IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 9, Issue 4 Ver. I (Apr. 2015), PP 86-90
www.iosrjournals.org

Assessment of accuracy predict the concentration of nitrate groundwater by spatial distribution model (surface kriging map): Hasht Bandi of Minab, Iran

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Abstract: *Recently, the spatial distribution models, such as surface kriging map were used extensively in the Assessmentof environmental pollutants such as nitrate groundwater. Therefore the Assessment of the accuracy of the maps in predicting concentration ofnitrate were determined. In this research, 162 water samples from 27 wells in HashtBandi of Minab (17 main and 10 controlled wells) were collected. The concentration of nitrate was measured by spectrophotometry DR28000 according to ferrous sulfate 8153 method. Kriging map accuracy Assessed by statistical analysis between measured and predicted concentration of nitrate in 10 controlled wells. The overall mean and rang of nitrate concentration in groundwater waters is 15.12±6.4 mg/1 and ND-41 mg/1, respectively. The least and most difference in measured with predicted concentration is related to (-20.33) well 2 and (-2.33) well 6 respectively. The mean ratio of the measured nitrate concentration (13.90±6.30 mg/1) to predicted (18.10±11.66) is %76.7. Surface kriging map has relatively high accuracy for Assessment of nitrate in groundwater water.*

Keywords:*Nitrate, Groundwater water, Kriging map and Assessment*

I. Introduction

Nitrate is the mineral composition of nitrogen, which in the last stage produces ammonia oxidation ,1] [2. Animal and chemical fertilizer or industrial and municipal wastewater are the sources of nitrate which enters to groundwater and surface water [4 ,3].Most of the researches shown that concentration ofnitrate in groundwater water in areas where agriculture activity is performed is more [7-5].Also Studies shown that consumption of drinking water with high concentration of nitrates causes Methemoglobin in infants, diabetes in children and stomach, bladder and liver cancer [11-8]. Based on instructions by world health organizationand American environment health agency, maximum allowed nitrate ion in drinking water by nitrogen is 10 mg/1 and by nitrate is 50 mg/1 [13 ,12]. Therefore measurement and assessmentconcentrationof nitrate in water resources was under attention of many researches for many years [16-14]. One of the most commonly used models for the assessmentof concentration of pollutantsenvironmental is spatial distribution model (surface kriging map) [19-17]. In different researches, predict accuracy of pollutants concentrationby kriging model was assessed. Safarianalyzedkriging map to estimate the chemical quality of groundwater water in Chamchamal plain. Results showed predict accuracy of kriging map is related to variable type and environmental factors[20]. Nazari and coworkers used Geostatistics method to assess the groundwater waters, Balarood plain. Results showed that spherical model is suitable for concentration evaluation of chloride, sulfate and electric conductivity[21]. Istokand Cooper used kriging mapto assess the concentration of heavy metals. Results showed that this model is appropriate for predicting the concentration of lead [22]. D'Agostinoet al. evaluated the concentration of nitrate groundwaterby kriging and cokrigingmaps. Results showed that these two methods are suitable to assess the concentration of nitrate groundwater waters [23].Therefore, we tried in the research to

assess the predict accuracy concentration of nitrate groundwater by surfacekriging mapin groundwater waters of Hasht Bandi of Minab.

II. Materials and methods

1.2. Study of Area

Hasht Bandiregion with 5000 population and 20 km^2 is located in northeast of Minab city and 163 kilometers from Bandar abbas (center of hormozgan Province) and in Geographical coordinates 27°.7` 19" N and 57°27`23"E (figure1) [24]. The climate of this region is hot and dry and occupation of most residents is farming. The level of groundwater water in this area is 50 to 80 meters.

2.2. Sample collection

In this sectional descriptive study, sample collection in three stages from May to July 2014, (every month, one stage). In each stage, two water samples were collected from each well. Hence, in a total of three stages, 162 water samples from 27 under studied wells (17 main and 10 control well), were collected, (figure 1). They attempted to collect samples concurrently. When water went out of the pump pipe for 10 minutes, sample was transferred in to 1.5 liter polyethylene container. Samples in the temperature of 4 □C was transferred to chemistry laboratory of health faculty in Bandar abbas city [24].

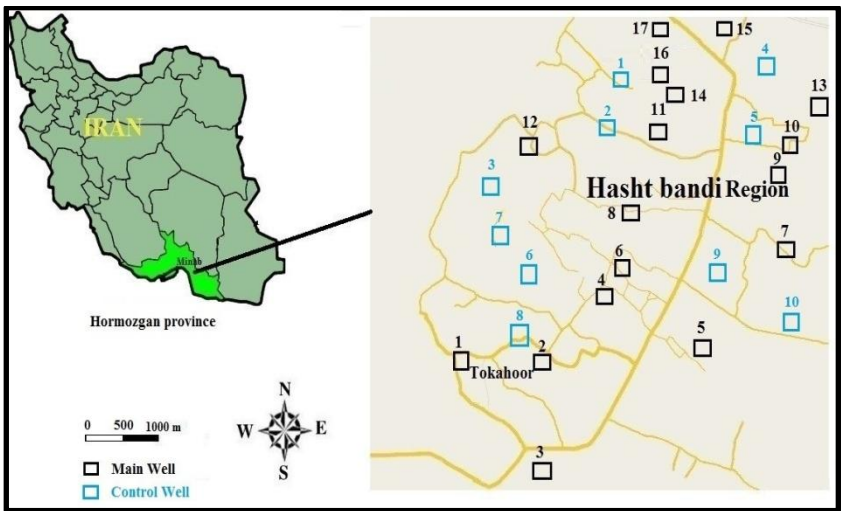

Figure 1. 27 sample well (17 main wells and 10 control wells), Hasht Bandi region

2.3. Measurement concentrationof nitrate

Concentrationof nitratewas measured by spectrophotometryDR28000 model (HACK Company). Measurement method of 8153 Ferrous Sulfate Method Powder Pillowswas used to determine the concentration ofnitrate. According to this method, the range of measurement is 2-250 mg/1-NO_2^-in the wavelength of 585 nm [25].

2.4. Kriging Map

Kriging map, through finding best line without error, accurately estimates the assumed variable rate (concentration of nitrategroundwater)in other places [18].
The general equation of kriging method is:

Equation 1: $$Z^*(x_p) = \sum_{i=1}^{n} \lambda_i Z(x_i)$$

To obtain a line without error, two equations must be solved simultaneously:

$$\sum_{i=1}^{n} \lambda_i \gamma(x_i, x_j) - \mu = (x_i, x)$$

Equation 2: $$\sum_{i=1}^{n} \lambda_i = 1$$

$Z^*(x_p)$ = is the estimated amountof variable in the range x_p , $Z(x_i)$ = is the estimated amount of variable in the range x_i , λ_i = is the data weight, μ = is the LAGRANGE coefficient, $\gamma(x_i, x_j)$ = is the VARIOGRAM amount according to variable size in point x_i and end point x_j [26]. In this research, the spatial distribution maps (surface kriging) was prepared with use of Surfer 12 software.

III. Results

The mean concentration of nitrates in the months of May, June and July is17.9±10.1,16.3±10.6, 16.2±9.4mg/l ,respectively. Mean and nitrate concentration range is 17. ± 6.6 mg/1 and ND[1]-41 mg/l,respectively (Table 1)

Table 1. Concentration of nitrate in 17 main wells in Hasht Bandi of Minab city (mg/l)

Wells	May	June	July	Mean
Well 1	[2]11.0	6.0	9.0	8.7
Well 2	ND	8.0	19.0	13.5
Well 3	16.0	11.0	19.0	15.3
Well 4	32.0	15.0	ND	23.5
Well 5	11.0	19.0	ND	15.0
Well 6	ND	16.0	12.0	14.0
Well 7	21.0	ND	6.0	13.5
Well 8	26.0	ND	41.0	33.5
Well 9	15.0	ND	19.0	17.0
Well 10	5.0	9.0	17.0	10.3
Well 11	19.0	31.0	ND	25.0
Well 12	35.0	12.0	20.0	22.3
Well 13	ND	ND	13.0	13.0
Well 14	6.0	0.0	ND	6.0
Well 15	14.0	28.0	5.0	15.7
Well 16	7.0	37.0	14.0	19.3
Well 17	32.0	3.0	ND	17.5
Mean	17.9	16.3	16.2	16.3
SD	10.1	10.6	9.4	6.6

Mean concentration of nitratein 10 control wells in months of May, June and July is 15.63 ± 8.18,11.57±5.32, 15.75±13.01 mg/l, respectively. Also the mean and range concentrationof nitrate is 13.90±6.30mg/landND-32 mg/l, respectively. Mean and rang concentration of nitrate groundwaterpredicted, is 18.10±11.66 and 4-36 mg/l, respectively. Totally, mean and range concentration of nitrate15.12± 6.4 mg/l and ND-41 mg/l (27 wells), respectively.

Table 2. Predicted and measured concentration of nitrate in groundwater in 10 controlled wells in Hasht Bandi of Minab city (mg/l).

	Measured				Predicted	Difference
	May	June	July	mean		
Well 1	21.00	17.00	14.00	17.50	29.00	-11.50
Well 2	27.00	17.00	3.00	15.67	36.00	-20.33
Well 3	17.00	6.00	ND	11.50	23	-11.50
Well 4	6.00	ND	3.00	4.50	7	-2.50
Well 5	10.00	ND	29.00	19.50	4	15.50
Well 6	24.00	16.00	31.00	23.67	26.00	-2.33
Well 7	ND	14.00	ND	14.00	29	-15.00
Well 8	ND	5.00	3.00	4.00	9	-5.00
Well 9	5.00	16.00	32.00	17.67	11.00	6.67
Well 10	15.00	7.00	11.00	11.00	7.00	4.00
Mean	15.63	11.57	15.75	13.90	18.10	
SD	8.18	5.32	13.01	6.30	11.66	

[1]Not detected (less than 2 mg/l)
[2] Mean of 2 samples

IV. Discussion

The highest and lowest concentration ofnitrateis related to 8 wells (main well) and 8 wells (control well) (figure 2). The difference concentration of nitrate in groundwater may be due to difference in the amount and type of chemical fertilizer and depth of the wells [29-27].

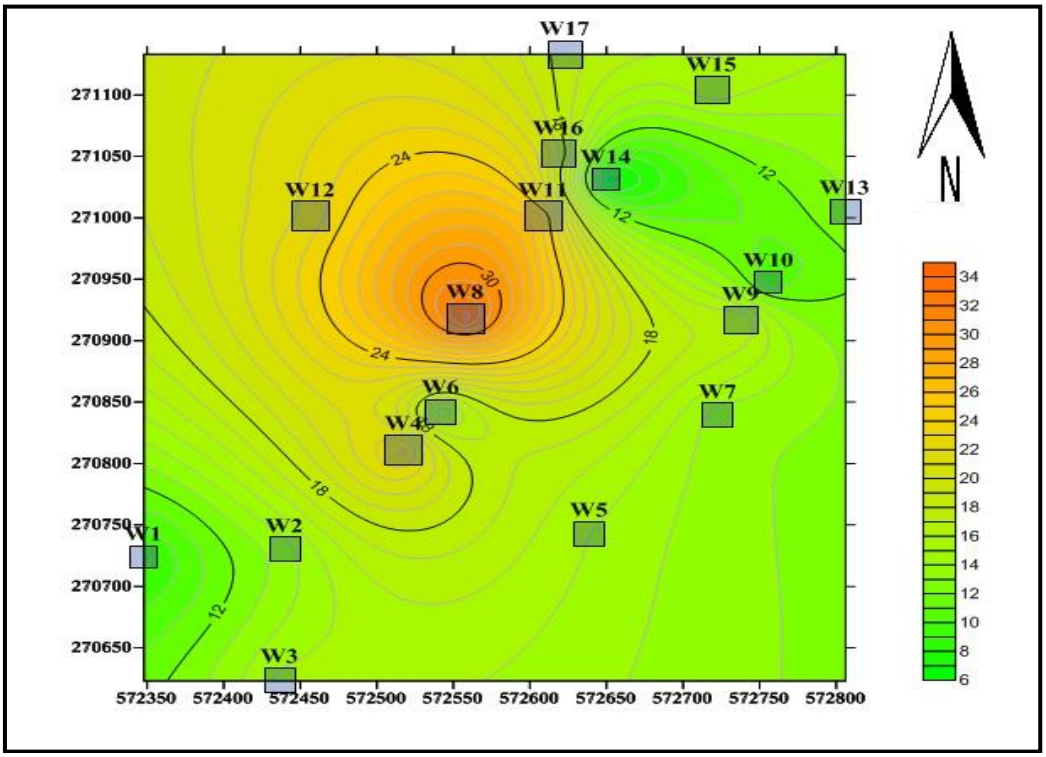

Figure 2. Surface kriging map concentration of nitrate in groundwaterin Hasht Bandi of Minab city.

Concentration of nitrate in all samples (%100) is lower than standard limits. Mean concentration of nitrate in groundwater is 30.24% of standard limitWHO and EPAnitrate of drinking water (mean27 wells) ,12] [13.Statistical analysis showed that, there is a significant difference between concentration of groundwaternitratein our research with standard limits of WHO and EPA (p value<0.05). The highest and least difference in measured concentration with predicted concentration is related to well 2 (-20, 33) and well 6 (-2, 33) (table2). Mean ratio of measured nitrate concentration (13.90±6.30 mg/l) to predicted (18.10±11.66) is 76.7%. On the other side, statistical analysis showed that there is no significant difference between measured with predicted concentration (p value<0.05). Our research results is just like research results ofD'Agostino et al[23], Ahmed et al[30], Barcaet al[31].

V. Conclusion

Since accuracy of KRIGING method in predicting nitrate concentration is %76, 7 (p value<0.05), therefore with preparation of surface KRIGING map, we can predict and evaluate the nitrate concentration in groundwater waters with high accuracy.

Acknowledgement

The authors of this article want to appreciate the cooperation of chemistry laboratory staff in Health College of hormozgan medical science university.

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