Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 12 [10] September 2023 :338-342

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
ORIGINAL ARTICLE **OPEN ACCESS**

Spatial Distribution of Arsenic and Cadmium in Industrial Waste Water of Bikaner City (Rajasthan) India

Divyaman Singh Rathore, Leela Kaur*, Rajaram Choyal
Department of Environmental Science, Maharaja Ganga Singh University, Bikaner, Rajasthan (INDIA)
*Email: leela.kaur@gmail.com

ABSTRACT
The quality of industrial wastewater in Bikaner city has been analyzed by studying the metals, Arsenic (As) and Cadmium (Cd) from four Industrial areas. Metal analysis was carried out to find out the spatial distribution of Arsenic and Cadmium in the study area. Spatial distribution is essential to give information about the reality of contamination. The spatial distribution of Arsenic and Cadmium within the study area was carried out by implementing the Quantum Geographic Information System (QGIS) technique. This technique was established on the Inverse Distance Weighted Predicted maps. The results showed that the content of As was 0.073 to 0.081 mg/L and the Cd content range was from 0.0175 to 0.0197 mg/L. These values were beyond the recommended limit of drinking water standards of WHO and BIS. It was found that the quality of industrial wastewater is not good for agricultural and domestic uses due to the direct discharge of effluents without prior treatment. Spatial distribution study assisted to analyze, understand and find out the solutions to industrial wastewater quality.
Keywords: *Industrial wastewater, Spatial distribution, Arsenic, Cadmium.*

Received 23.07.2023 Revised 21.08.2023 Accepted 21.09.2023

INTRODUCTION

Industrial waste water is commonly used for agricultural irrigation as it is economically viable alternative. Waste water irrigation is a replacement for chemical fertilizers and water supply sources [1]. Several studies showed waste water irrigation promotes crop production because it contains many essential nutrients [2], [3], [4]. However, Industrial waste water also contains certain toxic pollutants, such as organic and inorganic pollutants [5], which can enter in human body via food chain and cause negative impacts to human health [6]. Industrial waste water usually contains heavy metals such as Cr, Cd, Cu, Ni, Pb, As and Zn [7]. There are several industries in Bikaner which are manufacturing agrochemical fertilizers, electroplate, paint, chemicals, ceramics and metals. As is released from metallurgical and chemical industries [8] and Cd is discharged by fertilizer, electroplating and paint industries [9]. These metals can cause serious human health problems. As can cause nervous system and gastrointestinal disorders [10]. High As concentration may cause headaches, vomiting, abdominal pain and even death [11]. Cd is also considered as toxic metal even low concentration can cause negative impacts [12]. Cd may cause kidney dysfunction, osteomalacia, prostate and breast cancer [13]. The main purpose of the study was to investigate arsenic and cadmium content in industrial waste water and spatial distribution of As and Cd in the study area. Geographic Information System (GIS) is one of the advanced technologies which is utilized in various fields. GIS is a data-based technology that can present, describe, and manage various data sets such as maps of spatial distribution [14]. The spatial distribution of water parameters can be assessed. It is also used to determine the source of pollution [15]. GIS technology is also used by scientists for spatial queries, analysis, and integration since last three decades [16]. It is very useful software for the analysis of heavy metals by developing contour maps [17]. Recently, GIS played an important role in promoting water-connected phenomena representation and analysis [18]. This technology is widely used to monitor and manage wastewater especially in economically expanding and developing countries [19]. It is used to predict the effects due to changes in agricultural activity, runoff, nutrient transport, and soil erosion [20]. GIS is helpful to find out high contamination levels around industrial areas of Punjab [21]. GIS-based maps provide information related to water quality sampling points and also provide information related to existing levels of some major water quality parameters of Swan River [22]. It is a useful technology to create the spatial distribution of physico-chemical parameters and raster maps, to find out the water quality of

Bhadravathi Taluka, Karnataka, India [23]. This modern tool assesses groundwater pollution due to industrial effluents around Pali city and these industrial effluents also release in the Bandi River [24]. Hence, GIS software is very advantageous to create spatial distribution maps of the physico-chemical parameters and heavy metals by using the Inverse Distance Weighted (IDW) approach in several research studies [17], [26], [27], [28], [29].

MATERIAL AND METHODS

Study area **-** The study is conducted in the Rani Bazar industrial area, Khara industrial area, Bichhwal industrial area, and Karni industrial area of Bikaner. The latitude of Rani Bazar industrial area is 28.007235, and the longitude is 73.317078. GPS coordinates are 28^0 0' 26.0460" N and 73^0 19' 1.4808" E. Its elevation is about 235 m. The latitude of Karni industrial area is 28.0605146, and the longitude is 73.2942267. GPS coordinates are 28^0 3' 27.854" N and 73^0 17' 39.2172" E and its elevation is about 225 m. The latitude of Khara industrial area is 28.182575, and the longitude is 73.387705. GPS coordinates are 28°10'57.27''N and 73°23'15.74''E and its elevation is about 225 m. The latitude of Bichhwal industrial area is 28.066203 and the longitude is 73.33725. GPS coordinates are 28°3′58.32′′N and 73°20′14.1′′E.

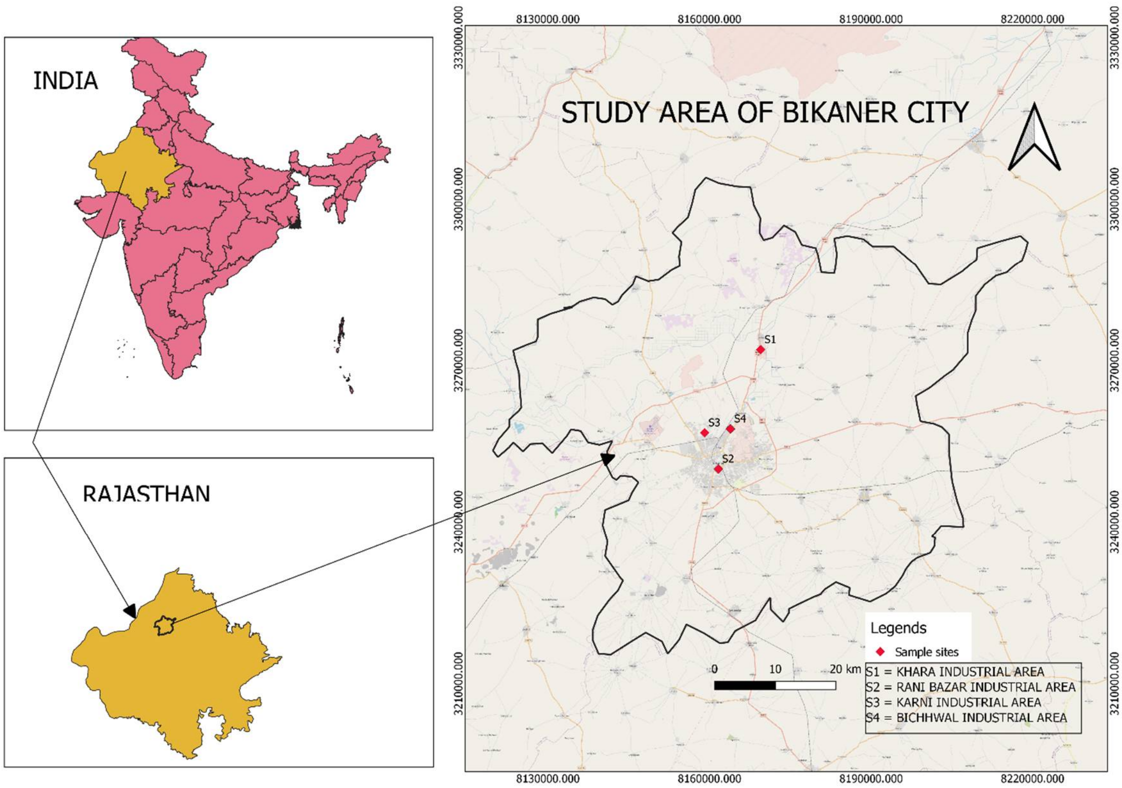

Figure 1. Study area.

Sample collection **-** In this study, arsenic and cadmium were evaluated in four industrial wastewater sites. The samples were collected in polypropylene 100 ml bottles. The bottles were pre-washed and rinsed with distilled water. Samples were stored at 40 °C until the analysis is done. Sample preparation **-** Samples were filtered in 250 ml conical flask. Nitric acid and hydrochloric acid (3:1 v/v) were added into samples for acid digestion. After then, each sample was put on the hot plate until a clean solution gets obtained, then the sample get cool down. A little amount of distilled water was added to the sample for filtration. Concentrations of arsenic and cadmium were determined by using an Inductively coupled plasma atomic emission spectrometer (ICPE-9000, Shimadzu's Private Ltd., Japan). Spatial analysis of As and Cd **-** qGIS software (3.10.5) was used for the spatial modeling of As and Cd in the study area. Here, the continuous layer was created by the interpolation method. Further, the Inverse Distance Weighting (IDW) method of interpolation was applied to find out the interpolated values and then, maps were generated.

RESULT AND DISCUSSION

The collected 4 Industrial wastewater samples from the study area of Bikaner city were analyzed in the laboratory. Arsenic and Cadmium metals were analyzed by using the specific analytical instrument and standard procedures. According to WHO [30] and BIS [31], the desirable limit and permissible limit for drinking water have been produced. The spatial distribution of As and Cd in Industrial wastewater was mapped based on IDW (Inverse Distance Weighted) interpolation using open-source software, QGIS. About 2 maps were generated. Concentrations of arsenic and cadmium in the study area are presented in Figure 2 and 3 respectively.

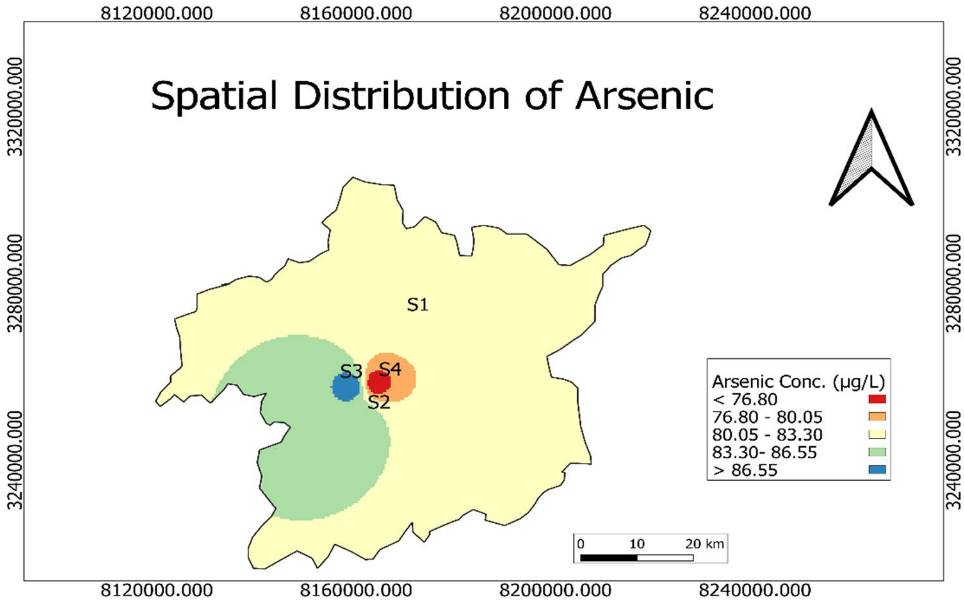

Figure 2. Spatial distribution of arsenic.

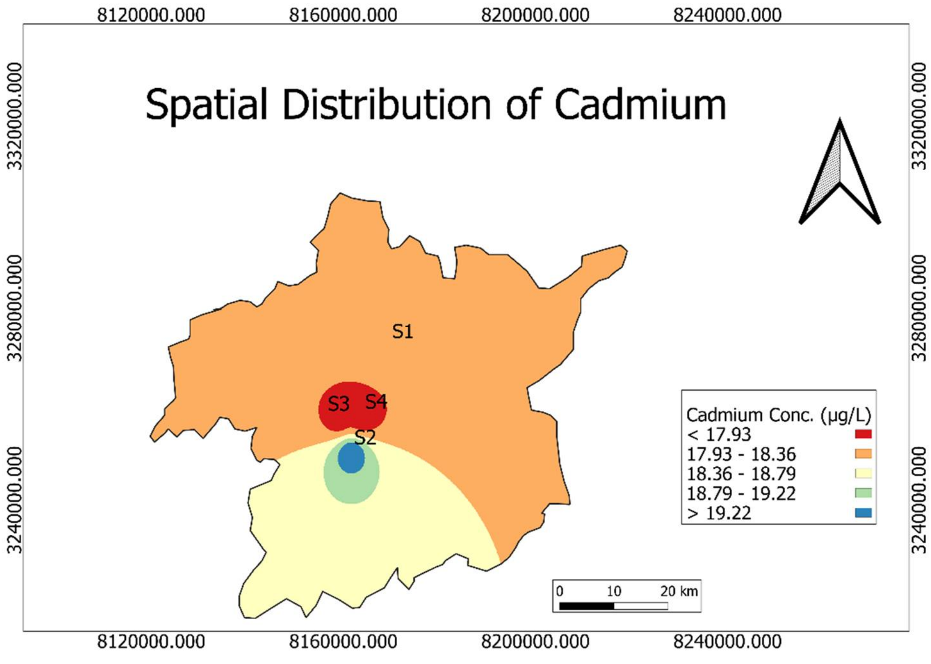

Figure 3. Spatial distribution of cadmium.

The result of the spatial analysis indicates that the study areas have high arsenic and cadmium concentrations. Here, S3 (Karni industrial area) and S2 (Rani Bazar industrial area) had high concentrations of As and Cd respectively. The average concentration of As and Cd exceeded the permissible limits given by WHO and BIS for drinking water. Industrial wastewater quality spatial assessment helps in the overall assessment of wastewater management issues for any area of taking necessary administrative decisions. It can provide useful insights for the development of wastewater management plans in study area.

CONCLUSION

The present study shows that GIS is an effective tool for industrial wastewater quality analysis and mapping. Spatial distribution maps help to create or anticipate the industrial wastewater quality status, pollution level, and the real extent of contamination in the study area. In this study, arsenic and cadmium concentrations are calculated and spatially analyzed by using the IDW interpolation method. The wastewater within the industrial area has a very high concentration of arsenic and cadmium. Which is proving that the wastewater nearby 4 Industrial areas is not only causing direct contamination of soil and vegetation but is also responsible for health hazards. Industrial wastewater quality is poor and not within WHO and BIS guidelines for drinking purposes as well as for domestic use. We need to follow adequate effluent treatment methods and reduce their potential environmental hazards. To control such stress, strict environmental laws become crucial.

ACKNOWLEDGMENT

All authors contributed equally to the conception and design of the study.

REFERENCES

1. WANG, H. jie., WANG, J., & YU, X. (2022). Wastewater irrigation and crop yield: a meta-analysis. J. Integr. Agric., 21(4):1215–1224.
2. Salakinkop, S.R, and Hunshal, C.S. (2014). Domestic sewage irrigation on dynamics of nutrients and heavy metals in soil and wheat (Triticum aestivum L.) production. Int. J. of Recycl. Org. Waste Agric., 3(3): 1-11.
3. Mojid, M.A, Wyseure, G.C.L. and Biswas, S.K. (2016). Effects of municipal wastewater irrigation on yield and fertilizer requirement of wheat (Triticum aestivum L.) in Bangladesh. The Agric., 14(1): 1-14
4. Tran, L.D., Phung, L.D., Pham, D.V., Pham, D.D., Nishiyama, M., Sasaki, A. and Watanabe, T. (2019). High yield and nutritional quality of rice for animal feed achieved by continuous irrigation with treated municipal wastewater. Paddy Water Environ., 17(3): 507–513.
5. Wang, J. (2018). Reuse of heavy metal from industrial effluent water. IOP Conf. Ser.: Earth Environ. Sci., 199(4): 1-6. https://doi.org/10.1088/1755-1315/199/4/042002
6. Azimi, A., Azari, A., Rezakazemi, M., and Ansarpour, M. (2017). Removal of heavy metals from industrial wastewaters: a review. In ChemBioEng Reviews, 4(1): 37–59. Wiley-Blackwell. https://doi.org/10.1002/cben.201600010
7. Dabrowski, A., Hubicki, Z., and Podkościelny, P. (2004). Selective removal of the heavy metal ions from waters and industrial wastewaters by ion-exchange method. J. Chemosphere, 56(2): 91-106.
8. Sun, L., Lu, M., Li, Q., Jiang, H., and Yin, S. (2019). Research progress of arsenic removal from wastewater. IOP Conf. Ser.: Earth Environ. Sci., 218(1): 1-5. https://doi.org/10.1088/1755-1315/218/1/012142
9. UNEP, "UNEP's Activities on Lead and Cadmium," Accessed from: https://www.unep.org/explore-topics/chemicals-waste/what-we-do/emerging-issues/lead-and-cadmium. on 20 November, 2022
10. Manalis, N., Grivas, G., Protonotarios, V., Moutsatsou, A., Samara, C. and Chaloulakou, A. (2005). Toxic metal content of particulate matter (PM10), within the greater area of athens. Chemosphere, 60(4): 557–566.
11. Roy, P., and Saha, A. (2002). Metabolism and toxicity of arsenic: a human carcinogen Sources of different forms of arsenic: human exposure and chronic arsenicism. Curr. Sci., 82(1): 38-45. https://doi.org/10.2307/24105925
12. Ullah, M.A., Shamsuzzaman, S.M., Islam, M.R., Samsuri, A.W. and Uddin, M.K. (2017). Cadmium availability and uptake by rice from lime, cow-dung and poultry manure amended Ca-contaminated paddy soil Bangladesh. J. Bot., 46(1): 291-296.
13. FDA (Food and Drug Administration), (2001). In: Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc. Report of the Panel on Micronutrients. D.s.C.f.F.S.a.A.N. Food and Drug Administration, editor. National Academy Press; Washington, DC: 2001.
14. Gupta, I., Kumar, A., Singh, C. and Kumar, R. (2015). Detection and mapping of water quality variation in the godavari river using water quality index, clustering and GIS techniques, J. Geogr. Inf. Syst., 7(2): 71–84.
15. Guo, L., Luo, J., Yuan, M., Huang, Y., Shen, H. and Li, T. (2019). Science of the total environment the influence of urban planning factors on PM 2. 5 pollution exposure and implications: A case study in china based on remote sensing, LBS, and GIS data, Sci. Total Environ., 659(5): 1585–1596.
16. Burrough, P.A, and McDonnell, R.A. (1998). Principles of Geological Information System, Oxford University Press, Oxford, pp 333.
17. Mahapatra, S. R., Venugopal, T., Shanmugasundaram, A., Giridharan, L. and Jayaprakash, M. (2020). Heavy metal index and geographical information system (GIS) approach to study heavy metal contamination: a case study of north chennai groundwater. Appl. Water Sci., 10(12): 1-17. https://doi.org/10.1007/s13201-020-01321-0
18. Khadim, H. J., and Oleiwi, H. O. (2021). Assessment of water quality in tigris river of al-kut city, iraq by using GIS. E3S Web Conf., 318, 04001: 1-9. https://doi.org/10.1051/e3sconf/202131804001
19. Al-Ansari, N., AlJawad, S., Adamo, N., Sissakian, V.K., Knutsson, S. and Laue, J., (2018). Water quality within the tigris and euphrates catchments. J. Earth Sci. and Geotech. Eng. Engineering, 8(3): 95-121.

20. Yusuf Ali, S. P. and Sajikumar, N. (2013). Assessing the effect of industrial effluent on the chalakkudy river using GIS based modelling. Second National Conference on Emerging Trends in Computing., 1: 298-303.
21. Singh, D. D., Thind, P. S., Sharma, M., Sahoo, S., and John, S. (2019). Environmentally sensitive elements in groundwater of an industrial town in india: spatial distribution and human health risk. Water (Switzerland), 11(11): 1-19. https://doi.org/10.3390/w11112350
22. Sharda, A.K., Sharma, M.P., and Dahyat, P. (2013). Water quality profile of swan river himachal pradesh, india using GIS. Hydro Nepal J. Water Energy Envrion., 13(13): 64-69.
23. Rajkumar, V. Raskar. and Sneha, M.K. (2012). Water quality analysis of bhadzavathitaluku using GIS. In. J. Environ. Sci., 2(4): 2443-2453.
24. Bhadra, B.K., Pathak, S., and Sharma, J.R. (2013). Impact of industrial effluents on groundwater around pali city, rajasthan using field and satellite data. J. Geol. Soc. India., 82(6): 675-691.
25. Suresh, M., Gurugnanam, B., Vasudevan, S., Dharanirajan, K. and Jawahar, R. N. (2010). Drinking and irrigational feasibility of groundwater, GIS spatial mapping in upper thirumanimuthar sub-basin, cauvery river, tamil nadu. J. Geol. Soc. India, 75(3):518–526.
26. Vetrimurugan, E., Brindha, K., Elango, L. and Osman M. N. (2017). Human exposure risk to heavy metals through groundwater used for drinking in an intensively irrigated river delta. Appl. Water Sci., 7(6): 3267–3280. https://doi.org/10.1007/s13201-016-0472-6.
27. Redvan, G. and Nasim, S.H. (2017). Study on groundwater quality using geographic information system (GIS), case study: Ardabil. Iran. Civil Engi. J., 3(9): 779–793. https://doi.org/10.21859/cej-030914
28. Severini, M.D.F., Carbone, M.E., Villagran, D.M., Marcovecchio, J.E. (2018). Toxic metals in a highly urbanized industry-impacted estuary (bahia blanca estuary, argentina): spatio-temporal analysis based on GIS. Environ. Earth Sci., 77(10): 393–411.
29. Yang, P., Drohan, P.J., Yang, M., Li, H. (2020). Spatial variability of heavy metal ecological risk in urban soils from linfen, china. CATENA 190(1): 104554
30. WHO, (2006). Guidelines for Drinking Water Quality, 3rd Edition, v.1., Recommendations, WHO, Geneva.
31. BIS. (2012). Indian Standard. Drinking Water Specification (Second revision). Bureau of Indian Standard (BIS), New Delhi, 1-11.

CITATION OF THIS ARTICLE

Divyaman Singh Rathore, Leela Kaur, Rajaram Choyal. .Spatial Distribution of Arsenic And Cadmium In Industrial Waste Water of Bikaner City (Rajasthan) India. Bull. Env.Pharmacol. Life Sci., Vol 12 [10] September 2023: 338-342