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Research Article

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Groundwater quality status using water quality index in Amalner town, Maharashtra

V. T. Patil[1] and P. R. Patil[2]

[1]Department of Chemistry, Z. B. Patil College, Dhule
[2]School of Environmental and Earth Sciences, North Maharashtra University, Jalgaon

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ABSTRACT

Groundwater samples collected during November 2009 - February 2010 from five different locations in Amalner town were subjected to comprehensive physicochemical analysis. Water quality index (WQI) values were computed to assess the groundwater with respect to drinking purpose. Groundwater samples from Shivaji Nagar, Dheku road and Weekly market indicated good water quality and fit for drinking purpose. The ground water samples from Shirud naka and Cotton market showed poor water quality as reflected by WQI value. The poor water quality has been found mainly due to higher values of EC, TDS, TA, TH and Cl^- in ground water.

Key words: Groundwater, Physico-chemical characteristics, Water quality índex, Drinking water quality.

INTRODUCTION

Water is extremely essential for survival of all living organisms. Life is not possible on this planet without water. Ground water is generally considered to be much cleaner than surface water but manmade activities are responsible for its pollution. Water pollution means contamination of water by foreign matter such as micro-organisms, chemicals, industrial or other wastes or sewage. Such matters deteriorate the quality of the water and render it unfit for its intended use [1]. Water quality is influenced by natural and anthropogenic effects including local climate, geology, and irrigation practices. The quality of water is of uttermost important to quantity in any water supply planning. The chemical character of any groundwater determines its quality and utilization. The quality is a function of the physical, chemical, and biological parameters and could be subjective, since it depends on a particular intended use [2].

Prolonged discharge of industrial effluents, domestic sewage and solid waste dump causes the ground water to become polluted and created health problems. Contamination of ground water can result in poor drinking water quality, loss of water supply, high clean-up costs, high costs for alternative water supplies, and/or potential health problems [3]. Hence there is always a need for and concern over the protection and management of ground water quality.

Ground water monitoring of dug wells and bore wells is one of the most important tools for evaluating the quality of ground water. Chemical analysis of water gives a concept about its physical and chemical composition by some numerical values but for estimating exact quality of water, it's better to depend on water quality index which gives the idea of quality of drinking water. Literature survey reveals that WQI has been reported by different groups of workers [4-6]. A water quality index (WQI) may be defined as a rating reflecting the composite influence of different water quality parameters [4].

Study area: Amalner town (latitude=21^o 2'30" N and longitude 75^o 4' E) in Jalgaon district lies at northern region of Maharashtra state. The monitoring of groundwater samples in and around Amalner town was carried out during November 2007 - February 2008 [7, 8]. The present study was carried out by selecting five water sample sites (Two tube well and two dug well and one municipal water site) during November 2009 - February 2010 from different localities in Amalner town (Fig.1).The location of sampling points are given in Table1.

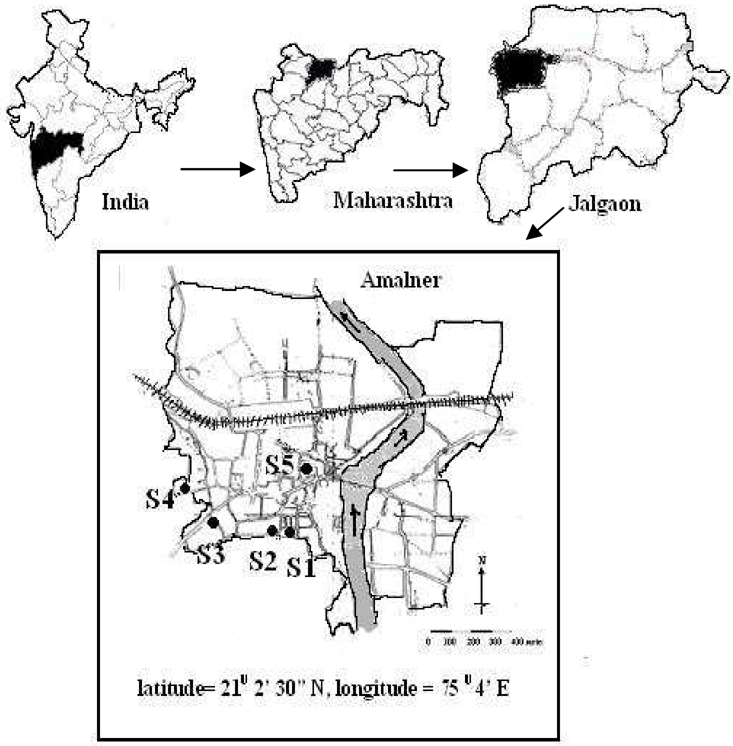

Fig.1: Sampling points and location map of the study area

Table1: Location of Sampling Points of the study area

Site No.	Sampling Point	Source	Latitude	Longitude	Altitude (m)
S_1	Shivaji Nagar	Tube well	21^{0}02'12.2"N	75^{0}03'37.6"E	192
S_2	Shirud Naka	Tube well	21^{0}02'12.6"N	75^{0}03'35.4"E	207
S_3	Cotton Market	Dug well	21^{0}02'13.5"N	75^{0}03'12.2"E	207
S_4	Dheku Road	Dug well	21^{0}02'47.6"N	75^{0}01'48.0"E	202
S_5	Weekly Market	Municipal Water	21^{0}02'34.7"N	75^{0}03'44.0"E	194

EXPERIMENTAL SECTION

Groundwater samples were collected in plastic canes of 3 litre capacity without any air bubbles as per standard procedure during post monsoon season (November 2009 to February 2010). The physico-chemical parameters such as pH, Electrical conductivity (EC), Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Total Alkalinity (TA), Total hardness (TH), Calcium (Ca^{2+}) Magnesium (Mg^{2+}), Sodium (Na^+), Potassium (K^+), Chloride (Cl^-), Fluoride (F^-), Nitrate (NO_3^-) Sulphate (SO_4^{2-}), Phosphate (PO_4^{3-}) were determined using standard methods [9-11] The results were compared with water quality standards prescribed by World Health Organization(WHO) and Indian Standards (IS 10500-91). AR grade reagents were used for the analysis and double distilled water was used for preparation of solutions.

Three steps were employed for WQI determination [4]. For computing WQI, the physico-chemical parameters pH, electrical conductivity, total dissolved solids, dissolved oxygen, total alkalinity, total hardness, calcium, magnesium, sodium, chloride, fluoride, nitrate and sulphate were selected. First, each of the 13 parameters has been assigned a weight (w_i) according to its relative importance in the overall quality of water for drinking purpose. These weights range from 1 to 5. The maximum weight of 5 has been assigned to the parameter NO_3^-. Magnesium was given the minimum weight of 1 as magnesium itself may not be harmful. The weights for the remaining parameters have been assigned according to their relative importance in the drinking water.

The relative weight (or weight per unit load of the pollutant) Wi for the i^{th} parameter (i = 1, 2… 12) is calculated from the relation;

$$W_i = \frac{w_i}{\sum_{i=1}^{n} w_i}$$

Where, W_i is the relative weight, w_i is the weight of each parameter. The calculated relative weight values are given in Table 2.

Table 2: Relative weight of physico-chemical parameters

Parameter	Weight(wi)	Relative weight(Wi)
pH	4	0.1
EC	4	0.1
TDS	4	0.1
DO	3	0.075
TA	2	0.05
TH	2	0.05
Ca^{2+}	2	0.05
Mg^{2+}	1	0.025
Na^{+}	2	0.05
Cl^{-}	3	0.075
F^{-}	4	0.1
NO_3^{-}	5	0.1
SO_4^{2-}	4	0.125
	$\sum w_i = 40$	$\sum Wi = 1.000000$

The relative weights were used for computation of Water quality index. The computed WQI values are classified into five types, Excellent water (WQI<50), Good (100-200), Poor (100-200), Very poor (200-300) to Water unsuitable for drinking (WQI>300) [4].

RESULTS AND DISCUSSION

The physico-chemical parameters with their WHO and Indian standards during post monsoon (November 2009 to February 2010) are summarized in Table 4.

Table 4: Average results of the physicochemical parameters with drinking water standards during post monsoon season (November 2009 to February 2010)

Sr. No.	Parameter	Sampling Points					IS 10500-91
		S_1	S_2	S_3	S_4	S_5	
1	pH	7.33	7.60	7.45	7.70	7.90	6.5-8.5
2	EC	1267	3198	2568	543.6	456.8	1400*
3	TDS	452	1400	1400	360	120	500
4	DO	5.7	3.7	7.2	8.3	9.1	5*
5	TA	319.8	594.6	594.6	234.2	216.2	200
6	TH	312	910	642	220	204	300
7	Ca^{2+}	45.69	121	81.76	46.49	42.48	75
8	Mg^{2+}	48.24	148.1	106.7	25.34	23.88	30
9	Na^{+}	282.1	240.7	319.7	35.73	60.17	200*
10	K^{+}	0.603	0.603	1.609	0.804	4.827	-
11	Cl^{-}	136.3	428.4	276.8	20.66	46.38	250
12	F^{-}	0.683	0.935	0.683	1.007	1.187	1
13	NO_3^{-}	2.543	4.904	5.688	1.511	0.363	45
14	SO_4^{2-}	26.97	98.88	77.53	22.47	15.73	200
15	PO_4^{3-}	0.953	0.714	0.714	0.953	1.429	-

(*All parameters are in mg/l except pH and EC. EC in micromhos/cm, *WHO)*

pH is a measure of the intensity of acidity or alkalinity and the concentration of hydrogen ion in water [12]. All the samples showed pH, nitrate and sulphate values within the prescribed limit given by IS 10500-91. Electrical conductivity is a measure of water capacity to convey electric current. It signifies the amount of total dissolved solids which in turn indicates the inorganic pollution load of water [13]. EC values were found higher than WHO limit for tube well site S_2 and dug well site S_3 indicating the presence of high amount of dissolved inorganic substances in ionized form. The sampling points S_2 and S_3 showed higher TDS values than the prescribed limit given by IS 10500-91. High concentrations of total dissolved solids may cause adverse taste effects.

Dissolved Oxygen in water is of great importance to all aquatic organisms and reflects the biological activity taking place in a water body and determines biological changes which are brought about by the aerobic organisms [14]. The sampling points S_2 showed low DO values indicating contamination by organic matter. Alkalinity is a total measure of substance in water that has "acid-neutralizing" ability. Total alkalinity values were found to be greater than the value prescribed by IS 10500-91.

The Hardness in water is due to the natural accumulation of salts from contact with soil and geological formations or it may enter from direct pollution by industrial effluents. The tube well sites S_1, S_2 and dug well site S_3 represent high hardness than the prescribed limit. In the present study, calcium concentration found within the prescribed limit except S_2 and $S_{3.}$

Sodium plays an important role in human body. Regulatory action is exercised by sodium, potassium, calcium and magnesium [15]. Magnesium and sodium content in the investigated water samples found higher than the prescribed limit except dug well site S_4 and municipal water site $S_{5.}$ Potassium concentration varied from 0.603 to 4.827 mg/L.

The chloride concentration serves as an indicator of pollution by sewage. The chloride content was found higher than the prescribed limit for tube well site S_2 and dug well site $S_{3.}$ Fluoride is present in almost every water, earth crust, many minerals, rocks etc. A small amount of fluoride is beneficial to human health for preventing dental cavities. The permissible limit of fluoride for drinking purpose is 1.5 mg/L. fluoride concentration greater than 1.5 mg/L can cause dental fluorosis and much higher concentration results in skeletal fluorosis [16]. The fluoride content in the study area was found below permissible limit. Nitrate and sulphate content was found within prescribed limit. Phosphate occurs in ground water as a result of domestic sewage, detergents, agricultural effluents with fertilizers and industrial waste water. The phosphate concentration varied from 0.714 to 1.429 mg/L.

The main objective of a water quality index is to turn complex water quality data into information that is understandable and useable by the population of the area. Water quality index based on some very important parameters can provide a simple indicator of water quality. It gives the public a general idea of the possible problems with water in a particular region [17]. The computed WQI values and the water quality during the period November 2009 to February 2010 have been indicated in Table 5**.**

Table 5: WQI values for post monsoon season (November 2009 to February 2010)

Site No.	Sampling Point	WQI	Water Quality
S_1	Shivaji Nagar	74.88	Good
S_2	Shirud Naka	147.8	Poor
S_3	Cotton Market	132.5	Poor
S_4	Dheku Road	59.89	Good
S_5	Weekly Market	57.49	Good

WQI values ranged from 57.49 to 147.8. Groundwater samples from tube well site $S_{1,}$ dug well site S_4 and municipal water site S_5 indicated good water quality. The water from these sites is suitable for drinking purpose. The sites S_2 and S_3 indicated poor water quality as reflected by higher WQI values. Higher content of EC, TDS, alkalinity, hardness, calcium, sodium and chloride may be responsible for poor water quality at these sites and water from these sites is unfit for drinking purpose. Proper treatments and disposal of the effluent, proper drainage for the domestic and agricultural wastes is essential for improvement in ground water quality.

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