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Nitrate Content in Drinking Water in Gilan and Mazandaran Provinces, Iran

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Abstract

Water pollution issue has become one of the most important public awareness issues. The excessive use of the fertilizers and pesticides in agriculture with the threat of the chemicals in water and crops especially in the two north provinces of Iran is a major concern of Iranian environmental scientists. This project is a trial to find out the status of nitrate content in drinking water of two great provinces in the north of Iran. The objectives of the present research: Determination the level of nitrate (mg/L) in drinking water of some agricultural and industrial cities and comparing of the probable effects of different industrial factories on the level of nitrate in drinking water of them. The tap water samples of 60 different sites from Rasht , Bandar Anzali and Talesh in Gilan province and Sari, Behshar and Amol in Mazandaran province in three consequent months in summer season (July, August and September) in 2013, were collected and by spectroscopy method were determined. There are no wastewater collection, treatment and disposal system in these cities. Sampling was replicated twice within each month at intervals of two weeks and the mean value considered as a result of one sample. To evaluate variability of nitrate content within sub-samples, five sub-samples (900 sub-samples) on the whole were analyzed separately. The mean concentrations of NO_3- (mg/L) in most examined water samples were lower than acceptable ranges (NO_3- ≤ 50 (mg/L) and only 11% of all samples were higher than it. A highly significant, positive correlation was found between nitrate contents of the August and September drinking water samples , compared to July ones. Results shows a significant difference between locations (p<0.03) and in the different sites as nitrate content in drinking water in industrial locations were obviously higher than other locations in the cities.

Keywords: Nitrate content; Drinking water; Gilan; Mazandaran

Introduction

Fresh water shortage is becoming an increasingly acute problem facing many nations in the world. In the Near East Region, some 16 countries out of 29 member states are classified as water-deficient, with less than 500 m^3 per capita of the annual renewable fresh water resources [1,2]. Although the Near East Region occupies about 14 percent of the world area and embraces almost 10 percent of the world population, it only receives 3.5 percent of total precipitation and only 2.2 percent of the annual internal renewable water resources (IRWR). Ground water provides drinking water for most of the Nation's population and it is sole source of drinking water for many rural communities and some large cities in Iran. Nitrate and nitrite and other chemicals can pass through the soil and contaminate ground water [3,4]. Knowing where, what type of contaminants and risks to ground water exist can alert water- resource managers and users of the need to protect water supplies. The risk of ground-water contamination by nitrate depends both on the nitrogen input to land surface and the degree to which an aquifer is vulnerable to nitrate leaching and accumulation. Beneath agriculture lands, nitrate is primary form of nitrogen. It is soluble in water and can easily pass through soil to the ground water table. Nitrate can persist in ground water for decades and accumulate to high levels as more nitrogen is applied to the land surface every year. Most drinking water in Iran generally is supplied through modern infrastructure such as dams, reservoirs, long-distance transmission pipelines, and deep wells [5]. Alireza Marandi, the former Health Minister of the Islamic Republic, also confirms that the water increasingly contains unsafe levels of nitrates and heavy metals due to population overgrowth [5,6]. Dangerous contents of Cadmium and Lead could been found in recent years in Mazandaran and Gilan agricultural products due to contaminated source tapped to address population and over fertilization with chemical fertilizers and high rain falling [3,7-9]. The consumption of risk nitrate diet increased the risk of formation of carcinogenic nitrosamine [4,10-12]. High levels of nitrate intake were linked with the Non-Hodgkin's lymphoma [13], bladder cancer [13], pancreatic cancer [14] and stomach cancer [3,15-18]. The US National Research Council found an association between high nitrate intake and gastric and esophageal cancer [13,19].

Even water from a tap or a well may contain toxins from human activity or those that are simply present in the ground. Although low levels of nitrate may occur naturally in water, higher levels are potentially dangerous to infants. It is often difficult to pinpoint sources of nitrates because there are so many possible sources of nitrogen and nitrates may include runoff or seepage from fertilized agricultural land, municipal and industrial waste water, refuse dumps, animal feedlots, septic tanks and private sewage disposal system, urban drainage and decaying plant debris [2]. Geologic formations and direction of ground water flow also may influence nitrate concentration. Shallow wells, poorly sealed or poorly constructed wells and wells that draw from shallow aquifers are at greatest risk of nitrate contamination. Increased nitrate concentrations can occur from: Rainfall, Erosion, Human pollution, Upwelling, Decomposition, Animal excretions, Natural breakdown of minerals [20-23]. There are many factors that

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affect the nitrate level in drinking water; among these factors are the rainfall amounts in different months (The average rainfall of the study area for example in Talesh has been reported as 1250 mm in summer, water- resources, the high sunlight intensity and direction of ground water flow also may influence nitrate concentration.

Aside from the difficulties with nitrates in drinking water, there are a very few published studies evaluating the nitrate levels in the various provinces and cities. A 2007 investigation was undertaken in Hamedan Province to determine the concentration of nitrate and nitrite in ground water sources in the province and to compare the nitrate and nitrite contents with the standard levels. Results indicate that few of samples had nitrate greater than 45 mg/L [24,25]. A documentary review of Iran's experiences with Wastewater Management in Urban and Rural Areas reveals that the nitrate content in groundwater resources in the cities of Mashhad and Arak is many times over the allowable limits [26,27].

This project is a trial to find out the status of nitrate content in drinking water of two great provinces in the north of Iran as there are no wastewater collection, treatment and disposal system in these cities and in Mazandaran and Gilan agricultural products due to contaminated source tapped to address population and over fertilization with chemical fertilizers and high rain falling, risk of high nitrate content in the tap water is likely possible. The objectives of the present research:

1-Determination the level of nitrate (mg/L) in drinking water of some main agricultural and industrial cities in the north of Iran

2-Comparing of the probable effects of different industrial factories on the level of nitrate in drinking water in these two important provinces

3-Comparison of nitrate content in different parts and location of studied cities

Materials and Methods

Study area

Northern Iran includes the Southern Caspian regions representing provinces of Gilan , Mazandaran , and Golestan. Gilan and Mazandaran Provinces are two of the 31 provinces of Iran. They lie along the Caspian Sea, Gilan in the west of the province of Mazandaran, east of the province of Ardabil, north of the provinces of Zanjan and Qazvin and Mazandaran. The northern part of the province is part of territory of South (Iranian) Talesh. At the center of the province is the main city of Rasht. Other towns in the province include Talesh, and Bandar Anzali. Mazandaran is one of the most densely populated provinces in Iran and has diverse natural resources, especially large reservoirs of oil and natural gas. The province's four largest counties are Sari, Babol, Amol and Qaemshahr. The name and description of all the sites in two studied provinces in this research are provided in Figure 1. The Caspian Sea constitutes the southern limit of the study area. The regional climate is humid and very humid with cool winter according to Emberger climate classification. Gilan has a humid subtropical climate with by a large margin the heaviest rainfall in Iran reaching as high as 1,900 millimeters in the southwestern coast and generally around 1,400 millimeters. Rainfall is heaviest between September and December because the onshore winds from the Siberian High are strongest, but it occurs throughout the year though least abundantly from April to July [28].

There are no wastewater collection, treatment and disposal system in these cities such as Sari. The common practice

for wastewater disposal is through percolation pits. These wells have 1 to 1.2 mm diameter and 8 to 10 m depth and normally require one time cleaning in about 1-to 2 year period. The wastewater is almost entirely of domestic origin. Some industries that produce an effluent are located in the project area such as dairy factories and soft drink factories. These factories have activated sludge wastewater pre-treatment plants, which produce effluent compliant with Iranian standards for industrial effluent discharge to the sewer network [29].

Sampling method

The tap water samples of 60 different sites from Rasht, Bandar Anzali and Talesh in Gilan province and Sari, Behshar and Amol in Mazandaran province in three consequent months in summer season (July, August and September) in 2013, were collected according to standard methods: 2347 and 1053 [30] and nitrate concentration, were studied by spectroscopy method [31-41]. The results were compared to Iranian standards and World Health Organization [19,23,24,30].

Nitrate determination

Nitrate levels can be expressed differently, but provide for the same standard. The World Health Organization [23, 24] standard is expressed on the basis of nitrates itself as 50 mg/liter, while the nitrate- nitrogen value of 10 mg/liter. This standard is essentially the same. The 1993 Guidelines concluded that extensive epidemiological data support the current guideline value should be expressed not on the basis of nitrate-nitrogen but on the basis of nitrate itself, which is chemical entity of concern to health. The guideline value for nitrate is therefore 50 mg/liter" [23,24]. The EU directive standard is set at 50 mg/L expressed on the basis of nitrate itself, or 10 mg/L expressed as the nitrate/nitrogen value [23-25].

Figure 1: Description of studied locations and drinking water samples collection.

In this study 900 sub-samples on the whole were analyzed separately. The results were compared to Iranian standards and World Health Organization [13,23,24,29,30]. The World Health Organization (WHO) and the European Community (EC), maximum contaminant level (MCL) of nitrate is given to be 50 mg/L.

Samples were collected and stored in clean acid-washed polyethylene bottles, following the sampling routines set for water quality studies [21]. After collection and delivery to the Pharmaceutical Research laboratory in Islamic Azad University, the water samples were acidified to a pH <2. Prior to the chemical analysis, water samples were filtered through a Whatman glass microfiber filter (GF/C). 400 mL of distilled water was added to a 500-mL Kjeldahl flask with previously treated boiling chips to avoid bumping. Steam distillated until it showed no positive reaction with Nessler reagent (100 g mercuric iodide and 70 g of potassium iodide in small amount of water). Dechlorinating agent (sodium thiosulfate (1/35 mol/L) was added in order to equivalent to the chlorine residue in the sample. In this step, pH of each sample to 9.5 with 1 mol/L sodium hydroxide solution was adjusted. 50 mL of samples (drinking water) in Kjeldahl flask was taken and 2.5 mL of borate buffer was added. Distilled 15.0 mL of the sample into 2.5 mL boric acid solution in 250 mL Erlenmeyer flask. The distillated solution to 100 mL with deionized water was diluted; 1 mL Nessler reagent was added and mixed thoroughly to allow the solutions to sit for 20 minutes for color development. Background correction with blank solution was performed and followed by sample analyses [30-42]. The absorbance was performed at 425.0 nm against a reagent blank using perkin Elmer UV/Vis spectrophotometer with single beam sample compartment.

Statistical method

Seasonal differences on the basis of the sites of drinking water were determined by student t-test. Seasonal changes were calculated by one way ANOVA and for analysis of the role of multiple factors univariate analysis was used by SPSS 17. Probability values of <0.05 were considered significant.

Results

The results were determined as mean ± SD of three replicates in each test. Results indicate that only in 20 samples (100 subsamples) had nitrate above standard levels. Few of samples which were taken from the cities from Bandar Anzali, Talesh, Sari, Behshahr had nitrate concentrations greater than 45 mg/L. The mean concentrations of NO_3- (mg/L) in most examined water samples were lower than acceptable ranges (NO3- ≤ 50 (mg/L) which is shown in Figure 2 and only 11% of all samples were higher than it. A highly significant, positive correlation was found between nitrate contents of the August and September drinking water samples, compared to July ones. All nitrate levels in ten sites in Bandar Anzali and Rasht are shown in Figures 3 and 4. Results indicate there is a significant (p<0.01) difference in different locations in these cities.

The Anzali Wetland complex (37°23′ to 37°37′ E_49°19′ to 49°35′ N), is the most important city in the southern Caspian region , situated on the southwest shore of the Caspian Sea northeast of Rasht and adjacent to Bandar-e-Anzali town on the northern boundary in Gilan province, northern Iran [43] . The Anzali Lagoons probably formed during the Holocene [44]. The area of the Anzali wetland complex is 15,000 ha (including Anzali wetland 10,990 ha, Siahkesheem marsh lands 3,650 ha and Selkeh Ab-bandans 360 ha). The lowlands of the basin are intensively cultivated for rice and the remaining natural cover of the upland is a temperate deciduous forest. The area considerable

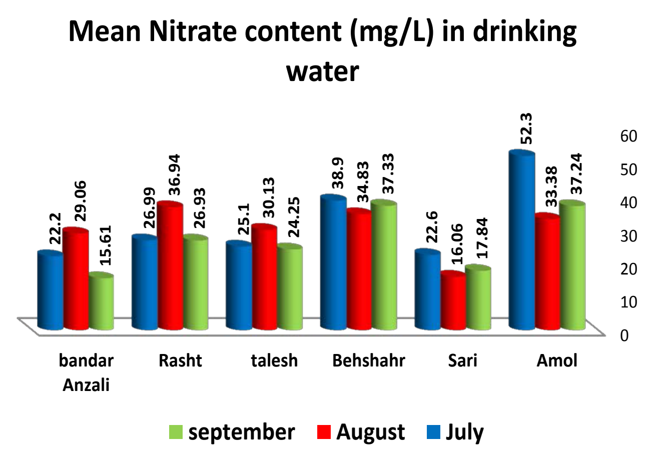

Figure 2: The Mean level of Nitrate contents (mg/L) in 180 drinking water samples in summer 2013.

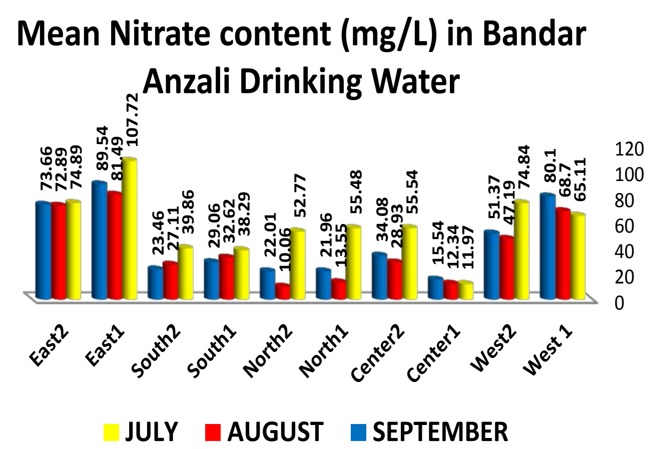

Figure 3: The mean level of nitrate concentration (mg/Liter) in different locations of Bandar Anzali drinking water in summer 2013.

from high amount precipitation (1500 mm/year) and does not have a dry season [43]. Therefore, the wetland, although it experiences some seawater penetration, is a freshwater ecosystem. In Figure 3 the mean level of nitrate concentration in different sites are compared. Results shows a significant difference between locations (p<0.03) and in the east sites nitrate content in drinking water were obviously higher than other locations in the city, which could be related to industrial wastewater of some factories and most of them have not wastewater treatment facilities and control equipment [45].

It is reported that every year large volumes of wastewater and industrial waste flow into eastern parts of Anzali wetland from the cities of Rasht and Khomam [45]. During recent years, the expansion of the industrial areas and the accompanying increase in population density has impacted the heavy metal content in the river pollution [46]. Results show Results shows a significant difference between locations (p<0.03) and in the east sites nitrate content in drinking water were obviously higher than other locations in the city just like the main city Bandar Anzali and it could be related to industrial wastewater of some factories and no wastewater treatment facilities again.

In Figure 5, in order to find the procedure of nitrate fluctuation, the mean level of nitrate contents were compared during different months.

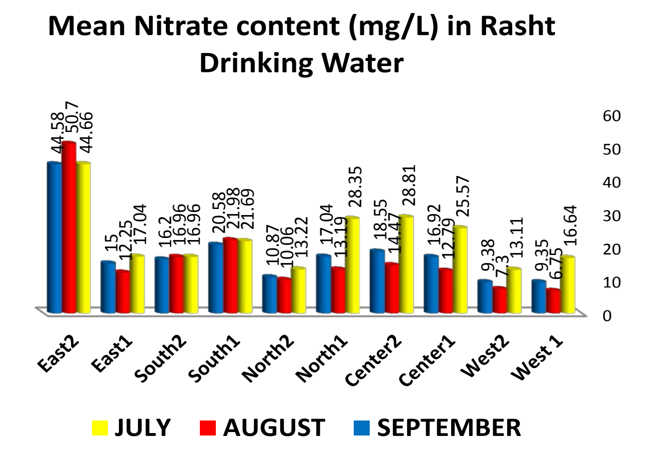

Figure 4: The mean level of nitrate concentration (mg/Liter) in different locations of Rasht drinking water in summer 2013.

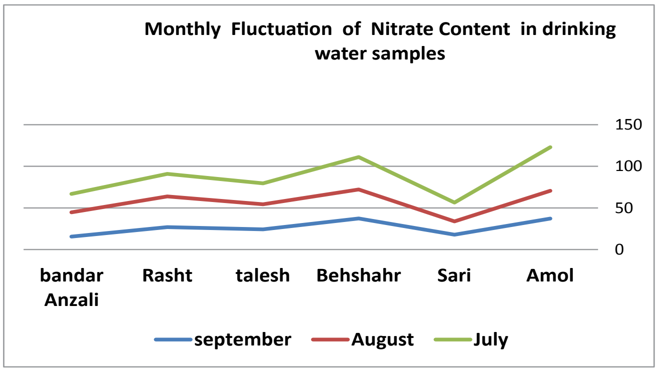

Figure 5: Monthly fluctuations of mean level nitrate contents in drinking water samples in summer 2013.

The Figure shows the same trend for all cities , as the NO3- contents in september were the lowest while in July were highest. The most of samples in Amol had highest level especially in July collected samples while sari had the lowest level ofnitrate in drinking water samples. The results in our study is the same as other environmental studies by Sheikhy Narany and her co-authors in 2014 [47]. They represented that the slope of the land surface was created using digital elevation model (DEM) maps of the Amol-Babol Plain. In low slope areas there is increased infiltration from runoff, which shows greater potential for groundwater contamination, while high slope areas, cannot retain runoff for a long time reducing infiltration to the groundwater. Their results showed that Amol City was having a high probability of nitrate contamination and high probability risk.

Results indicated that samples examined in July contained significantly higher nitrate levels than other months ($p<0.01$) and months of study had the meaningfully proportion in nitrate concentration.

Conclusion

It is clear that the result of our study shows a variation in the nitrate levels in the different drinking water of cities. It is often difficult to pinpoint sources of nitrates because there are so many possibilities. The best way to reduce nitrate in the drinking water is to identify any potential sources of nitrate on the water sources and find ways to manage those sources. A high nitrate level may signal the presence of other contaminants including pesticides, and disease causing bacteria, therefore examine the tap water from all cities and the surrounding area for sources of other contaminants are recommended.

We suggest that some projects should be done to improve the operational efficiency and financial sustainability of two provincial water and wastewater companies, due to improve water distribution systems, including metering, sanitary sewers and a wastewater treatment plant in Gilan and Mazandaran provinces.

Acknowledgment

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References

1. Food and Agriculture Organization of the United Nations (FAO) (1997) Irrigation in the Near East in figures: Water Reports No. 9.
2. Food and Agriculture Organization of the United Nations (FAO) (2003) Regional Office for the Near East.
3. Seifi F, Ziarati P, Arbabi Bidgoli S (2013) Seasonal Fluctuation of Heavy Metal and Nitrate Pollution in groundwater of Farmlands in Talesh, Gillan , Iran. Intl J Farm & Alli Sci. 2 (20): 836-841.
4. Ziarati P (2012) Assessing the Health Risk of Nitrate Content in Vegetables to the General Population in Tehran-Iran.
5. Ministry of Health and Medical Education (2001) Occupational and Environmental Health Center. Nitrate in the water.
6. Kadoom (2010) Drinking water unsafe in Tehran.
7. Ziarati P, Khoshhal Z, Asgarpanah J, Qomi M (2013) Contaminations of Heavy Metals in Tea Leaves, Finished Tea Products and Liqour in Gilan Province, Iran. Intenational Journal of Farming & Allied Sciences 2: 383-387.
8. Ziarati P, Arbabi S, Arbabi-Bidgoli S, Qomi M (2013) Determination of Lead and Cadmium Contents in (Oryza sativa) rice samples of agricultural areas in Gillan-Iran. Intenational Journal of Farming & Allied Sciences 2: 268-271.
9. Zazuoli MA, Mohseni Bandpei A, Ebrahimi M, Izanloo H (2010). Investigation of Cadmium and Lead Contents Iranian Rice Cultivated in Babol Region. Asian Journal of Chemistry, 22: 1369-1376.
10. Maanen JM, pachen DM, Dallinga JW, Kleinjans JC (1998). Formation of Nitrosamines During Consumption of Nitrate-Amine Rich Food, and The Influence of The Use of Mouthwashes. Cancer Detection and Prevention. 22(3):204-212.
11. Ziarati P, Arbabi Bidgoli S (2012) Evaluation of the Nitrate Content in Leafy Vegetables of Southern Parts of Tehran: A Four Seasonal Study. OMICS, Open Access Scientific Reports 1.
12. Ziarati P (2012) Comparison nitrate content in soil of vegetable farms. Journal of Asian Association of Schools of Pharmacy 1(1): 53 57
13. World Health Organization (2007), Nitrate And Nitrite In Drinking-Water.
14. Coss A, Cantor KP, Reif JS, Lynch CF, Ward MH (2003) Pancreatic Cancer and Drinking Water and Dietary Sources of Nitrate and Nitrite. American Journal of Epidemiology, 159 (7):693-701.
15. Abu-Dayeh AGH (2007) Determination of Nitrate and Nitrite Content in Several Vegetables in Tulkarm District. Available in Site: scholar.najah.edu/sites/default/files/all-thesis/alaa_al-qato.pdf
16. Addiscott TM, Benjamin N (2004) Nitrate and Human Health. Soil Use and Management , 20(2): 98-104.
17. www.howtodothings.com/view.
18. www.positivehealth.com.
19. Guidelines for drinking-Water Quality. Introduction (2005) World Health Organization.
20. Robert D, Cox (1980) Determination of nitrate and nitrite at the parts per billion level by chemiluminescence. Analytical Chemistry, Vol. 52, No. 2: 332-335.

21. Grasshoff K, Ehrhardt M, Kremling K (1983) Methods of seawater analysis. 2nd edn.

22. Yves Collos (1998) Nitrate uptake, nitrite release and uptake, and new production estimates. Marine Ecology Progress Series 171: 293-301.

23. World Health Organization (2003) Regional Office for the Eastern Mediterranean.

24. World Health Organization(2005) WHO: Guideline for Drinking Water Quality.

25. Nixon S (2004) Indicator Fact Sheet (WEU10) Drinking Water Quality." European Environmental agency.

26. Khaniki GHR, Dehghani H, Mahvi Rafati AHL, Tavanafar F (2008) Investigation of Nitrate and Nitrite in Ground Water SW sources of Hamadan Province, Iran. India Environment portal. Reaserch Journal of Chemistry and Environment 12: 56-58.

27. Mahmoudian SA (2006) Wastewater Management in Urban and Rural Areas (A review of I.R. of Iran's experiences). Reginal center on Urban water Management. UNESCO.

28. Ravanbakhsh M, BazdideVahdati F, Moradi A, Amini T (2013) Flora, life form and chorotypes of coastal sand dune of southwest of Caspian Sea, Gilan province, N Iran 2013 JNAS Journal 2-12: 666-677.

29. http://wwwwds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2005/03/29/000104615_20050401100439/Rendered/INDEX/Integrated0Saf1et010Appraisal0Stage.txt

30. Institute of Standards and Industrial Research of Iran (ISIRI) (1998) Characteristics of drinking water, Standard No.1053 and 2347.

31. Resource conservation and recovery act methods from S-846 (1987) Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. 3rd edn., US. GPO, Washington, DC.

32. Methods for Chemical Analysis of Water and Waste(1983) Environmental Monitoring Systems Laboratory (EMSL), Cincinnati, OH.

33. 1992 Standard Methods for the Examination of Water and Wastewater 18th edition, American Public Health Association.

34. 40-CFR Appendix B to Part 136 - Definition and Procedure for the Determination of the Method Detection Limit-Revision 1.11

35. Water and Environmental Analysis According to U. S. EPA Regulations-PerkinElmer, Part Number 0993-503.

36. http://www.perkinelmer.com/CMSResources/Images/44-74589BKT _LAMBDA Water Booklet . pdf.

37. Standard Methods for the Examination of Water and Wastewater (1992) 18th edition . American Public Health Association, American Water Works Association, Water Environment Federation. Method 4500-E 87553-207.

38. Environmental Protection Agency (EPA's) or the American Society for Testing and Materials (ASTM's) approved and published methods are used to determine nitrate concentrations in water.

39. Eaton AD, Clessicens SL, Greenberg EA (1995) Standard methods for the Examination of Water and Wastewater, 19th ed. American Public Health Association, 1015 Fifteenth Street, NW, Washington, DC 49-51.

40. Eaton AD, Chair AWWA (1995) Standard methods for the examination of Water and Wastewater, 19th ed. United Book Press Inc. Baltimore, Maryland USA, 1995, pp 4-67

41. Booth RL(1983) Methods for the Chemical analysis of Water and Wastes, 2nd ed. Environmental Monitoring and Support Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268: 352.

42. US Environmental Protection Agency (2013) Drinking Water Contaminants. Geneva.

43. Seifi-Nigje Gheshlagh F, Ziarati P, Arbabi Bidgoli S (2013) Seasonal Fluctuation of Heavy Metal and Nitrate Pollution in ground water of Farmlands in Talesh, Gilan,Iran. Intl J Farm & Alli Sci, 2 (20): 836-841.

44. Jafari N (2009) Review article: Ecological integrity of wetland, their functions and sustainable use. Journal of Ecology and Natural Environment 1: 045-054.

45. Leroy SAG, Lahijani HAK, Djamali M, Naqinezhad A, Moghadam MV, et al. (2011) Late Little Ice Age palaeoenvironmental records from the Anzali and Amirkola Lagoons (south Caspian Sea): Vegetation and sea level changes. Palaeogeography, Palaeoclimatology, Palaeoecology 302: 415-434.

46. Darabi Golestan F, Hezarkhani A, Zare MR (2013) Interpretation of the Sources of Radioactive Elements and Relationship between them by Using Multivariate Analyses in Anzali Wetland Area. Geoinfor Geostat: An Overview 1: 4.

47. Charkhabi AH, Sakizadeh M, Rafiee GhR (2005) Seasonal Fluctuation in Heavy Metal Pollution in Iran's Siahroud River. A Preliminary Study. ESPR-Environ Sci & Pollut Res 1-7.