

# **POLLUTION STATUS OF NIKOL LAKE LOCATED IN EASTERN AHMEDABAD, GUJARAT- INDIA**

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**Abstract:** Pollution is viewed as the release of substances and energy as waste product of human activities which result in harmful changes within the natural environment. The pollutant which causes pollution can be defined as “anything living or non living or any physical agent that in its excess makes any part of the environment undesirable. In the present study water of Nikol lake was analyzed for various physicochemical parameters. The study was carried out for a period of one year (March 2010 to February 2011). Monthly data’s been collected but were represented seasonally along with standard error. Different parameters studied were Temperature, Electrical conductivity, Turbidity, Total dissolve solids, pH, Alkalinity, Total Hardness, Calcium, Magnesium, Dissolved Oxygen, Biochemical oxygen demand, Chloride, Nitrate and Phosphate. The results obtained from the above study indicate that the water of Nikol lake shows very high level of pollution and ecological balance of lake is totally disturb.

Keywords: Monitoring, Nikol Lake, Pollution, Water quality, Organic waste and Sewage waste

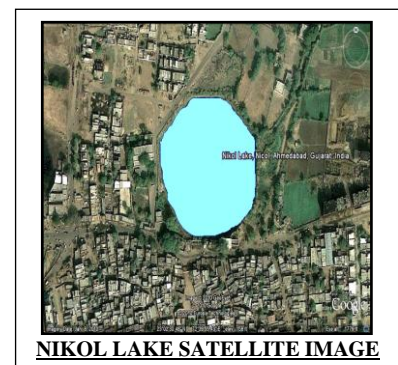
## **I. INTRODUCTION**

Water quality in an aquatic ecosystem is determined by physical, chemical and biological parameters [1]. Lake water is an essential renewable resource for mankind and the environment and it is important for civil, industrial and recreational purposes.



**NIKOL LAKE**

Sustainable use of water resources requires the coupling of surface water assessment and monitoring programs with decision making and management tools Giardino et al. [2]. The polluted water is undesirable for drinking, recreation, visual enjoyment or as a habitat for the aquatic life normal to it. Pollutants are generally associated with the direct input of (mainly human) waste products. Rapid urbanization and rapid population increase have produced sewage problems because treatment facilities have not kept pace with need. Untreated and partially treated sewage from municipal wastewater systems and septic tanks in unsewered areas contribute significant quantities of nutrients, suspended solids, dissolved solids, oil



**NIKOL LAKE SATELLITE IMAGE**

and biodegradable organic carbon to the water environment. Although essential to the aquatic habitat, nutrients such as nitrogen and phosphorus may also cause over fertilization and accelerate the natural aging process (eutrophication) of lakes. This acceleration in turn produces an overgrowth of aquatic vegetation, massive algal blooms, and an overall shift in the biologic community--from low productivity with many diverse species to high productivity with large numbers of a few species of a less desirable nature.

The study has been carried out for Nikol lake, located in Ahmedabad city of Gujarat state. Ahmedabad is the commercial capital of the Gujarat state and the 7<sup>th</sup> largest city of India. Nikol lake is

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located in the eastern part of Ahmedabad city. Initially in this lake sewage and waste water from the industries were discharged. The waste water from the surrounding slum area was also discharged directly into the lake. The lake covers an area of 20,907 m<sup>2</sup>. And its exact latitude and longitude are 23°02'30.95" N and 72°39'55.49" E.

## II. MATERIAL AND METHODS

The study was carried out for Nikol Lake, located in Ahmedabad city. In the study the sampling was done during morning hours. The water samples were collected in polyethylene bottles. The closed bottles were dipped into the lake at a depth of 0.5 to 0.7 m, and then the bottles were opened inside and were closed again to bring them out to the surface. The samples were collected from five different points and were mixed together to prepare an integrated sample. From the time of sample collection to the time of actual analyses, many physical and chemical reactions would change the quality of the water sample; therefore to minimize this change the samples were preserved soon after the collection. The water samples were preserved by adding chemical preservatives and by lowering the temperature. The water temperature, pH, DO, EC and TDS were analyzed immediately on the spot, very soon after the collection, whereas the analyses of remaining parameters were done in the laboratory.

The study was carried for a period of 1 year (March 2010 to February 2011). Monthly data were collected, but results were represented season wise. Four months make one season [March to June summer season, July to October monsoon season, and November to February winter season]. The collected water samples were brought to the laboratory and relevant analysis was performed. pH was determined electrometrically using a digital pH meter, electrical conductivity was measured by a conductivity meter, dissolved oxygen is measured by a DO meter, total dissolved solid was measured by using a TDS meter and similarly turbidity is measured by a nephelometric turbidity meter. Alkalinity, chloride, TDS, calcium, magnesium, total hardness, nitrate and phosphate were determined by methods suggested by [3], [4] and [5]. The statistical study was done by calculating mean value and standard error from the monthly data to represent them season wise. The formula used for calculating standard error is given below.

### STANDARD DEVIATION

$$\sigma = \sqrt{\frac{\sum (x_i - m)^2}{n - 1}}$$

### STANDARD ERROR

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$$

## III. RESULTS AND DISCUSSIONS

**Temperature:** The temperature plays a crucial role in physico-chemical and biological behavior of an aquatic system [6]. The temperature of Nikol Lake ranges between 18 ± 0.82 to 32 ± 0.91. The maximum temperature was recorded during the summer season and minimum was recorded during the winter season. The maximum temperature during summer might be due to greater solar radiation, low water level, clear atmosphere and higher atmospheric temperature. [7], also made similar observations in their study of the Dahikhura reservoirs. Generally water temperature corresponds with air temperature indicating that the samples collected from the shallow zone have a direct relevance with air temperature, shallow water reacts quickly with changes in atmospheric temperature [8] and [9].

**Electrical Conductivity:** Conductivity of water depends upon the concentration of ions and its nutrient status and variation in dissolved solid content. Seasonal variation in the conductivity is mostly due to increased concentration of salt because of evaporation. Electrical conductivity recorded in Nikol Lake ranges between 3.78 ± 0.08 to 4.63 ± 0.14. The high value of conductivity was recorded during the summer season whereas a low value was recorded during the monsoon season. The relatively high conductivity recorded during the study may be attributed to the predominance of non-leached substratum and the large size of the catchment area [10]. The increase in conductivity also may be due to the addition of wastewater from the surrounding slummy area Verma et al. [11]. Dilution of water during the monsoon causes a decrease in electrical conductance. The lowest value in the monsoon season was possibly due to rainfall in the catchment area. These present results are in conformity with the earlier works elsewhere [12] and [13]. [14] also observed such a type of result in some pond of Ayodhya.

**Turbidity:** According to [15], clay, silt, organic matter, phytoplankton and other microscopic organisms cause turbidity in lake water. According to [16], high turbidity shows the presence of a large amount of suspended solids.

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Turbidity is the measure of the light scattered by suspended particles. A reduction in turbidity is associated with a reduction in suspended matter and microbial growth. Turbidity in Nikol lake recorded ranges between  $18 \pm 1.35$  to  $25 \pm 0.71$ . The maximum turbidity in water was recorded during summer season and minimum turbidity was recorded during monsoon season. The high turbidity during summer season may be due to addition of large amount of sewage waste and pollutant from the surrounding slums area. The increase in turbidity might also be due to the growing of aquatic vegetation and also by lowering the volume of water. High level of turbidity may minimize the phytoplankton population [17]. The low value of turbidity during monsoon might be due to dilution resulting from monsoon showers and comparatively low terrigenous run off and high water. Radhika et al. [18], observed similar type of result.

**Total Dissolve Solid:** Dissolve solids are composed mainly of carbonates, bicarbonates, chloride, sulphate, nitrate, calcium, magnesium potassium iron and manganese in natural water. Due to contamination of domestic waste water, garbage, fertilizer, etc in the natural surface water body the value of TDS was reported to be high. Indeed, high concentration of TDS enriches the nutrient status of water body which was resulted into eutrophication of aquatic ecosystem. The amount of Total dissolve solid in Nikol lake ranges between  $1420 \pm 22.9$  to  $1870 \pm 40.8$ . The maximum amount of total dissolve solid was recorded during winter and minimum was recorded during monsoon. The increase in the amount of TDS is due to addition of sewage waste and detergent from the surrounding region. This addition of waste in lake release organic substance in the water which results into high value of TDS. The decrease in the amount of TDS during monsoon season was also recorded this might be due to dilution of water by the rain water. This result is supported by [19]. Similar result was also observed by [20] and [21].

**pH:** pH is the scale of intensity of acidity and alkalinity of water. It measures the concentration of hydrogen ions. Alkaline state of pH might be due to the chemical buffering and release of bicarbonate and carbonate ions or salts [22]. The pH values ranges between  $8.7 \pm 0.2$  to  $9.3 \pm 0.18$ . The maximum pH was recorded during summer season and minimum pH was recorded during monsoon season. [23], reported that the pH value above 8 in natural water are produced by photosynthetic rate that demand more  $\text{CO}_2$  than quantities furnished by respiration and decomposition. The pH of water also depends on the relative quantities of calcium, carbonate and bicarbonate. High pH in summer may be due to high decomposition activities. Similar result was observed by [24] and [25]. [26], explained that the factors like photosynthesis, respiratory activity, temperature exposure to air, disposal of industries wastes etc bring out changes in the pH. The low value of pH could be due to accumulated organic matters due to decay and decomposition of vegetation which on biological oxidation gives up  $\text{CO}_2$  which ultimately reduces the pH Solanki et al. [27].

**Alkalinity:** The change in alkalinity depends on carbonates and bicarbonates, which in term depend upon release of  $\text{CO}_2$ . Change in carbonates and bicarbonates also depend upon release of  $\text{CO}_2$  through respiration of living organisms. The amount of total alkalinity in Nikol lake ranges between  $228 \pm 7.87$  to  $264 \pm 15.2$ . The minimum value of alkalinity was recorded during winter and maximum value was recorded during monsoon season. The addition of large amount of sewage waste and organic pollutant in the lake also effect photosynthesis rate, which also result in death of plants and living organism. The degradation of plants, living organism and organic waste might also be one of the reasons for increase in a carbonate and bicarbonate, resulting an increase in alkalinity value Verma et al. [28]. Similar results were also observed by [14]. The main source of alkalinity in the water of lake is the addition of soap and detergent used by the local residential for bathing and washing purpose. Similar result was observed by [23]

**Total Hardness:** Hardness of water is mainly due to the presence of calcium and magnesium ions, and is an important indicator of the toxic effect of poisonous elements [29]. According to [4], the hardness of water is the measure of the capacity of water to react with soap. Total hardness recorded in the Nikol lake ranges between  $378 \pm 8.49$  to  $414 \pm 8.04$ . The maximum amount of total hardness was recorded during summer season and minimum amount was recorded during monsoon season. The high value of hardness during summer may be due to evaporation of water and addition of calcium and magnesium salts by mean of plants and living organism. [30], observed similar result in J.N.U lake. The above result was also supported by Udhayakumar et al. [31]. High values of hardness are probably due to regular addition of large quantities of sewage and detergent into lakes from the nearby residential localities. Similar observation was made by Kaur et al. [32] and [33].

**Calcium:** [34] observed that the calcium is an important nutrient for aquatic, organism. The amount of calcium in the water of Nikol lake ranges between  $72 \pm 3.7$  to  $88 \pm 1.83$ . The minimum amount of calcium was recorded during monsoon season and maximum amount was recorded during summer season. The amount of calcium increases during summer season due to rapid oxidation /decomposition of organic matter Verma et al. [35]. Calcium is present in water naturally, but the addition of sewage waste might also be responsible for the increase in amount of calcium. Udhayakumar et al. [31] and Angadi et al. [36] also observed similar result in their studies of water bodies. The decrease may be due to calcium being absorbed by living organisms in winter. The death and decay of living organism

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during summer and there decomposition in lake may also be responsible for the increase in calcium value. In maximum water bodies the amount of calcium recorded are always higher than magnesium.

**Magnesium:** Magnesium is found in various salt and minerals, frequently in association with iron compound. Magnesium is vital micronutrient for both plant and animal. In Nikol lake the amount of Magnesium recorded ranges between  $47 \pm 1.47$  to  $54 \pm 2.27$ . The minimum value was recorded during summer season and maximum value was recorded during winter season. Magnesium is often associated with calcium in all kind of water, but its concentration remain generally lower than the calcium [37]. Magnesium is essential for chlorophyll growth and act as a limiting factor for the growth of phytoplankton [38]. Decrease in level of magnesium reduces the phytoplankton population. [39], have suggested that the considerable amount of magnesium influence water quality. Magnesium is essential for chlorophyll bearing plant. **Dissolved Oxygen:** Dissolved oxygen is one of the important parameter in water quality assessment. It reflects the biological and physical process prevailing in the water. Its presence is essential to maintain the higher form of biological life in the water body, its presence is essential to maintain the higher form of biological in the water body is largely determined by oxygen balance of system. The amount of dissolved oxygen recorded in the Nikol lake ranges between  $2.14 \pm 0.15$  to  $5.28 \pm 0.34$ . The minimum amount of DO was recorded during summer season and maximum amount was recorded during monsoon season. According to Kataria et al. [40], depletion of dissolved oxygen in water is due to high temperature and increased microbial activity. A rapid increase in algae such as eutrophic conditions, can lead to depletion of dissolved oxygen. Similar observation was made by [41] and [42]. According to Singh et al. [43], lower dissolved oxygen in summer may be due to higher temperature and low solubility of oxygen in water consequently affecting the BOD. Seasonal fluctuation of dissolved oxygen with high value observed during monsoon may be as a result of the increased solubility of oxygen at lower temperature Prasannakumari et al. [44]

**Biochemical Oxygen Demand:** Variation in BOD indicates dynamism in aquatic life present in the lake. The increase in the amount of organic matter in the water leads to increase in BOD. The BOD value in the Nikol lake ranges between  $1.24 \pm 0.25$  to  $2.38 \pm 0.09$ . The minimum demand of oxygen was recorded during summer and maximum demand was recorded during monsoon season. The higher value of BOD during monsoon was due to input of organic wastes and enhanced bacterial activity. [45], made similar observation in certain freshwater ecosystem of Santal Pargana, (Jharkhand). The reason of high BOD in monsoon might also be due to presence of several microbes in water bodies, which accelerate their metabolic activities with the increase in concentration of organic matter in the form of municipal and domestic waste discharge into water bodies and so the demand of oxygen increased.

**Chloride:** The chloride concentration was used as an important parameter for detection of contamination by sewage, prior to development of bacteriological and other test like BOD and COD. Chloride ions are essential for plants and animals. They are stored in plants and animal bodies as sodium chloride (NaCl). The amount of chloride recorded in the water of Nikol lake ranges between  $113 \pm 2.38$  to  $135 \pm 4.22$ . The minimum value was recorded during monsoon season and maximum was recorded during summer season. The higher concentration of chloride during summer month may be associated with frequently run-off loaded with contaminated water from the surrounding. [46], also observed the same pattern. The high chloride concentration of the lake water may be due to high rate of evaporation Prasad et al. [47] or due to organic waste of animal origin [48].

**Nitrate:** Nitrates are contributed to freshwater through discharge of sewage and industrial wastes and run off from agricultural fields. Some ground waters naturally have high nitrate concentration. In Nikol lake the amount of nitrate recorded ranges between  $7.14 \pm 0.08$  to  $11.16 \pm 0.33$ . The minimum amount was recorded during monsoon season and maximum was recorded during summer season. The high nitrate concentration during summer might be due to influx of nitrogen rich compound from the surrounding region along with the sewage waste. The  $\text{NO}_3$  is usually derived from anthropogenic sources like agricultural field, domestic sewage and other waste effluents containing nitrogenous compounds [49].

**Phosphate:** Phosphate is considered to be the most significant among the nutrients responsible for eutrophication of lakes, as it is the primary initiating factor. Algae require only small amount of phosphate. Excess amount of phosphate may cause eutrophication leading to extensive algal growth called algal blooms. The amount of phosphate recorded ranges between  $1.18 \pm 0.02$  to  $2.14 \pm 0.08$ . The minimum amount was recorded during winter season and maximum amount was recorded during summer season. The water body receives the influx of sewage effluents and decomposed organic matter. It might also be due to addition of human waste and release of detergent into the aquatic environment. The main source of phosphate in the Nikol lake came from waste product of the daily activities of the local community including human excrement and detergents. Detergent polyphosphates produce orthophosphate by hydrolysis in natural water [50] and this are the only directly utilizable form of soluble inorganic phosphorus [51].



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**Result Table**

Sr. no.	PARAMETERS	YEAR 2010 - 2011		
		Summer Mean ± S.E.	Monsoon Mean ± S.E.	Winter Mean ± S.E.
1.	Temperature in °C	32 ± 0.91	24 ± 1.29	18 ± 0.82
2.	Electrical conductivity in mhos/cm	4.63 ± 0.14	3.78 ± 0.08	4.10 ± 0.15
3.	Turbidity in NTU	25 ± 0.71	18 ± 1.35	21 ± 0.41
4.	Total Dissolve Solid in ppm	1618 ± 13	1420 ± 22.9	1870 ± 40.8
5.	pH	9.3 ± 0.18	8.7 ± 0.2	9.0 ± 0.11
6.	Alkalinity in ppm	252 ± 6.06	264 ± 15.2	228 ± 7.87
7.	Total Hardness in ppm	414 ± 8.04	378 ± 8.49	408 ± 6.06
8.	Calcium in ppm	88 ± 1.83	72 ± 3.7	74 ± 1.83
9.	Magnesium in ppm	47 ± 1.47	48 ± 1.47	54 ± 2.27
10.	Dissolved Oxygen in ppm	2.14 ± 0.15	5.28 ± 0.34	4.26 ± 0.19
11.	Biochemical Oxygen Demand in ppm	1.24 ± 0.25	2.38 ± 0.09	1.96 ± 0.15
12.	Chloride in ppm	135 ± 4.22	113 ± 2.38	124 ± 3.16
13.	Nitrate in ppm	11.16 ± 0.33	7.14 ± 0.08	10.28 ± 0.07
14.	Phosphate in ppm	2.14 ± 0.08	1.46 ± 0.14	1.18 ± 0.02

## IV. CONCLUSIONS

Nikol lake is shallow and small natural lake, which has a sensitive ecosystem that responds to the changes and the activities of its surrounding. A detailed physicochemical study of lake water during all the three season revealed that the Nikol lake showed different seasonal fluctuation for various physicochemical parameters. The results of the water quality trends clearly showed that maximum number of parameters were above the desirable limit. Therefore water of Nikol lake shows very high level of pollution. The water quality status of Nikol lake is mainly affected by the land use pattern of its catchment area. A basin protection strategy comprising development of a monitoring system, assessment of pollution, pollution control and basin conservation should be implemented in order to minimize the impact of changes within the Nikol lake catchment. If proper attention is not paid to sustainable management of the water resource, supervision of logging and raising the awareness of the local people, the situation may deteriorate and the environment of the Nikol lake could be endangered.

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