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# Effect of Proximity to Polluted Lakes on Groundwater and Air Quality of Adjoining Areas

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***Abstract:*** **The present research work was carried out on the two most important lakes of Bengaluru city in India namely, Bellandur and Varthur lakes. The two lakes have been constantly in the headlines due to increasing pollution reports. This research was done to analyse the effect of these contaminated lakes on the groundwater and biological air quality of the surrounding areas. For this, we have compared the groundwater and air quality at a radius of 0 km and 2 km for both lakes. Our hypothesis was that the polluted lakes would affect the groundwater and air qualities to a greater extent near the lakes (0 km) compared to that at a greater distance from the lakes (2 km). To test this hypothesis, the biological water quality of groundwater and control samples was analysed by Biological Oxygen Demand, Most Probable Number and total bacterial count. The most significant observation was that the total bacterial count of the groundwater sample collected at the radius of 0 km from the Bellandur lake was found to be almost 9 times higher than the 2 km radius sample, which indicates potential contamination from the adjoining lake. Air quality analysis revealed more number of distinct bacterial colonies at 0 km compared to 2 km radius for both lakes, which suggests likely effect of the polluted lakes on air quality. Thus, our results indicate the very urgent requirement of remedial and restoration efforts to protect the two very important lakes of Bengaluru city and their adjoining areas.**

***Keywords:*** **Lakes, Bengaluru, Groundwater pollution, Air quality, Bellandur, Varthur.**

## I. INTRODUCTION

The pollution of air and water has a very adverse effect on the environment including the human health, which has become a threat in the recent years. The rapid industrialization, the extensive use of motorized vehicles and the population explosion have become the major factors in contributing towards the growing air pollution. The primary air pollutants dominating the air pollution are pathogen-laden aerosols and poisonous gases like carbon monoxide, nitrogen oxides, sulfur oxides, hydrocarbons, and particulate matter (both solid and liquid). The dispersion of these pollutants in high concentrations in the world's atmosphere has created an alarming situation that has a very strong impact on human health. There are chances of serious health problems that can occur when these air pollutants are concentrated and come in contact with the humans. [1], [2], [3]

Groundwater is considered to be an essential source of water for all the major activities like domestic, industrial and agricultural purposes all over the world. However, in the recent years it has been noted that there is an alarming increase in groundwater contamination. There are several reasons for the contamination but the major ones include industrial effluents, agricultural, medical and household wastes. The groundwater pollution shows an adverse effect on human health. Human activities are responsible for affecting the distribution, quantity, and chemical quality of water resources. [4] Not only groundwater but wetlands in general has been deteriorated in recent years due to heavy pollution and great

extent in the urbanization leading to a threatening cause for the ecosystems. The survey conducted before the urbanization shows that Bengaluru, the capital city of Karnataka state in India, had about 379 water bodies in 1973 there has been a further decline of about 81 major water bodies. During the recent studies, it reveals that about 40% of the water bodies in Bengaluru are sewage fed. [5]

Bellandur lake, one of the largest lakes in Bengaluru, has always been in the headlines because of the transformation of this beautiful lake into a sewage tank. The constant cause of concern is the formation of the foam in the lake and this is due to the improper sewage system and lack of effluent treatment plants unable to treat industrial wastes. [6], [7], [8], [9], [10], [11], [12], [13], [14] Similar has been the fate of Varthur lake, another large lake in the city of Bengaluru. [15], [16], [17] The major objective and interest of this study was to analyze the effect of proximity to these two lakes on air and groundwater quality of that region. Though a lot of work has been done on Bellandur and Varthur lakes and their pollution, not much is known and understood about how the presence of such highly contaminated water bodies in the proximity affects the groundwater and air quality. Understanding this would help in awareness and use of better water and air purification strategies for people residing and working in the nearby areas.

The source of groundwater collected from the residential area was borewell water. The water samples from different sources were collected from the residential area at the periphery of the lakes and at a distance of 2 km radius. Our hypothesis was that groundwater from houses located adjacent to the polluted lakes would be more contaminated compared to that from houses located further away. In order to determine the biological quality of the collected samples Biological Oxygen Demand, Most Probable Number, total bacterial count were conducted. [18], [19], [20] Similarly, to analyze the air quality bacterial and fungal plates were exposed at the periphery of the lake and at the distance of 2 km radius. Here our hypothesis was that the biological air quality adjacent to polluted lake would be inferior to that at a distance from the lake.

The results were obtained after conducting the various tests for the analysis of air and groundwater quality. Biological oxygen demand, most probable number and total bacterial counts were determined for all the groundwater samples, analyzed in triplicates. It was observed that the total bacterial count of the groundwater samples from the surroundings of Bellandur lake was significantly higher than that of the samples from a distance of 2 km radius from the Bellandur lake. The quality of the air surrounding the lakes and at a distance of 2 km radius was analyzed to detect the number of distinct bacterial and fungal colonies. The air quality was analyzed using air exposure method based on the principle of gravity settlement on to agar plates. The number of distinct bacterial colonies in the air surrounding both Bellandur and Varthur lakes were comparatively higher than that of the distance of 2km radius from the lakes. Thus, based on these significant results, the effect of proximity to Bellandur lake on groundwater quality was more evident compared to that of Varthur lake. The air quality results were similar for both lakes. Therefore, we have shown that proximity to these two polluted lakes can adversely affect the groundwater and air quality of those regions.

Thus, this study would help in the understanding of the effects of pollution of Bellandur and Varthur lakes on groundwater and air quality, which would be useful in determining and undertaking future remedial measures.

## II. MATERIALS AND METHODS

**Sample Collection:** Water samples were collected from the houses near Bellandur and Varthur lakes in sterile collection bottles. From the houses at the periphery of each lake six water samples were collected, of which three samples were collected from houses with borewell water supply and the other three from houses with Cauvery/ Municipal water supply for control (non-borewell sources). Similarly, at a radial distance of two kilometers from the lake, six samples were collected. Thus, there were total of twelve samples collected from each of the two lakes.

**Determination of Biological Oxygen Demand (BOD):** First day after the water sample was collected, the Dissolved Oxygen content was determined. These water samples were collected and filled in the sample bottles under water to prevent entry of air bubbles. These bottles were tightened by placing the stopper. The samples were labeled as K1, K2, K3, BI, B2, B3, etc. Alkaline iodide solution (NaOH-Karnataka fine chem and KI-Karnataka fine chem), Manganese chloride solution ($MnCl_2$-39137 K05-SDFCL), Stock solution i.e, 0.1M Sodium thiosulphate ($Na_2S_2O_3.5H_2O$- Karnataka fine chem.) Starch [$(C_4H_{10}O_6)_N$ Karnataka fine chem], Working solution (25ml of stock solution+ 175ml of distilled water) were prepared. Half of the bottles were preserved in the dark to be examined at day five. The rest half of these were used for the determination of the Dissolved Oxygen. 2ml of manganese chloride solution and 2ml of alkaline iodide

solution, which was prepared by adding sodium hydroxide along with potassium iodide in distilled water was added to the samples using pipettes whose tips were placed at the bottom of water sample. The stopper was replaced carefully and the reagents were mixed thoroughly in the water sample. A brown color precipitate was formed. Then 2ml of concentrated HCl was added and the bottle was again tightened with the stopper without allowing any entry of the water sample. The bottle was shaken thoroughly to dissolve the precipitate. 50 ml of sample was titrated with working solution of 0.025N Sodium thiosulphate that was prepared the stock solution by adding sodium thiosulphate and distilled water. The titration was done till appearance of pale yellow color was observed. Then 2ml of starch solution was added, which changed the color of the sample into blue. The titration was continued till the sample was clear and the readings were noted. Same procedure was followed for the samples which were kept in dark room for day 5. DO was calculated using the formula:

$$\text{D.O. (in mg/ litre)} = \frac{(8^* \times 1000 \times N) \times v}{V}$$

Where,

V = Volume of sample taken (ml)

v = volume of titrant used

N = Normality of the titrant

*= 8 is the constant since 1 ml of 0.025 sodium thiosulfate solution is equivalent to 0.2 mg oxygen

BOD was calculated using the formula $DO_{(day\ 1)}$- $DO_{(day5)}$.

**Determination of Most Probable Number (MPN):** Double strength and single strength lactose broth was prepared by following the standard composition (Lactose, Peptone-54075 K05 SDFCL, Beef extract-B-0143 Spectrum chemicals pvt ltd, pH7). And bromo cresol purple solution was taken (31005 SDFCL). Presumptive test was conducted by collecting water samples. 3 lactose double strength broth tubes were labeled as 10 and 3 single strength broth tubes were labeled as 1, another 3 tubes of single strength as 0.1 and 1 tube as control. Then double strength and single strength lactose broth along with bromocresol purple was added to respective tubes. Durham tubes were added to all the test tubes in inverted position. The tubes were sterilized by autoclaving. Each 10 tubes were inoculated aseptically with 10ml of water sample using 10ml sterile pipette. Using 1ml pipette the 3 tubes were inoculated with 0.1 ml of water sample. Using 0.1ml pipette the 3 tubes were inoculated with 0.1 ml of water sample. All 10 inoculated tubes were incubated at 37$^o$C for 48 hours. All the lactose fermentation tubes were examined for the production of acid and gas after 48 hours of incubation. Acid production was observed by the change of purple broth to yellow broth and gas production was seen in the Durham tube with the appearance of air bubbles. Results were noted. Confirmed test was conducted with Lauryl tryptose broth (Himedia M080) and other glass wares likes test tubes, Durham tubes were autoclaved along with broth. Confirmed test was done by taking all the positive tubes from presumptive test. 5ml of Lauryl tryptose broth was taken in test tube and durhams tubes were added which were further sterilized by autoclaving. Then 0.5ml of sample was added aseptically. Tubes were incubated for 48 hours at 37$^o$C. Results were noted by observing the production of gas in Durhams tubes. Completed test required EMB agar (Himedia M317 100G), sterilized petriplates, inoculation loop. Completed test was conducted by collecting the positives from confirmatory test and streaked on EMB agar plates aseptically. The plates were incubated for 48 hours at 37$^o$C. Plates were checked for the positive results which were observed by the appearance of green metallic sheen on the colonies.

**Total Bacterial count:** Total count was performed on Luria Bertani (Himedia M1245) agar plates. 10-fold serial dilutions of the collected water samples were carried out in Luria Bertani broth. 0.1 ml of sample was plated using the pour-plate method. This was repeated for each dilution. The samples were incubated at 37$^o$C for about 24 hours. Plates containing between 30 and 300 colonies were counted. Colony forming units were calculated and results were recorded.

**Air Exposure by Gravity Settlement:** Luria Bertani (Himedia M096 500G) and Potato dextrose agar (Himedia M1245) were prepared and sterilized by autoclaving. Plates were exposed to air for 5 minutes at the sites for collection of air samples. Plates were incubated for 24 hours at 37$^o$C for LB plates and 5 days at 28$^o$C for PDA plates. Plates were then observed for microbial growth. Gram staining was carried out for bacterial colonies. Colonies with distinct morphologies were noted. Results were recorded.

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## III. RESULTS AND DISCUSSION

***A. Groundwater and air samples were collected from the periphery and from a distance of 2km radius of Bellandur and Varthur lakes:***

Bellandur and Varthur lakes, two of the largest lakes in Bengaluru, India, have been in the news lately because of reported pollution from sewage effluents leading to foam formation and fire (Fig. 1) Our hypothesis is that these highly polluted lakes would affect the groundwater and air qualities of areas adjacent to these lakes. To analyze the groundwater and air samples from the periphery and from a distance of 2km radius from the Bellandur and Varthur lakes, borewell water samples were collected in sterile bottles from household water supply and air samples were collected by air exposure method from the residential area at the periphery (0 km radius) and distance of 2 km radius of the lakes (Fig. 2). During the collection of the samples a short survey was also carried out to get a detailed study of the water being consumed by the people around the lakes. Also, the municipal and Cauvery water samples were collected as control from periphery and distance of 2km radius from the lakes. These were considered as control because all these water sources were non-borewell sources and according to our hypothesis, the presence of adjacent polluted lakes should not have a direct effect on water quality. However, we cannot rule out other contamination sources for these control samples.

**Fig. 1: Polluted Bellandur lake (left) and Varthur lake (right) showing foam formation**

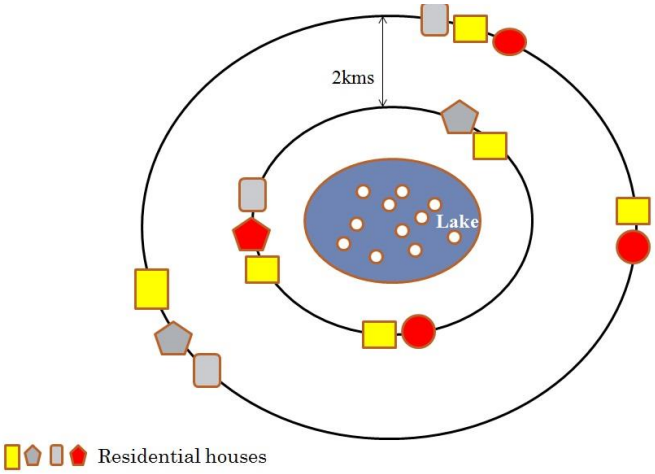


**Fig. 2: Schematic diagram showing groundwater and air sample collection strategy from the proximity of polluted lake and from a distance of 2km radius**

***B. The Biological Oxygen Demand (BOD) for groundwater surrounding Bellandur lake was slightly higher than that of the groundwater from a distance of 2km radius of Bellandur lake:***

The Biological Oxygen Demand of the groundwater samples from Bellandur and Varthur lakes were analyzed to check the amount of biochemically degradable organic matter present in the water sample. Biological Oxygen Demand of the groundwater samples from both the lakes were analyzed using standard method. The Biological Oxygen Demand values of the ground water sample from the periphery of the Bellandur lake [8 mg/l] is slightly higher than the distance of 2km radius from the Bellandur lake[6.93mg/l] (TABLE I, Fig. 3). The Biological Oxygen Demand values of the groundwater from the Varthur lake does not show a notable difference. The test measures the oxygen requirements of bacteria and other organisms. Even time and temperature, as well as plant life in the water could have an effect on the test. So, the difference could be due to the presence of more organic matter at a distance of 0 km due to the proximity to the lake-

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either from any channel connecting the polluted lake water to the groundwater table or from seepage. The absence of any notable difference in the Varthur lake does not necessarily indicate that pollution is absent. One possibility could be that the water is highly contaminated by chemical effluents leading to an antimicrobial or antibiological activity, which could have affected our results. To test this hypothesis, chemical studies of these water sources should be conducted in parallel to biological studies.

**TABLE I: Dissolved oxygen (DO) and Biological Oxygen Demand (BOD) values of the triplicate borewell (groundwater) and control samples collected from the periphery (0 km radius) and from a distance of 2km radius of both Bellandur & Varthur lakes. The average value for the control samples is 7.425 mg/L.**

| | SOURCES | BELLANDUR LAKE | | | | VARTHUR LAKE | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | DO DAY 1 (mg/l) | DO DAY 5 (mg/l) | BOD (mg/l) | AVERAGE | DO DAY 1 (mg/l) | DO DAY 5 (mg/l) | BOD (mg/l) | AVERAGE |
| **0 KM RADIUS** | Borewell-1 | 30.4 | 8 | 22.4 | 8 | 44.8 | 40 | 4.8 | 3.7 |
| | Borewell-2 | 52.8 | 51.2 | 1.6 | | 28.8 | 25.6 | 3.2 | |
| | Borewell-3 | 56 | 56 | 0 | | 57.6 | 54.4 | 3.2 | |
| **2 KM RADIUS** | Borewell-1 | 60.8 | 51.2 | 9.6 | 6.93 | 49.6 | 46.4 | 3.2 | 4.26 |
| | Borewell-2 | 56 | 48 | 8 | | 43.2 | 38.4 | 4.8 | |
| | Borewell-3 | 59.2 | 52.8 | 6.4 | | 52.8 | 48 | 4.8 | |
| **CONTROL** | Control-1 | 59.2 | 48 | 11.2 | | 54.4 | 48 | 6.4 | |
| | Control-2 | 57.6 | 52.8 | 4.8 | | 52.8 | 49.6 | 3.2 | |
| | Control-3 | 60.8 | 51.2 | 9.6 | | 51.2 | 49.6 | 1.6 | |
| | Control-4 | 68.8 | 64 | 4.8 | | 51.2 | 46.4 | 4.3 | |
| | Control-5 | 64 | 51.2 | 12.8 | | 49.6 | 46.4 | 3.2 | |
| | Control-6 | 65.6 | 40 | 25.6 | | 52.8 | 51.2 | 1.6 | |

***C. The Most Probable Number (MPN) of the groundwater surrounding the lake and at a distance of 2km from the lake was similar for both Bellandur and Varthur lakes:***

The Most Probable Number of the groundwater samples from Bellandur and Varthur lake was analyzed to detect the amount of faecal coliforms contamination in the water samples. The MPN analysis of the groundwater samples of both Bellandur and Varthur lake was done using standard 3-tube method. It was found that MPN values of the groundwater samples do not have much difference from the periphery and distance of 2km on both Bellandur and Varthur lakes (data not shown). The distribution of the coliforms can almost be equal and there can be a probability of presence of other pathogenic organisms which do not show much difference as Most Probable Number is used only for the detection of coliforms. Thus, all sources analyzed could be considered potable based on these results.

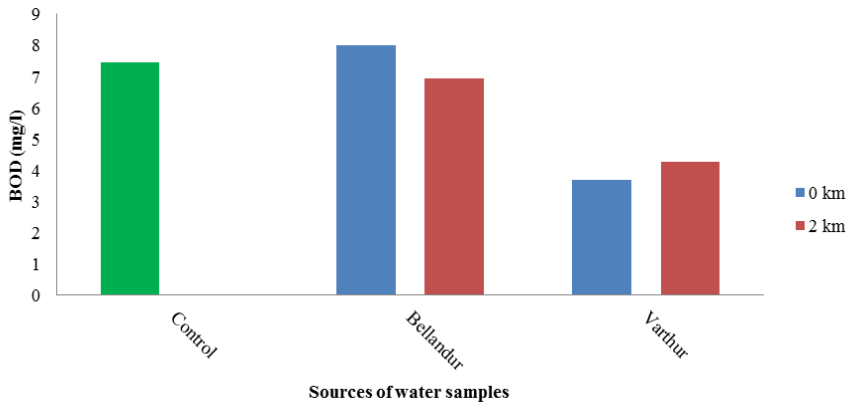


**Fig. 3: Graph showing the comparison of average BOD values of the groundwater and control samples collected from the periphery and from a distance of 2km radius of both Bellandur and Varthur lakes**

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***D. The total bacterial count of the groundwater samples in the surroundings of the Bellandur lake was found to be almost 9 times higher than that in the water sources at 2km radius:***

The total bacterial count of the groundwater was analyzed to detect the total bacterial population in the water samples of both Bellandur and Varthur area water samples. Total bacterial count was analyzed using the pour plate method. It was found that the total bacterial count of the groundwater samples from the surroundings of Bellandur lake was almost 9 times higher than that of the samples from a distance of 2 km radius from the Bellandur lake (TABLE II, Fig. 4). There was not much notable difference in the total bacterial count of the Varthur lake samples from surroundings and 2km radius. Chemical pollution in Varthur lake could have affected the biological results in our studies. There was a large variation between 0 km and 2 km samples around Bellandur lake because the entire microbial population both aerobic as well as microaerophiles has been taken into account. It was found that there was a high difference in the number of colonies from the periphery of the Bellandur lake than the distance of 2km from the lake and it can be due to the evident contamination of the lake. The BOD of the corresponding samples did not show such a drastic difference which could be because BOD is a representation of only the aerobic organisms whereas pour plate takes into account aerobic, facultative anaerobes and microaerophilic organisms. From our triplicate results, it seems that there was contamination from the adjoining polluted Bellandur lake either due to the presence of any channel connecting the polluted lake water to the groundwater table or from seepage.

**TABLE II: Total bacterial count values of triplicate borewell (groundwater) and control samples collected from the periphery and from a distance of 2km radius of both Bellandur and Varthur lakes. The average value for the control samples is 32.5.**

| | SOURCES | BELLANDUR LAKE | | VARTHUR LAKE | |
|---|---|---|---|---|---|
| | | CFU/mL | Average | CFU/mL | Average |
| **0 KM RADIUS** | Borewell-1 | $2.07\times10^2$ | $6.52\times10^2$ | 0.3×10 | 7 |
| | Borewell-2 | $1.125\times10^3$ | | 1.6×10 | |
| | Borewell-3 | $6.24\times10^2$ | | 0.2×10 | |
| **2 KM RADIUS** | Borewell-1 | $0.2\times10^3$ | 73.6 | 1×10 | 52 |
| | Borewell-2 | 0.4×10 | | 5×10 | |
| | Borewell-3 | 1.7×10 | | 9.6×10 | |
| **CONTROL** | Control-1 | 1.8×10 | | 0.2×10 | |
| | Control-2 | 2.6×10 | | 1.7×10 | |
| | Control-3 | 0.8×10 | | 2.1×10 | |
| | Control-4 | $1.2\times10^2$ | | 5×10 | |
| | Control-5 | 1.2×10 | | 6.5×10 | |
| | Control-6 | 2.2×10 | | 3×10 | |

***E. The number of the distinct bacterial colonies in air from the surroundings is comparatively more than that from the distance of 2km radius for both Bellandur and Varthur Lakes.***

Both Bellandur and Varthur lakes are majorly populated due to inflow of untreated sewage. This has resulted in froth formation in recent times and this froth have been reported to be floating in surrounding areas. These aerosols could be a potential source of air quality deterioration due to presence of pathogenic organisms. The quality of the air surrounding the lakes and at a distance of 2 km radius was analyzed to detect the number of distinct bacterial and fungal colonies. The air quality was analyzed using air exposure method based on the principle of gravity settlement on to agar plates. The number of distinct bacterial colonies in the air surrounding both Bellandur and Varthur lakes were comparatively higher than that of the distance of 2km radius from the lakes (TABLE III, Fig. 5). The number of the fungal colonies were almost similar in the periphery and a distance of 2km radius of both Bellandur and Varthur lakes (TABLE IV, Fig. 6). The bacterial colony difference can be due to the effect of the contamination whereas the fungal spores can be found dispersed in the air, thus making the difference unapparent.

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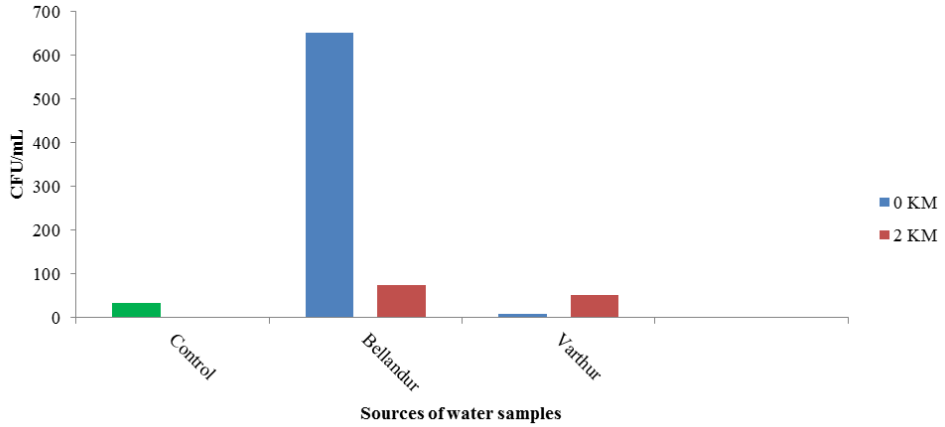


**Fig. 4: Graph showing average total bacterial count values (CFU/mL) of the borewell (groundwater) and control samples collected from the periphery and from a distance of 2km radius both Bellandur and Varthur lakes**

**TABLE III: Colony morphology & Gram reactions of distinct bacterial colonies from the periphery and distance of 2km in the air exposure plates from Bellandur and Varthur lakes**

| | | SL.NO. | COLONY MORPHOLOGY | GRAM REACTION | NO. OF DISTINCT COLONIES |
|---|---|---|---|---|---|
| BELLANDUR LAKE | 0 km | 1 | White, circular, entire, flat | Gram +ve rods | 6 |
| | | 2 | Yellow, circular, entire, flat | Gram +ve cocci | |
| | | 3 | Orange, circular, entire, raised | Gram +ve cocci | |
| | | 4 | Creamish, irregular, entire, raised | Gram +ve cocci | |
| | | 5 | White, irregular, entire, flat | Gram +ve rods | |
| | | 6 | Yellow, irregular, entire, flat | Gram +ve rods | |
| | 2 km | 1 | White, entire, irregular, flat | Gram +ve rods | 4 |
| | | 2 | White, entire, wrinkled, flat | Gram +ve rods | |
| | | 3 | White, entire, tiny, wrinkled | Gram +ve rods | |
| | | 4 | White, entire, circular, flat | Gram +ve cocci | |
| | | SL.NO. | COLONY MORPHOLOGY | GRAM REACTION | NO. OF DISTINCT COLONIES |
| VARTHUR LAKE | 0 km | 1 | White, entire, irregular, smooth, flat | Gram +ve rods | 5 |
| | | 2 | White, lobate, irregular, flat | Gram +ve rods | |
| | | 3 | Yellow, entire, circular, raised | Gram +ve rods | |
| | | 4 | White, entire, irregular, wrinkled | Gram +ve rods | |
| | | 5 | Cream, entire, irregular, flat | Gram +ve rods | |
| | 2 km | 1 | White, entire, wrinkled, irregular | Gram +ve cocci | 3 |
| | | 2 | White, circular, flat | Gram +ve cocci | |
| | | 3 | Yellow, circular, raised | Gram +ve rods | |

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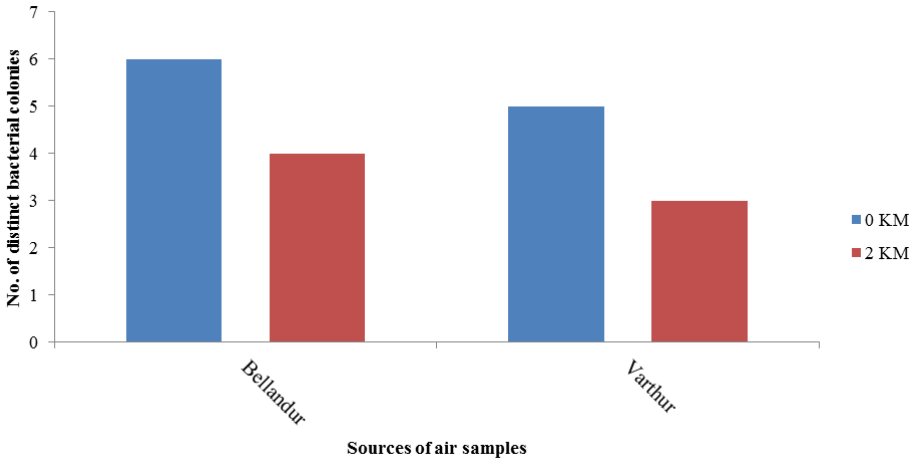


**Fig. 5: Graph showing a comparison of number of distinct bacterial colonies of Bellandur and Varthur lakes between those obtained from the periphery and from a distance of 2km radius on air exposure plates**

**TABLE IV: Colony morphology of distinct fungal colonies from the periphery and distance of 2km in the air exposure plates from Bellandur and Varthur lakes**

| | | SL.NO. | COLONY MORPHOLOGY | NO. OF DISTINCT COLONIES |
|---|---|---|---|---|
| BELLANDUR LAKE | 0 km | 1 | Black & white, Powdery, irregular, raised, filiform | 4 |
| | | 2 | Creamish, circular, flat, wrinkled, irregular | |
| | | 3 | Greenish, filamentous, raised, filiform | |
| | | 4 | White, irregular, flat, entire | |
| | 2 km | 1 | Greenish, powdery, circular, raised, filiform | 3 |
| | | 2 | White, irregular, flat, tiny, wrinkled | |
| | | 3 | Cremish, circular, raised, entire, shiny | |
| | | SL.NO. | COLONY MORPHOLOGY | NO. OF DISTINCT COLONIES |
| VARTHUR LAKE | 0 km | 1 | White, irregular, flat, wrinkled, entire | 5 |
| | | 2 | Orange, circular, shiny, raised, entire | |
| | | 3 | White, circular, flat, entire | |
| | | 4 | Black, circular, powdery, raised, undulate | |
| | | 5 | Creamish, circular, raised, shiny, entire | |
| | 2 km | 1 | Creamish green, powdery, irregular, raised, filiform | 5 |
| | | 2 | Greenish, circular, raised, undulate | |
| | | 3 | White, circular, flat, entire | |
| | | 4 | Whitish cream, irregular, powdery, raised, filiform | |
| | | 5 | Yellow, circular, raised, entire, shiny | |

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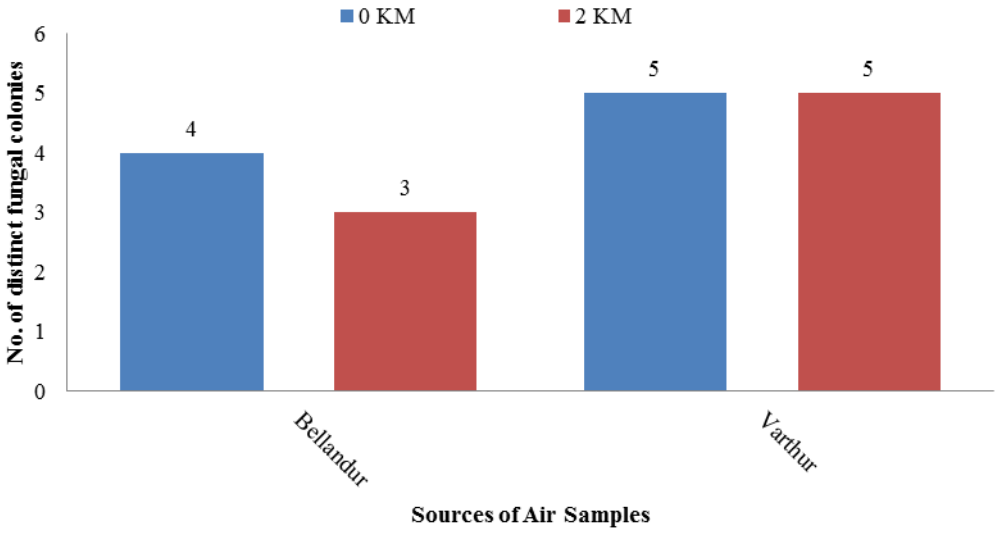


**Fig. 6: Graph showing a comparison of number of distinct fungal colonies of Bellandur and Varthur lakes between those obtained from the periphery and from a distance of 2km radius on air exposure plates**

## IV. CONCLUSION

This research was done to analyze the effect of these contaminated lakes on the groundwater and air biological quality of the surrounding areas. For this, we have compared the groundwater and air quality at a radius of 0 km and 2 km for both lakes. Our hypothesis was that the polluted lakes would affect the groundwater and air qualities to a greater extent near the lakes (0 km) compared to that at a greater distance from the lakes (2 km). To test this hypothesis, the water samples were collected from the radius of 0 km and 2 km from borewell water supplies. Non-borewell water supply sources (Cauvery/municipal water sources) were considered as control. During the collection of the samples a short survey was also carried out to get a detail study of the water being consumed by the people. A total of twelve samples from each of the two lakes were collected. To check biological water quality, Biological Oxygen Demand, Most Probable Number and total bacterial count were estimated. The most significant observation was that the total bacterial count of the groundwater sample collected at the radius of 0 km from the Bellandur lake was found to be almost 9 times higher than the 2 km radius sample, which indicates potential contamination from the adjoining lake. Air quality analysis revealed more number of distinct bacterial colonies at 0 km compared to 2 km radius for both lakes, which suggests likely effect of the polluted lakes on air quality. Thus, our results indicate the very urgent requirement of remedial measures to protect the lakes and adjoining areas from further contamination and the need for efforts to be taken for the restoration of the two very important lakes of Bengaluru city.

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## REFERENCES

[1] Kampa Marilena and Elias Castanas, “Human health effects of air pollution”, Environmental Pollution, vol.151, no.2, pp.362-367, 2008.

[2] Honda Trenton, Vivian C Pun, Justin Manjourides, Helen Suh, “Anemia prevalence and hemoglobin levels are associated with long-term exposure to air pollution in an older population”, Environment International, vol.101, pp.125–132, 2017.

[3] Costa Lucio G, Toby B Cole, Jacki Coburn, Yu-Chi Chang, Khoi Dao, “Neurotoxicity of traffic-related air pollution”, NeuroToxicology, vol.59, pp.133-139, 2015.

[4] Pawari M J, Sagar Gawande, "Ground Water Pollution & Its Consequences", International Journal of Engineering Research and General Science, vol.3, no.4, 2015.

[5] Kiran R. and Ramachandra T.V. "Status of Wetlands in Bangalore and its Conservation aspects", ENVIS Journal of Human Settlements, pp. 16-24, 1999.

[6] Akshatha M, "Environment • Lakes • FAQs and Guides Story Of Bellandur Lake", 2015.

[7] Ramesh N, Krishnaiah S, "Assessment of Physico-Chemical Parameters of Bellandur Lake, Bangalore, India", International Journal of Innovative Research in Science, Engineering and Technology, vol.3, no.3, 2014.

[8] Lokeshwari. H, and G. T. Chandrappa, "Impact of heavy metal contamination of Bellandur Lake on soil and cultivated vegetation", Current Science, vol.91, no.5, 2006.

[9] Pattusamy V, N. Nandini, M.Vijay Kumar and K.Bheemappa, "Water Quality Studies of Bellandur Lake, Urban Bangalore, Karnataka, India", International Journal of Advanced Research, vol.1, no.4, pp.77-82, 2013.

[10] Ramesh N, Krishnaiah. S, "Scenario of Water Bodies (Lakes) In Urban Areas- A case study on Bellandur Lake of Bangalore Metropolitan city", IOSR Journal of Mechanical and Civil Engineering, vol.7, no.3, pp.06-14, 2013.

[11] Roselene. Helen and Paneerselvam, "Physico Chemical Analysis And Role Of Phytoplanktons In Bellandur Lake", Journal Proceedings of the 12th World Lake Conference Edited by Sengupta M and Dalwani R, pp.1729- 1726, 2008.

[12] Chandrashekar J S, K.Lenin Babu and R. K Somashekar, "Impact Of Urbanization On Bellandur Lake, Bangalore- A Case Study", Journal Of Environmental Biology, vol.24, no.3, pp.223-227, 2003.

[13] Begum Abida, S.Hari Krishna, Irfanulla Khan, H. Ramaiah, K. Veena and K. Vinuta, "Analysis Of Flouride Level In Water And Fish Samples Of Sankey, Bellandur And Madivala Lakes Of Bangalore, Karnataka", vol.1, no.3, pp.596-601, 2008.

[14] Samal Nihar R, Papita Saha, Pankaj K. Roy, Malabika Biswasroy, R Venkat Ramana and Asis Mazumdar, "Limnology Analysis Of An Urban Polluted Lake In Bangalore City In India, Desalination And Waste Treatment", vol.30, no.1-3, pp.217-228, 2011.

[15] Ramachandra T V, "Spatial Analysis and Characterisation of Lentic Ecosystems: A Case Study of Varthur Lake", Bangalore International Journal of Ecology & Development, vol.9, pp.39-56, 2008.

[16] Mahapatra, Durga Madhab and Chanakya, HN and Ramachandra, TV, "Assessment of treatment capabilities of Varthur Lake, Bangalore, India", International Journal of Environmental Technology and Management, 14 (4). pp. 84-102, 2011.

[17] Ramachandra T V, Ahalya N and Mandy Payne, "Status of Varthur Lake: Opportunities For Restoration And Sustainable Management", 2003.

[18] Sharma Priyanka, Sujata Gupta, "Study of amount of Oxygen (BOD, OD, COD) in water and their effect on fishes", American International Journal of Research in Formal, Applied & Natural Sciences, 2013.

[19] Chandra R, Nishadh KA, Azeez PA, "Monitoring water quality of Coimbatore wetlands, Tamil Nadu, India", Environ Monit Assess., vol.169, no.1-4, pp.671-6, 2010.

[20] Nandini N, Aboud Jumbe, B S Anupama, Santhaveerana Goud, "Intestinal Pathogens and Microbial Pollution of Urban Lakes-A Case Study on Yellamallappa Chetty Lake, Bangalore, India", Proceedings of Taal2007: The 12th World Lake Conference, pp. 1742-1752, 2008.