

# NITRATE TOXICITY LEVEL IN DUG WELL WATER OF BARAMATI TAHSIL AREA, INDIA

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## ABSTRACT

Groundwater parameter changes spatially in summer and winter seasons. In the present study, spatio-temporal variation of nitrate toxicity in Dug well water of Baramati Tahsil area was studied. A total of 15 water samples were collected in the period of post-monsoon (POM) winter 2015 and pre-monsoon (PRM) summer 2016 seasons from dug wells by using standard methods of APHA [1]. Ground water samples were analysed by using standard methods of APHA suggested for determination of nitrate concentration. The results obtained from analysis indicates that concentration of nitrate in POM and PRM was above the maximum permissible limit of WHO and BIS recommended for drinking purpose. In POM 38% dug well water samples were above the standard limit of WHO [2] and BIS [3]. In PRM 25% samples were above the maximum permissible limit of WHO. This indicates that peoples especially children using the water from dug wells near the irrigated field showing higher concentration of nitrate than standard limit. It causes a high risk of methemoglobinemia (sometimes referred to as "Blue baby syndrome") in infants and babies. In canal irrigated area concentration of nitrate was found higher than the non-canal-irrigated area, this may due to improper disposal of animal and human wastes, the use of more nitrogenous fertilizers in farms in canal irrigated area as compared with non-canal-irrigated area. The groundwater of such wells was not suitable for drinking purpose without treatment at the time of analysis. High Nitrate containing water is more effective and useful for irrigation purpose.

**Key words:** Nitrate toxicity, Pre-monsoon, Canal irrigated area, Dug well, WHO

## 1. Introduction

Today maximum population of world and the India faces drinking water problems. These problem creates international and regional disputes over water, water scarcity and contamination, uncontrolled use of soft water, ecological degradation and the threats to climate change [4]. Twenty countries (most of them in Africa and the Middle East) suffer chronic water scarcity, causing severe damage to food production and stunted economic development. In 2025 one-third of the global population is expected to live in chronic water shortage areas [5].

Water-related diseases have largely been eliminated from developed countries; they remain a major concern in much of the developing world. While data are incomplete, the World Health Organization assessment shows that, there are 4 billion cases of diarrhea each year in addition to millions of other cases of illness associated with the lack of access to clean water. Since many illnesses are undiagnosed and unreported, the true extent of these diseases is unknown [6]. About 2.3 billion in the world suffer from diseases that are linked to water [7, 8].

Many researchers worked on the groundwater quality of dug well and bore wells for drinking and agricultural purposes. They inferred that water from dug wells were contaminated through physical processes, geochemistry of the environment and anthropogenic activities. Consequently, consumers of such

waters are exposed to series of health risks [9, 10, 11 and 12]. The bore well water from Baramati tahsil area found nitrate level above prescribed limit, These bore-wells was attributed to the use of chemical fertilizers in urban farming, indiscriminate animal grazing, improper disposal of animal and human wastes [13].

Health problems from nitrates in water sources are becoming a serious problem. In over 150 countries, nitrate from fertilizers seeped into wells, fouling the drinking water [14]. Nitrate is one of the most commonly identified groundwater contaminants [15]. It is primarily regulated in drinking water because excessive levels can cause methaemoglobineamia (blue-baby syndrome).

The climate of the Baramati tahsil area is slightly different in irrigated and non-irrigated area. The winter season is from December to about the middle of February followed by summer season which last up to May. June to September is the south-west monsoon season, whereas October and November constitute the post-monsoon season. The mean minimum temperature is about 12°C and means maximum temperature is about 39°C. The average annual rainfall for the period 2003 to 2012 of Baramati tahsil was 505.76 mm [16].

## 2. Material and Methods

### 2.1 Study area

Baramati tahsil belongs to western part of Maharashtra. It belongs to Pune division. It is located 100 km towards east from district headquarters Pune. 240 km from state capital Mumbai towards east (Figure 1). Baramati tahsil has its head quarter that is Baramati town. Baramati tahsil lies between 18°04' to 18°32' north latitudes and 74° 26' to 74° 69' east longitudes. It is located at altitude of 550 meters above means sea level [17].

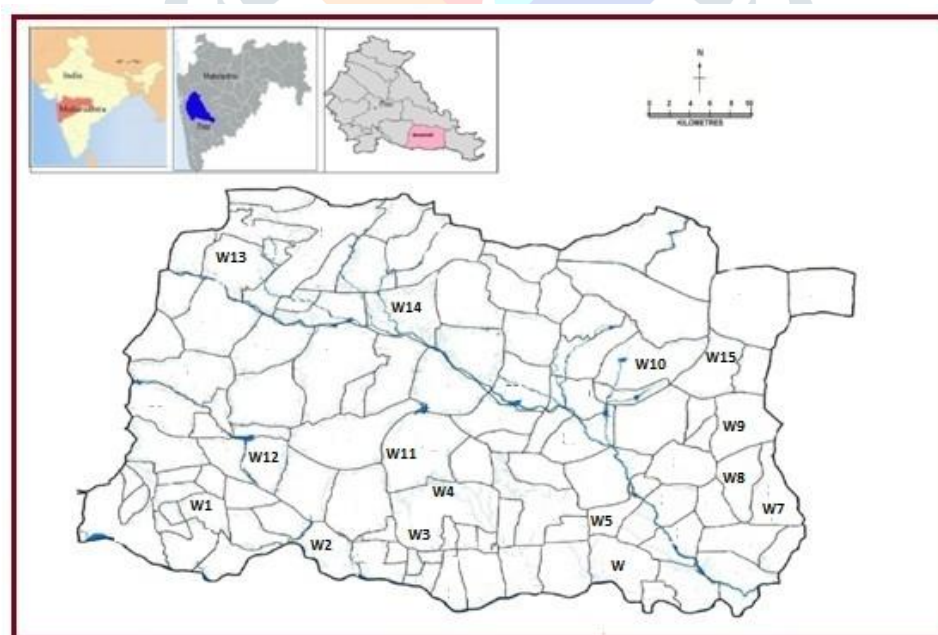


Figure 1: Location map of the sampling sites

### 2.2 Sampling sites

Dug well water samples from different wells of fifteen sampling sites of Baramati tahsil area were selected randomly by considering the topography and anthropological activities of the study area (Figure 1).

### 2.3 Sample Collection

Dug well Water samples from the selected sites were collected in a good quality polyethylene bottle of one-litre capacity during the period post-monsoon (POM) winter 2015 and pre-monsoon (PRM) summer 2016 seasons in triplicate. Fifteen dug well water samples (W1- W8 from canal irrigated area and W9-W15 from non-canal-irrigated area) were selected for collection of water samples for nitrate analysis.

### 2.4 Analysis of Nitrate

The chemical composition of water in various water bodies varies in different seasons. Therefore, it is necessary to test water frequently so that any small change in water quality is noted. It is also known that a seasonal changes in environmental conditions were the major source of variation in the water chemistry [18]. In view of this, it was decided to collect the dug well water samples from fixed sampling stations twice in a year covering pre-monsoon (summer) and post-monsoon (winter) seasons.

In dug well water, nitrates may be added by leachate from soil and by contamination. The main contributor for nitrate in ground water was the nitrogenous fertilizers of both animal and chemical origin and also sewage and industrial waste. Nitrate is an important plant nutrient. Metabolic waste of aquatic community and dead organism add to the nitrogenous organic matter. Various methods are used for the determination of nitrates.

In the present study, Brucine method [19] was employed. Nitrate and brucine react to produce yellow colour, the intensity of which can be measured at 410 nm. The reaction is highly dependent upon the heat generated during the reaction. However, carrying out the reaction for a fixed time at a constant temperature can control heat. The method is suitable for the samples having a very wide range of salinity.

In a hard glass tube, 10 ml sample 2 ml NaCl (30%) were added and samples were kept in wire rack. Then 10 ml of sulphuric acid added. After mixing thoroughly it was followed by the addition of 0.5 ml brucine reagent. The wire rack was placed in hot water bath for about 20 minutes. Finally, the reading was taken after cooling the solution at 410 nm. Nitrate concentration was estimated by comparing the absorbance with standard curve. Prepared a standard curve between concentration and absorbance by taking the dilutions from 0.1 to 1.0 mg N/l at the interval of 0.1 and employing the same procedures for the other groundwater samples [19]. The results obtained were compared with standard parameters suggested by WHO and BIS.

## 3. Results and Discussion

Nitrate concentration of dug well water of study area in winter 2015 ranges from 14.60 to 52.60 mg/l having average 32.68 mg/l. Standard deviation was  $\pm 12.28$  while median of the data in this season is 35.50. In summer 2016 nitrate value ranges from 16.30 to 47.50 mg/l having average 33.60 mg/l and deviation in nitrate concentration was found to be  $\pm 09.76$  (table 1).

Table 1: Nitrates level in Dug well water of Baramati Tahsil area, India

Sample No.	Sampling sites	Winter 2015 (POM)	Summer 2016 (PRM)	Average of two seasons	Standard Deviation (S.D.)
W1	Karanjepul	35.80	38.60	37.20	$\pm 1.98$
W2	Malshikarewadi	35.50	38.70	37.10	$\pm 2.26$
W3	Pawaimal	47.80	42.50	45.15	$\pm 3.75$

W4	Pandhare	44.60	42.90	43.75	±1.20
W5	Malad	52.60	45.80	49.20	±4.81
W6	Nirawagaj	38.70	39.80	39.25	±0.78
W7	Dhekalwadi	48.10	47.50	47.80	±0.42
W8	Kanhheri	36.70	39.00	37.85	±1.63
W9	Rui	25.60	27.20	26.40	±1.13
W10	Gojubavi	28.50	27.50	28.00	±0.71
W11	Dhakale	15.00	23.50	19.25	±6.01
W12	Chopdaj	21.60	24.50	23.05	±2.05
W13	Chandgudewadi	22.50	25.60	24.05	±2.19
W14	Karhati	22.60	24.60	23.60	±1.41
W15	Katphal	14.60	16.30	15.45	±1.20
Average		32.68	33.60	33.14	±0.65
Maximum		52.60	47.50	50.05	±3.61
Minimum		14.60	16.30	15.45	±1.20
Median		35.50	38.60	37.05	±2.19
Standard Deviation		±12.28	±9.76	±11.02	±1.78

25 to 38 % samples in canal-irrigated area showed higher concentration of nitrate than the recommendations of WHO and BIS (45 mg/l). No any samples in non-canal-irrigated area had nitrate values more than 45 ppm. In canal-irrigated area, the surrounding area of the sampling sites was irrigated. Sugarcane is the main crop in this area. Percolation of water from field was observed in the dug well, which may increases the nitrate concentration. Nitrogenous fertilizers used on large scale for crops in irrigated area, would be the possible causes of nitrate toxicity of dug well water. Minimum nitrate level was observed in Katphal village (S.N. W15) which is included in non-canal-irrigated area where fertilizer use by farmers is low while Maximum nitrate concentration was observed in Malad village (S.N. W5) which is included in canal irrigated area where fertilizer use by farmers for crop is more (Table 1).

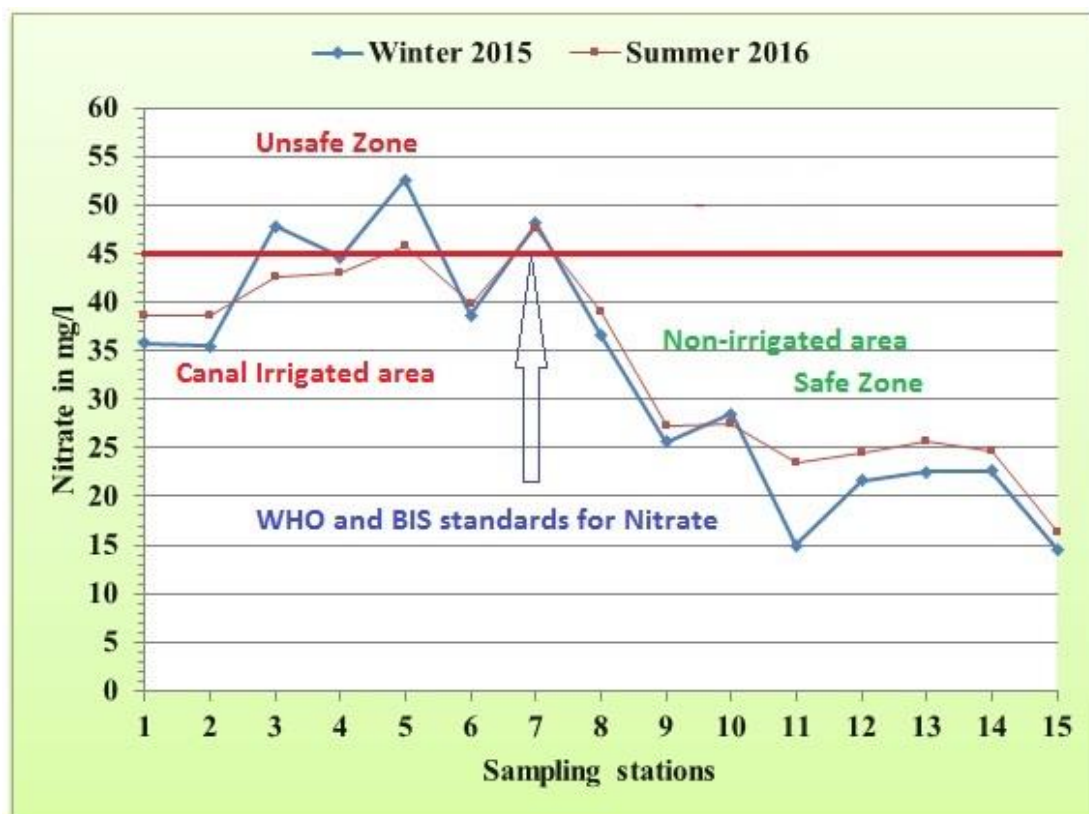
In the rural areas of Baramati tahsil, at certain places nitrate concentration was more. This was attributed to the nitrogen excretion by cattle in the dug well (i.e. animal wastes percolation) and dairies where large number of buffalo and cows are housed in relatively small areas. An excreta of these animals get accumulated and is leached by rainfall and other water sources causing high nitrate level in dug well water. The extent of such groundwater toxicity depends on bio-degradation, soil and rock strata characteristics through which percolation takes place. Thus, nitrate toxicity in the study area was combined effect of agricultural activity and animal wastes.

In the village Malad 52.60 mg/l of nitrate level was observed, which is situated on the bank of Nira River (S. N. W5). Dug well water sample number W3, W5, W7 were showed higher value of nitrate above permissible limit (45 mg/l) of BIS and WHO for drinking purpose. Figure 2 clearly indicates the concentration of nitrate present in canal-irrigated and non-canal-irrigated area of Baramati region.

In the study area, nitrate concentrations were found higher in winter than the summer. The high values of nitrates can cause nitrate toxicity. The Dug well water from Nira River side villages such as Pawaimal, Malad, Dhekalwadi have high concentration of nitrate. It was resolved that Majority of groundwater samples from irrigated area were unsafe for drinking purpose. Ocheri Maxwell et al [20] stated that nitrate concentration greater than 45 mg/l is undesirable in domestic water supplies. They found different sources of nitrate such as fertilizers, animal wastes and wastes from residual areas and septic tanks etc. have been investigated.

Most humans over one year of age have the ability to rapidly convert methemoglobin back to oxyhemoglobin; hence, the total amount of methemoglobin within red blood cells remains low instead of relatively high levels of nitrate/nitrite uptake. However in infants under six months of age, the enzyme systems for reducing methemoglobin to oxyhemoglobin are incompletely developed and methemoglobinemia can occur.

Adults can tolerate higher levels of nitrate-nitrogen with little or no documented adverse health effects and may be able to drink water with nitrate-nitrogen concentrations considerably greater than the 10 mg/l level with no acute toxicity effects. In this study therefore, attempt was made to assess the level of nitrate in dug wells among seasons in Baramati tahsil area, Pune, India. In the Baramati area dug wells and bore-wells were mostly used as a source of water for drinking and agricultural purpose.



**Figure 2: Spatio-temporal variation in nitrate of groundwater from Baramati, Pune area**

The groundwater resources contaminated with high levels of nitrate ( $> 45\text{mg/l}$  as  $\text{NO}_3$  or  $10\text{ mg/l}$  as  $\text{NO}_3\text{-N}$ ) are a human hazard. Incidents of nitrate pollution of groundwater have been reported by several workers like Hill [21] and Baalousha [22]. Urine deposited by grazing stock is the principal source of nitrate in the irrigated area. Because of the importance of nitrate as an essential element in the plant and animal nutrition, its concentration is of considerable interest in studies of human influence on the water chemistry. Natural nitrate concentration in groundwater ranges from 0.1 to 10 mg/l [23].

#### 4. Conclusion

The nitrate concentration found after analysis of Dug well water concludes that Dug wells in canal irrigated area of Baramati was polluted with nitrate. 38% Dug wells from canal-irrigated area have nitrate concentrations above WHO and BIS prescribed limit of drinking water for the winter season and 25% dug wells in summer season showed nitrate values above prescribed limit. In non-canal-irrigated area no any dug well have nitrate concentrations above WHO and BIS prescribed limit of drinking water. This implies that

users of drinking water from canal irrigated dug wells especially children stands a high risk of methaemoglobineamia (blue-baby syndrome). Nitrate level was noted to be higher in these dug wells in the winter season than in the summer season. The source of nitrate in these is attributed to the use of chemical fertilizers in farming, indiscriminate animal grazing, improper disposal of animal and human wastes and seasonal influence.

To reduce the rate of contamination, there should be control of all land use activities capable of polluting dug wells. Water from these wells may use for other purpose other than drinking. This water should treated by using suitable method for domestic uses. Water from these sources is good for irrigation purpose because nitrate is very important parameter required for the growth of plant.

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