allow the consolidated use of environmental tools to characterize water samples into different categories, source divisions, relationships, and contrasts in the parameters used based on hydrochemical attributes (Shrestha *et al*., 2008).

They represent the multivariate nature of the daily environment more precisely, which provides an approach to deal with countless expansive datasets by abridging the excess and provides a method for capturing and analyzing genuinely multivariate dataset samples (McGarigal *et al*., 2000). Heavy metals are the contaminants that cause ecological equilibrium to be disrupted making it diverse in terms of environmental balance and survival issues among aquatic and other living beings, and most plant and animal species do not have enough strength to escape the dangerous effects of heavy metals.

The use of multivariable statistical techniques, which have been widely used in recent years, is one of the most important methods of effective investigation of the quality of water supplies. In the investigation of water resource quality variations, multivariable statistical methods are used to retrieve hidden data (Al-Sanjari, 2009). Hence, the present study was carried out to assess the surface water quality in the rural areas of Meshginshahr using cluster analysis.

MATERIALS AND METHODS

Studies of surface water were carried out the in rural areas of Meshginshahr in Ardabil Province which is located in the north-western Iran (Figure 1). Five sampling stations were selected on the river in the spring and summer and sampling was carried out in 2011. Sampling was done using half-liter polyethylene containers in the laboratory which was washed by nitric acid before, following the standard method for water sampling from water resources. In the laboratory in order to stabilize and prevent the precipitation of dissolved elements in the sample, with the addition of concentrated nitric acid, pH of samples were observed and adjusted to 2.

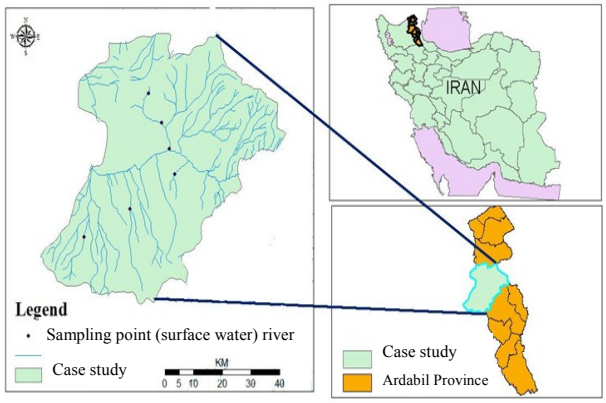

Figure 1. The location of sampling points in surface water network area of Meshginshahr, Ardabil, Iran

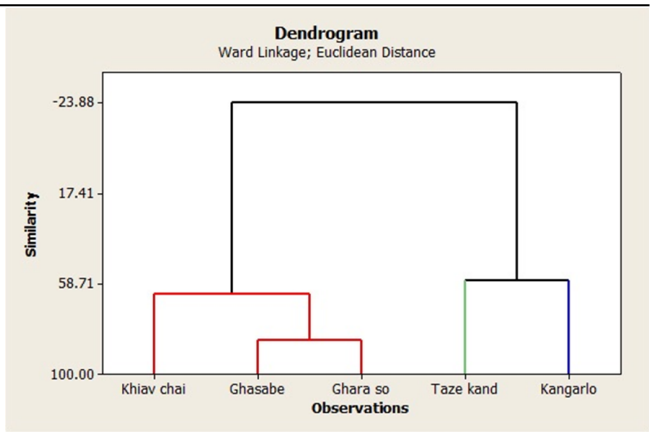

Figure 2. Dendrogram of cluster analysis at the sampling stations of Meshginshahr

In order to analyze the heavy metals concentration, 25 mL of concentrated nitric acid was added to samples and were kept in heater for 10 min and then under hood at 50°C. The samples were shaken for 10 min at moderate speed (85 rpm) and filtered through Whatman No. 42 filter. Then, in order to read the heavy metal concentration (ppm) with three replications, atomic absorption spectrometer of model Perkin Elmer 2380 was used. In order to classify stations, quality MINITAB software was used.

Cluster analysis

Cluster analysis is a multivariate analysis method used for grouping the stations according to the desired characteristics, so that the stations are placed in a group with similar features and grouping is appropriate whenever stations have more homogeneity within groups and more heterogeneity between groups. There are two types of cluster analysis method: distance- based methods and model-based methods. Currently, the most used methods are distance- based methods. In this study, ward's cluster analysis method was used in which grouping is done based on the minimum in-group variance and maximum between groups variance.

RESULTS AND DISCUSSION

For the classification of sampling stations water quality and determining the sources of emissions, ward cluster analysis method using Euclidean distance based on measured average standard was performed. Cutting the dendrogram based on the Euclidean distance divided stations into three groups. Analysis of the samples to determine levels of heavy metals like cadmium, chromium and lead were done. Figure 2 shows the dendrogram of cluster analysis based on measured parameters. Table 1 shows the values of the heavy metals like lead, cadmium and chromium in low water season (summer) and high water season (spring) at five studied stations in surface water resources of the region Meshginshahr.

This study showed a difference between MS and a significant difference between clusters there was no difference between and within clusters of measured parameters. But it became clear that in one cluster, a significant difference exists between evaluated parameters (Table 2). Cluster analysis showed that the

Table 1. Concentration of heavy metal like lead, chromium, cadmium at studied stations (ppb)

S. No	Pb	Cd	Cr	Season	Station
1	0.001	0.004	Nil	Spring	Khiavchai
2	0.089	0.024	0.005	Summer	-
3	0.078	0.034	Nil	Spring	Ghasabeh
4	0.063	0.025	0.047	Summer	-
5	0.023	0.032	0.002	Spring	Tazekand
6	0.336	0.022	0.036	Summer	-
7	0.002	0.001	0.041	Spring	Kangarlou
8	0.281	0.019	0.069	Summer	-
9	0.091	0.039	0.022	Spring	Gharesou
10	0.069	0.019	0.029	Summer	-

Table 2. Cluster analysis for heavy metals like lead, cadmium and chromium in groundwater

Cluster	Statistical parameters	Cd	Cr	Pb
1	$\bar{X}$	0.0050	0.0140	0.0450
	$\bar{X}_h - \bar{X}$	0.0253	-0.0099	-0.0613
2	$\bar{X}$	0.0362	0.0292	0.0752
	$\bar{X}_h - \bar{X}$	0.0059	-0.0053	-0.0338
3	$\bar{X}$	0.0370	0.0235	0.1680
	$\bar{X}_h - \bar{X}$	0.0067	-0.0004	0.0617
Mean	Total	0.0303	0.0239	0.1063

first group (cluster III) includes Kangarlou and Tazekand stations. These stations were above the average of the study area for cadmium and chromium and its quality changes were mainly caused by waste activities in the aquaculture, agriculture and geological activities.

The second group (cluster II) was Khyavchayy station which had higher cadmium, equal lead and lower chromium than the average of all studied stations. The quality of these stations were mainly affected by pollutants from the agricultural wastewater and geological formations in the region. The third group (cluster I) include Qsabh and Gharesou stations. Gharesou station had higher chromium and lead than permissible limit for drinking water quality, and station Qsabh had higher chromium than permissible limit for drinking water quality. The results of cluster analysis showed the difference between groups was caused by differences in the sources of the pollutants in the station.

CONCLUSION

The results showed that the most polluted stations are Kangarlou and Tazekand stations (high emissions group) (HP) and the amount of pollution were distinct from other stations and have the greatest distance from the rest. After that, the second group of stations with average emissions (MP) was Khiavchai and in the third group were Gharesou stations, and Qsabh stations which were in low emissions group (LP). According to the results of cluster analysis and the results of the water samples, it was determined that there was a certain correlation between the classification of cluster analysis and the results of the initial samples value.

For example, stations Kangarlou and Tazekand have the highest amounts of chromium and cadmium with the highest standard and in cluster analysis classification, they were grouped together or separate. On this basis, it was concluded that cluster analysis is an appropriate method for grouping polluting sources of several stations in different regions.

REFERENCES

Abbas AFM, Ahmad A and Easa AM. 2008. Assessment of surface water quality selected estuaries of Malaysia: multivariate statistical techniques. *The Environmentalist*, 29(3): 255-262.

Adebola O, Seun MA and Oladele O. 2013. Water quality assessment of river Ogun using multivariate statistical techniques. *Journal of Environmental Protection*, 4(5): 466-479.

Al-Sanjari MN. 2009. Interpretation of water quality parameters for Tigris river within Mosul city by using principal components analysis. *Tikrit Journal of Pure Science*, 14(2): 68-74.

Hu J, Qiao Y, Zhou L and Li S. 2012. Spatiotemporal distributions of nutrients in the downstream from Gezhouba dam in Yangtze river, China. *Environmental Science and Pollution Research*, 19(7): 2849–2859.

Juahir H, Zain SM, Yusoff MK, Ismail TTH, Armi ASM, Toriman ME and Mokhtar M. 2011. Spatial assessment of langtan river basin (Malaysia) using environmentric techniques. *Environmental Monitoring Assessment*, 173(1-4): 625-641.

McGarigal K, Cushman S and Stafford S. 2000. Multivariate statistics for wildlife and ecology research, Springer, New York. 283 P.

Pejman AH, Nabi Bidhendi GR, Karbassi AR, Mehrdadiand N and Esmaeili Bidhendi M. 2009. Evaluation of spatial and seasonal variations in surface water quality using multivariate statistical techniques. *International Journal of Environmental Science and Technology*, 6(3): 467-476.

Pradhan UK, Shirodkar PV and Sahu BK. 2009. Physico-chemical characteristics of the coastal water off Devi estuary, Orissa and evaluation of its seasonal changes using chemometric techniques. *Current Science*, 96(9): 1203-1209.

Qadir M, Sharma BR, Bruggeman A, Choukr-Allah R and Karajeh F. 2007. Non-conventional water resources and opportunities for water augmentation to achieve food security in water scarce countries. *Environmental Monitoring Assessment*, 87(1): 2-22.

Sayadi MH and Rezaei MR. 2014. Impact of land use on the distribution of toxic metals in surface soils in Birjand city, Iran. *Proceedings of the International Academy of Ecology and Environmental Sciences*, 4(1): 18-29.

Sayadi MH and Sayyed MRG. 2011. Comparative assessment of baseline concentration of the heavy metals in the soils of Chitgar industrial area Tehran (Iran) with the comprisable reference data. *Environmental Earth Science*, 63(6): 1179-1188.

Sayadi MH, Sayyed MRG and Suyash K. 2010. Short-term accumulative signatures of heavy metal in river bed sediments, Tehran Iran. *Environmental Monitoring and Assessment*, 162(1-4): 465-473.

Sayyed MRG and Sayadi Anari MH. 2011. Variation in the heavy metal accumulations within the surface soils from the Chitgar industrial area of Tehran (Iran). *Proceedings of the International Academy of Ecology and Environmental Sciences*, 1(1): 27-37.

Shrestha S, Kazama F and Nakamura T. 2008. Use of principal component analysis, factor analysis and discriminant analysis to evaluate spatial and temporal variations in water quality of the Mekong river. *Journal of Hydroinformation*, 10(1): 43-56.

Singh KP, Malik A and Sinha S. 2005. Water quality assessment and apportionment of pollution sources of Gomti river (India) using multivariate statistical techniques: a case study. *Analytica Chimica Acta*, 538(1-2): 355-374.

Singh KP, Malik A, Mohan D and Sinha S. 2004. Multivariate statistical techniques for the evaluation of spatial and temporal variations in water quality of Gomti river (India): a case study. *Water Research*, 38(18): 3980 -3992.

Tobiszewski M, Tsakovski S, Simeonov V and J Namiesnik J. 2010. Surface water quality assessment by the use of combination of multivariate statistical classification and expert information. *Chemosphere*, 80 (7): 740-746.

Zhao Y, Xia XH, Yang ZF and Wang F 2012. Assessment of water quality in Baiyangdian lake using multivariate statistical techniques. *Proceedia Environmental Science*, 13: 1213-1226.

Submit your articles online at www.jresearchbiology.com

Advantages

- Easy online submission
- Complete Peer review
- Affordable Charges
- Quick processing
- Extensive indexing
- You retain your copyright

submit@jresearchbiology.com

www.jresearchbiology.com/Submit.php