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Surveying the Geographical Distribution of Aluminium Concentration in Groundwater Resources of Sistan and Baluchistan, Iran

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Abstract: Providing safe water and protecting the resources from pollution sources have become a major concern for the decision-making centers. It is necessary to prevent degradation of water resources by determining and measuring pollutants and enacting state laws. In this regard and to this end, concentration of aluminum in groundwater in Sistan and Baluchistan was measured and the pollution sources were determined. After acquiring information about the location and status of regional water resources used in Sistan and Baluchistan, 457 samples from different areas were collected in 2015 and pH, TDS and aluminum concentration were measured by graphite furnace atomic absorption spectrometry. In addition, a plot of dispersion of groundwater resources and a profile of these groundwater resources were developed using Geographic Information System (GIS) software. The results showed that average and standard deviation of aluminum concentration were 0.015± .010 mgL^{-1}. Therefore, the groundwater resources met the standards for being used as drinking water supply.

Key words: Aluminium, groundwater, Geographic Information System (GIS), Sistan and Baluchistan, dispersion

INTRODUCTION

Some metals are naturally found in the human body and they are necessary and required for man's health. But, some another metals interrupt metabolism of multicellular organism by inducing poisonous effects (Sajadi *et al*., 2015; Abedi and Rostami, 2012). Aluminum is one these metals which is the third abundant metal in the earth crust (8.1%). This metalloid is found in variety minerals and dissolves in water when the minerals disintegrate (Sajadi *et al*., 2015, Bozkurtoglu *et al*., 2006):

$$Al_2Si_2O_5(OH)_4 + 6H^+ \rightarrow Al^{+3}2Si(OH)_4 + H_2O$$

While the metal is prisoned in natural mineral structure, it imposes no risk on living organisms; however, dissolved aluminum is a great risk to living creatures (Rondeau *et al*., 2000). With neutral pH, concentration of dissolved aluminum in water ranges from 0.001-0.05 mg L^{-1}, while in acidic water rich in organic compound, this range is 0.5-1 mg L^{-1}. Human body is under the risk of exposure to aluminum via food and water and knowing that strict regulations are introduced in food industries to control aluminum concentration in food products. Therefore, drinking water is the main source of aluminum intake (Batayneh, 2012, Sajadi *et al*., 2015). Aluminum is the main cause of >100 metabolic and

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identity diseases; so that the element acts as a neurotoxin and induces diseases of nervous system such as Alzheimer's disease, Parkinson's disease and Lou Gehrig's disease (Corder *et al*., 1993, Becaria *et al*., 2002, Fewtrell *et al*., 2001). Public associations like Europe Aluminum Institute, Canada and America Food and Agricultural Products Supervision Organization, FDA and many academic associations monitor aluminum concentration in drinking water. Aluminum is in the list of 83 main contaminators that need to be controlled according to sanitary drinking water act. The USA Water Resource Preservation Org., the USA Environment Preservation Org. and Iran Standard Org. have determined acceptable aluminum content in drinking water < 0.05, 0.2 and 0.2 mg L^{-1}, respectively. The present study is an attempt to determine geographical distribution of aluminum in groundwater resources in Sistan Baluchistan Province using GIS system.

MATERIALS AND METHODS

Sistan and Baluchistan is the largest province of Iran that located in south east of Iran between 25° 03' and 31° 28' Northern latitudes and 58° 47' and 63° 19' Eastern longitudes. It is one of the driest region of Iran. This district is divided to 9 counties and the capital of it, is Zahedan (Fig.1). In this study, the concentrations of aluminum in water resources of Sistan and Baluchistan was conducted in during 2015. For this purpose, 457 samples of dug well all over 10,000 wells according to the following formula (Eq. 1) with significance level 5 % from various and possible location of ground waters of Sistan and Baluchistan resources as much as possible due to security issues, according to standard methods were collected and tested. Because the region's surface water resources are seasonal, generally the groundwater resources being use for all purposes, the average of rain fall in this region is about 100 mm per year with standard deviation 30 up to 160 %. All samples were stored in a cool box and then pass on to the laboratory in standard conditions. Preparation of samples procedure was considered in all of steps, including collection, storage, transportation and final analysis to protect samples from secondary pollution (Barkhordari *et al*., 2011) (Farzianpour *et al*., 2014) At the end the contents of contaminants were analyzed using graphite furnace atomic absorption spectrometry (Sajadi *et al*., 2015). A hand held global positioning system (GPS, Garmin Montana 650 model) with position accuracy of less than 10 meter was applied to specify the location of sampling points. The sampling locations are shown in Fig 1. Finally, Geographic Information System (GIS) was used to plot the geo-statistical distribution of heavy metals polluted ground water and additionally, to identify the areas with maximum level of pollutants:

$$n = \frac{\frac{z^2 pq}{d^2}}{1 + \frac{1}{N}\left(\frac{z^2 pq}{d^2} - 1\right)} \quad (1)$$

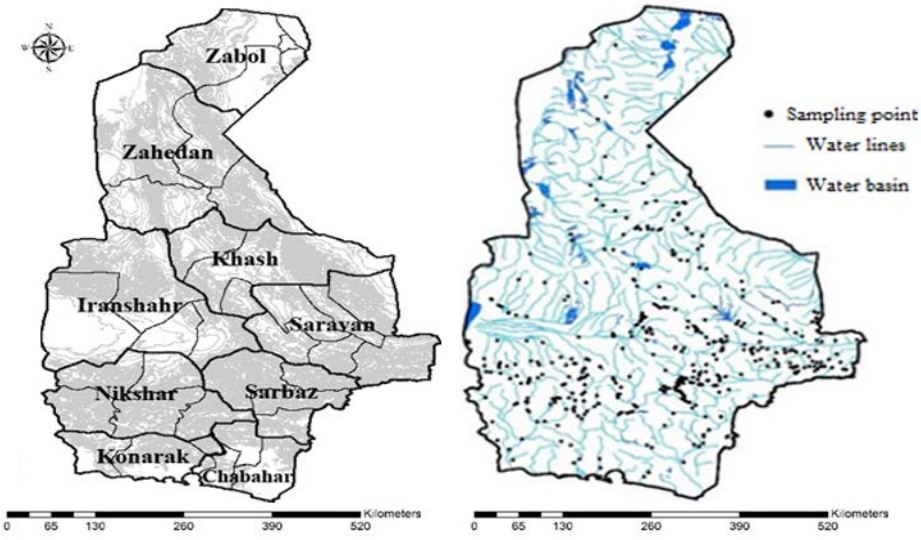

Fig 1. Sampling points, Sistan and Baluchistan

RESULTS AND DISCUSSION

Figure 2 and 3 shows the of aluminium and TDS concentration in groundwater of Sistan and Baluchistan, Iran. Also, the average and standard deviation of aluminium, pH and Total Dissolved Solid in Sistan and Baluchistan are shown. Table 1. Statistical analyses showed that concentration of aluminum in groundwater resources of water system of Sistan Baluchistan province was as per the standards. That is, mean aluminum

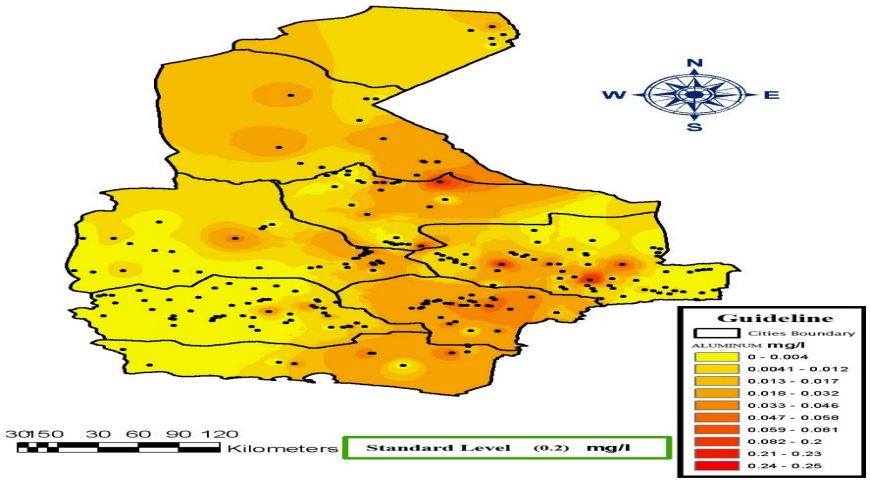

Fig 2. The inverse distance weighted of aluminium concentration

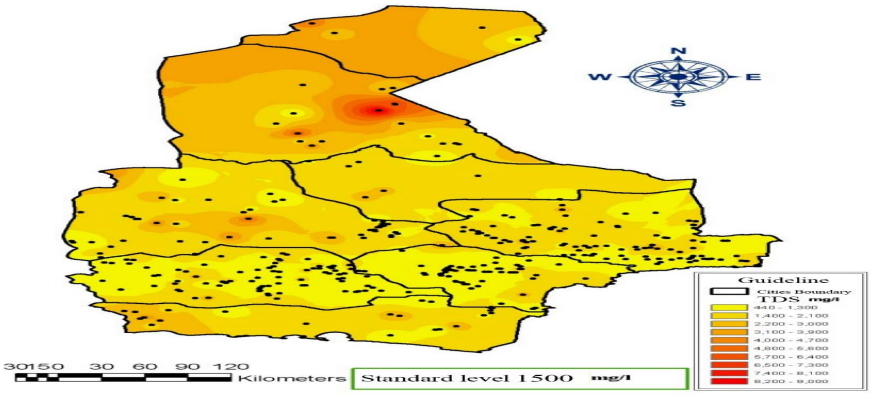

Fig 3. The inverse distance weighted of TDS concentration

Table 1: The amount of aluminium, pH and total dissolved solid in Sistan and Baluchistan, 2015

		Aluminum (mg L^{-1})	pH	TDS (mg L^{-1})
Cities	Number	Average±STDEV	Average±STDEV	Average±STDEV
Iranshar	106	0.017±0.019	7.790±0.367	1120.440±620.3
Chabahar	18	0.014±0.007	7.920±0.278	1246.540±589.3
Khash	47	0.014±0.008	7.480±0.187	989.023±519.2
Zahedan	37	0.016±0.012	7.940±0.265	1910.800±800.7
Zehak-Zabol	15	0.015±0.012	7.845±0.237	672.840±280.1
Saravan	58	0.014±0.010	7.800±0.199	890.720±429.1
Sarbaz	27	0.015±0.011	7.775±0.180	529.670±229.1
Konarak	59	0.014±0.009	7.709±0.350	1485.330±373.1
Nikshar	90	0.019±0.008	7.410±0.319	1248.390±289.7
Total	457	0.015±0.010	7.740±0.264	1121.520±458.9

concentration of all measurement sites were less than WHO and EPA limited levels. With this, trivial intake is estimated. If assuming 2 L as daily water consumption by a normal individual and that average concentration of aluminum was 0.059 mgL^{-1}, 0.118 mg aluminum would be daily intake which is within the standard limits. Therefore, those consuming >2l water per day, need to be more cautious. Canada Personal Health Organization has announced 7.2 g day^{-1} oral intake of aluminum as maximum allowable intake of the element (Maleki *et al*., 2005).

Moore (1991) reported that there was 20-45 mg aluminum in daily diet of a 70 kg individual (Abedi *et al*, 2014). In short, aluminum concentration in water resources of Sistan Baluchistan was within the standard limits and the drinking water system is safe from aluminum concentration viewpoint.

CONCLUSION

In this study, concentration of aluminum in Sistan and Baluchistan groundwater was measured and then pollution sources by inverse distance weighted using GIS software were plotted. Results showed average and standard deviation of aluminum concentration were 0.015±0.010 mg L^{-1}. So, this groundwater resources met the standards and can being used as drinking water supply.

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REFERENCES

Abedi, G. and F. Rostami, 2012. Assessment of quality of life in hepatitis B patients compared with healthy people. Life Sci. J., 9: 5339-5343.

Abedi, G., S.H. Darvari, A. Nadighara and F. Rostami, 2014. The relationship between quality of life and marriage satisfaction in infertile couples using path analysis. J. Mazandaran Uni. Med. Sci., 24: 184-193.

Barkhordari, A., S. Poorabdian, J. Khoobi and M. Karchan, 2011. The study of changes in the serial peak flowmetery test in the workers of car painting workshops in Isfahan. Scient. J. Kurdistan Uni. Med. Sci., 15: Pe73-Pe80.

Batayneh, A.T., 2012. Toxic (aluminum, beryllium, boron, chromium and zinc) in groundwater: Health risk assessment. Int. J. Environ. Sci. Technol., 9: 153-162.

Becaria, A., A. Campbell and S.C. Bondy, 2002. Aluminum as a toxicant. Toxicol. Ind. Health, 18: 309-320.

Bozkurtoglu, E., M. Vardar, F. Suner and C. Zambak, 2006. A new numerical approach to weathering and alteration in rock using a pilot area in the Tuzla geothermal area, Turkey. Eng. Geol., 87: 33-47.

Corder, E.H., A.M. Saunders, W.J. Strittmatter, D.E. Schmechel and P.C. Gaskell *et al*., 1993. Gene dose of apolipoprotein E type 4 allele and the risk of Alzheimer's disease in late onset families. Sci., 261: 921-923.

Farzianpour, F., J. Shojaee, G. Abedi, F. Rostami, 2014. Assessment of quality of life in cancer patients. Am. J. Agric. Biol. Sci., 9: 147-152.

Fewtrell, L., J. Bartram and W.H. Organization, 2001. Water Quality: Guidelines, Standards and Health: Assessment of Risk and Risk Management for Water-Related Infectious Disease. IWA Publishing, London, UK.,.

Moore, J.W., 1991. Sulfur: Inorganic Contaminants of Surface Water. Springer, Berlin, Germany,.

Rondeau, V., D. Commenges., H. Jacqmin-Gadda and J.F. Dartigues, 2000. Relation between aluminum concentrations in drinking water and alzheimer's disease: An 8-year follow-up study. Am. J. Epidemiol., 152: 59-66.

Sajadi, S.A., E. Bazrafshan, F.J. Behnam, A. Zarei and H. Biglari, 2015. Survey on the geo-statistical distribution of heavy metals concentration in Sistan and Baluchistan's Groundwater via geographic information system, Iran. Iran. J. Health Sci., 3: 1-8.