# Water quality monitoring of three Lentic water bodies of Ujjain District (M.P.) India

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## Abstract

The present study aimed to calculate water quality index (WQI) in order to assess the suitability of water for domestic use and drinking purposes. Water quality index (WQI) is valuable and unique rating to depict the overall water quality status in a single term that is helpful for the selection of appropriate treatment technique to meet the concerned issues. Water quality analysis were carried out on surface samples collected from three sampling sites Sahebkhedi lake, Undasa wetland and Purushottam sagar of Ujjain Dist. for the month of May 2017 to June 2018. The analysis of different parameters namely – pH, Hardness, Calcium, Chlorides, Alkalinity, D.O., BOD were carried out as per standard methods, prescribed as in the APHA (2005). The present study concludes that these water bodies are not fit for drinking purpose and domestic use because it accounts for high anthropogenic activities, worship rituals and several thousands of pilgrims take hoy bath.

Key Words: *BOD, DO, Eutrophic, Lentic waterbodies, Water Pollution, Water Quality Index.*

## Introduction

Water is a precious life supporting natural resource for which we have countless uses that are all important to our lives. Water pollution is a phenomenon that is characterized by the deterioration of its quality as a result of various human activities. In India only 12% of people get good drinking water (Kudesia, 1980). Inadequate management of water resources as directly or indirectly resulted in the degradation of hydrological environment (Karanth, 1989). Every living beings needs water. Man must always have an adequate supply of potable water for his various daily needs. Specifically, man needs water for drinking, cooking, bathing, washing, agricultural purpose, manufacturing and industrial purposes. Water quality assessment is required for the management of waterbodies. Controlling water pollution is urgent for ecological sustainability of water resources as well as for underlying economic reasons and human health (Bhutiani *et al.,* 2018). The WQI is used to assess the quality of major water supply sources representing the level of pollution (Sari and wan, 2008). The use of WQI

in the first instance was used by Horton (1965) and Brown *et al.* (1970). Since then, diverse methods for the calculation of WQI have been evolved till date. The water quality criteria, on the basis of WQI, have been prescribed as excellent, good, medium, bad and unsuitable for drinking or very bad (Chaturvedi and Bassin, 2010). The present investigations was carried out to calculate the Water Quality Index (WQI) in order to assess the suitability of water collected from different three sampling sites in Ujjain (M.P.).

## Materials and Methods

### Study Area

**Site I** (Sahebkhedi Lake)**:** It is situated near RD Gardi medical college on Agar road Ujjain (M.P.). This study site is situated at a distance of about 7 km from the Ujjain, its live capacity is 10.32 mq and it has a dead storage is 2.15 mq., its length and water speed area are 3 km and 383 hectare respectively. In this lake used for fish culture, Irrigation and Public water supply.

**Site II** (Undasa wetland): Undasa wetland is located just outside the municipal limits of Ujjain city in M.P. This is situated at 75°50' and 23°13' on Ujjain- Maksi road along the Pingleshwar nala. The catchment area of this wetland extends up to

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11.25 sq miles with an average storage capacity of 186.668 mcft. Its live capacity is 5.32 mq., and its dead storage capacity is 0.09 mq. It has a water speed area 183.30 hectare and its length is 2.6 km. It is used for drinking water supplies, irrigation and bathing. This is considered as a holy waterbody and several thousands of pilgrims take holy bath.

**Site III** (Purushottam sagar) :  It is situated near Ankpat Marg, near Idgah of Ujjain City (M.P.) It is one of the important Pilgrims point of Ujjain also known as Solah sagar. Purushottam sagar is Perennial aquatic body, The average length and width are approximately 400 and 230 meters respectively. It is used for fish culture & Trapa cultivation.

The present study has been conducted for a period of one year from July 2017 to June 2018. The Physico-chemical study includes a regular record of air temp., water temp., colour, odour, taste, turbidity, depth range, transparency, pH, dissolved oxygen, BOD, COD, $CO_3$, $HCO_3$, total hardness, magnesium, calcium and chloride, The methods being used for the analysis of various physico-chemical parameters are as given in standard method for the examination of water and waste water (APHA, 2005).

**Water Quality Index:**
WQI is a statistical way of calculating the pollution status of any water body. It was calculated by using formulae of (Brown *et al*., 1972).

$$WQI_A = \Sigma^n_{i=1} \, wiqi / \Sigma^n_{i=1} \, wi$$

Table 1 Water Quality Index (WQI) and status of water quality (Brown *et al*., 1972, Chatterji and Raziuddin, 2002).

| Water Quality Index Level | Water Quality Status |
|---|---|
| 0-25 | Excellent water quality |
| 26-50 | Good water quality |
| 51-75 | Poor water quality |
| 76-100 | Very Poor water quality |
| Above 100 | Unsuitable for drinking |

## Results and Discussion
Growth, production, survival and reproduction of The results of the physicochemical analysis of the water samples collected and analysed for Sahebkhedi lake, Undasa wetland and Purushottam

sagar are shown in tables 1,2,3 while the statistics and calculated water quality index (WQI) shown in (Fig -1). The WQI has been used to integrate various water quality parameters and their aspect into a single frame showing a clear image of water quality of three water bodies Sahebkhedi lake, Undasa wetland and Purushottam sagar. The variation in WQI from July 2017 to June 2018 has been noticed (Fig. 1).

It is observed that higher values of WQI during summer season because of high pollution load and highly stressed condition followed by rainy and winter season. Yogendra and Puttaiah (2008), also observed that the pollution load is relatively high during summer season when compared to the winter and rainy season from urban waterbody in Shimoga Town, Karnataka. Minimum value of WQI is noticed in the month of December at Sahebkhedi lake study site and maximum were reported at Purushottam sagar in the month of June. This water quality rating study clearly shows that the status of the water is unsuitable for drinking purpose. Water quality index is reported in the order as Purushottam sagar > Undasa wetland > Sahebkhedi lake (Fig. 1). However, very high values of WQI are recorded from Purushottam sagar throughout the entire study period which indicates water bodies to be in highly polluted. This waterbody is unfit for drinking purpose and domestic use without proper treatment. The rapid increase of the day to day activities are considered as domestic wastes, the animal, fruits or vegetables residues (also called garbage). Worship materials like flowers, coconut etc and common waste products include nitrogenous compounds like Urea and ammomia and during rainy season gutter or dirt from the nearest colonies have been created pollution in the Pond and during festivals Jhankis and Dolgyaras immersion are also created pollution in this pond. Bhasin *et al*. (2016), also observed in similar variable physico-chemical values in Kshipra river. Undasa wetland is also polluted, and this water body is not suitable for drinking purpose because it accounts for high anthropogenic activities, soil erosion, land degradation, worship materials like flowers, coconut ets. from the temple and several thousands of pilgrims take holy bath. Jatwa *et al*. (2018), from Undasa wetland observed that Undasa wetland receives a considerable
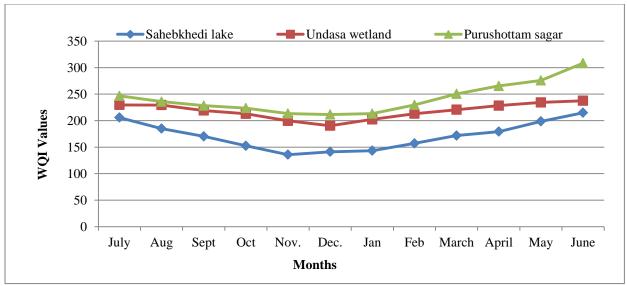
**Fig 1. Water quality monitoring of three waterbodies of Ujjain District (M.P.)**

amount of domestic water waste and sewage from nearby urban and rural areas. Sahebkhedi lake is moderate polluted, but this waterbody is unfit for drinking purpose without proper treatment. Yogendra and Puttaiah (2008), recorded Water Quality Index in different seasons indicate that poor quality of water in Urban waterbody in Shimoga Town, Karnataka.

Among all the physicochemical parameters selected for the water quality index calculations, pH is an important parameter which determines the suitability of water for various purposes. In the present study the values of pH fluctuated between 7.7- 8.4 at Sahebkhedi lake. The minimum value of pH 7.7 has been recorded during the winter 2017 however maximum value of pH has been observed during monsoon 2017 (Table-1). At Undasa wetland in pH values fluctuated between 7.9-8.6. The minimum value of pH 7.9 has been recorded during the winter 2017 and maximum value of pH has been recorded during monsoon 2017 (Table-2). Similarly at Purushottam sagar in pH values fluctuated between 8.1-8.5. The minimum value of pH 8.1 has been recorded during the winter season 2018 and maximum value of pH has been recorded during monsoon season 2017 (Table-3). Similar pattern was observed by Bhtuiani *et al.* (2018). In India many small confined water pockets are particularly alkaline in nature (Sharma *et al.,* 1984). Total hardness is an important limnological parameter indicating level of water quality

and organic production in the lake (Wetzel, 1983). The hardness values ranged between 132-164 mg/lt at Sahebkhedi lake (Table-1) followed by at Undasa wetland and Purushottam sagar hardness values range from 148-200 mg/lt and 172-216 mg/lt respectively (Table-2) (Table-3). More or less similar trend was observed by Khanna *et al.* (2014) and Bhutiani *et al.* (2018).

Calcium values ranged between 48.09 to 61.72 at Sahebkhedi lake (Table-1) followed by at Undasa wetland calcium ranged from 52.90 to 68.13 (Table-2) and similarly at Purushottam sagar calcium ranged from 60.12 - 72.94 mg/lt respectively (Table -3). Chloride occurs in all types of natural waters. The high concentration of chloride is considered to be an indication of pollution due to high organic waste of animal origin. At Sahebkhedi lake Chloride values range from 41.99 to 61.99 mg/lt (Table-1). At Undasa wetland and Purushottam sagar Chloride values range from 39.99 - 83.99 and 51.99 - 78.99 mg/lt respectively (Table-2) (Table-3). Alkalinity value less than 100 mg/l is desirable for domestic use. However, in large quantities it imparts bitter taste to water. In the present study at Sahebkhedi lake the total alkalinity of the water samples is found in the range 154- 212 mg/lt (Table-1). At Undasa wetland and Purushottam sagar total alkalinity range from 170-242 and 198-268 mg/lt respectively (Table-2 and 3). More or less similar trend was observed by Bhutiani *et al.* (2018).

**Table 1 : Monthly fluctuation of Physico – chemical parameters at Sahebkhedi Lake from July 2017- June 2018**

| S N | Parameter | July | Aug. | Sept | Oct. | Nov. | Dec. | Jan. | Feb | Mar | Apr. | May | June |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time | 6:40 AM | 7:20 AM | 7:25 AM | 8:15 AM | 6:56 AM | 8:20 AM | 6:45 AM | 7:30 AM | 7:30 AM | 7:15 AM | 7:10 AM | 6:43 AM |
| 1. | Env. Condition | Sunny day | Cloudy weather | Cloudy weather | Cloudy weather | Cold weather | Cold weather | Cold weather | Cold weather | Clear weather | Sunny weather | Sunny day | Cloudy weather |
| 2. | Depth (m) | | | 3.41 | 3.41 | 3.34 | | 1.79 | | 0.43 | 0.6 | 0.73 | |
| 3. | Air temp. °C | 21 | 21 | 17 | 22 | 19 | 14 | 10 | 13 | 15 | 26 | 27 | 25 |
| 4. | Water temp. °C | 22 | 20 | 21 | 20 | 17 | 19 | 17 | 20 | 23 | 25 | 28 | 28 |
| 5. | Water Colour | Muddy | Muddy | Muddy | Muddy | C.L. | C.L. | C.L. | C.L. | C.L. | C.L. | Greenish | Greenish |
| 6. | Odour | O..L | O.L. | O.L. | O.L. | O.L. | O.L. | O.L. | O.L. | O.L. | O.L. | O.L. | O.L. |
| 7. | Taste | T.L. | T.L. | T.L. | T.L. | T.L. | T.L. | T.L. | T.L. | T.L. | T.L. | T.L. | T.L. |
| 8. | Turbidity (NTU) | 55 | 59 | 50 | 38 | 28 | 25 | 29 | 34 | 38 | 42 | 45 | 48 |
| 9. | Transparency (cm) | 50 | 38 | 60 | 98 | 124 | 129 | 109 | 76.2 | 74 | 68 | 60 | 56 |
| 10. | pH | 8.1 | 8.4 | 8.2 | 8.0 | 7.9 | 7.7 | 7.7 | 7.50 | 7.8 | 7.9 | 8 | 8 |
| 11. | Dissolved Oxygen (mg/l) | 4.8 | 5.6 | 5.6 | 6 | 7.2 | 7.2 | 6.4 | 5.6 | 5.6 | 5.2 | 4.8 | 4.8 |
| 12. | Carbonate (mg/l) | 14 | 14 | 12 | 12 | 10 | 10 | 8 | 10 | 12 | 12 | 12 | 16 |
| 13. | Bicarbonate (mg/l) | 178 | 180 | 174 | 164 | 144 | 148 | 150 | 172 | 176 | 180 | 192 | 196 |
| 14. | Total alkalinity (mg/l) | 192 | 194 | 186 | 176 | 154 | 158 | 158 | 182 | 188 | 192 | 204 | 212 |
| 15. | Total hardness (mg/l) | 160 | 152 | 148 | 140 | 136 | 136 | 132 | 140 | 144 | 148 | 156 | 164 |
| 16. | Calcium (mg/l) | 59.31 | 59.31 | 57.71 | 54.50 | 51.30 | 48.09 | 49.69 | 52.90 | 54.50 | 57.71 | 60.12 | 61.72 |
| 17. | Magnesium (mg/l) | 2.891 | 0.947 | 0.940 | 0.950 | 1.924 | 3.862 | 1.919 | 1.915 | 1.916 | 0.940 | 1.422 | 2.394 |
| 18. | Chloride (mg/l) | 59.99 | 55.99 | 53.99 | 53.99 | 49.99 | 45.99 | 41.99 | 43.99 | 46.99 | 51.99 | 55.99 | 61.99 |
| 19. | BOD (mg/l) | 20.2 | 17.2 | 15.6 | 13.8 | 12.4 | 12.8 | 13.4 | 15.2 | 16.6 | 17.2 | 19.4 | 21.6 |
| 20. | COD (mg/l) | 41.6 | 41.2 | 40.4 | 34.2 | 27.4 | 27.8 | 30.2 | 34.8 | 39.4 | 41.8 | 42.6 | 42.8 |

**Table 2 : Monthly fluctuation of Physico – chemical parameter at Undasa wetland from July 2017- June 2018**

| S N | Parameter | July | Aug. | Sept | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apri | May | June |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Time** | 7:35 AM | 6:38 AM | 6:50 AM | 7:20 AM | 7:44 AM | 7:35 AM | 6:15 AM | 7:00 AM | 6:55 AM | 6:40 AM | 6:20 AM | 7:20 AM |
| 1. | Env. Condition | Partly cloudy | Cloudy weather | Cloudy weather | Cloudy weather | Cold weather | Cold weather | Cold weather | Cold weather | Clear weather | Sunny day | Clear weather | Sunny Day |
| 2. | Depth (m) | | | 2.23 | 2.25 | 1.95 | | 1.24 | | 0.69 | | 0.51 | |
| 3. | Air temp. °C | 20 | 21 | 16 | 17 | 20 | 16 | 7 | 13 | 12 | 21 | 28 | 26 |
| 4. | Water temp. °C | 21 | 20 | 20 | 19 | 17 | 19 | 16 | 20 | 22 | 25 | 29 | 28 |
| 5. | Colour | Muddy | Muddy | Muddy | Muddy | C.L. | C.L. | C.L. | C.L. | C.L. | C.L. | Greenish | Greenish |
| 6. | Odour | Fishy smell | Fishy smell | Fishy smell | Fishy smell | Fishy smell | O.L. | O.L. | O.L. | O.L. | O.L. | O.L. | O.L. |
| 7. | Taste | T.L. | T.L. | T.L. | T.L. | T.L. | T.L. | T.L. | T.L. | T.L. | T.L. | T.L. | T.L. |
| 8. | Turbidity (NTU) | 70 | 76 | 73 | 42 | 32 | 30 | 32 | 40 | 46 | 52 | 58 | 64 |
| 9. | Transparency (cm) | 43 | 30 | 28 | 81 | 120 | 122 | 114 | 70 | 68 | 64 | 55 | 52 |
| 10. | pH | 8.4 | 8.6 | 8.4 | 8.2 | 8.2 | 8.0 | 7.9 | 8.0 | 8.1 | 8.2 | 8.2 | 8.3 |
| 11. | Dissolved Oxygen (mg/l) | 4.4 | 4.4 | 4.8 | 5.2 | 5.6 | 6.4 | 5.6 | 4.8 | 4.8 | 4 | 4.4 | 4.4 |
| 12. | Carbonate (mg/l) | 16 | 16 | 14 | 12 | 12 | 10 | 12 | 14 | 12 | 14 | 16 | 18 |
| 13. | Bicarbonate (mg/l) | 188 | 184 | 184 | 172 | 168 | 160 | 164 | 176 | 192 | 204 | 208 | 224 |
| 14. | Total alkalinity (mg/l) | 204 | 200 | 198 | 184 | 180 | 170 | 176 | 190 | 204 | 218 | 224 | 242 |
| 15. | Total hardness (mg/l) | 192 | 176 | 168 | 160 | 156 | 152 | 148 | 160 | 172 | 180 | 188 | 200 |
| 16. | Calcium (mg/l) | 65.73 | 62.52 | 62.52 | 59.31 | 57.71 | 52.90 | 54.50 | 59.31 | 62.52 | 64.92 | 67.33 | 68.13 |
| 17. | Magnesium (mg/l) | 6.764 | 4.833 | 2.889 | 2.891 | 2.892 | 4.839 | 2.888 | 2.891 | 3.853 | 4.339 | 4.821 | 7.259 |
| 18. | Chloride (mg/l) | 78.99 | 77.99 | 77.99 | 73.99 | 69.99 | 39.99 | 47.99 | 55.99 | 57.99 | 63.99 | 81.99 | 83.99 |
| 19. | BOD (mg/l) | 22.6 | 22.2 | 21.4 | 21.2 | 19.6 | 19.2 | 20.6 | 21.4 | 22.2 | 22.6 | 23.6 | 23.8 |
| 20. | COD (mg/l) | 55.2 | 55.4 | 53.4 | 48.6 | 45.2 | 43.6 | 44.2 | 48.4 | 50.6 | 55.4 | 58.6 | 60.2 |

**Table 3: Monthly fluctuation of Physico- chemical parameter at Purushottam Sagar from July 2017- June 2018**

| S N | Parameter | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan | Feb | Mar. | Apr. | May | June |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Time** | 8:20 AM | 8:10 AM | 8:8 AM | 7:50 AM | 6:56AM | 9:25AM | 6:30AM | 9:00AM | 8:38 AM | 7:00 AM | 8:18 AM | 8:4 AM |
| 1. | Env. Condition | Sunny day | Cloudy | Mostly cloudy | Partly cloudy | Cold weather | Cold weather | Winter time | Cold weather | Bright sunny day | Sunny Day | Sunny day | Partly cloudy |
| 2. | Depth (m) | | 1.12 | | | | | 1.01 | | | 0.74 | 0.59 | 0.59 |
| 3. | Air temp. °C | 20 | 19 | 18 | 23 | 20 | 15 | 7 | 17 | 26 | 23 | 25 | 25 |
| 4. | Water temp. °C | 22 | 21 | 20 | 20 | 18 | 19 | 16 | 20 | 22 | 27 | 29 | 29 |
| 5. | Water colour | Muddy | Muddy | Muddy | Muddy | Greenish | Greenish | Greenish | Greenish | Greenish | Greenish | Greenish | Greenish |
| 6. | Odour | Fishy smell | Fishy smell | Fishy smell | Fishy smell | Fishy smell | Fishy smell | Fishy smell | Fishy smell | Fishy smell | Fishy smell | Fishy smell | Fishy smell |
| 7. | Taste | Bitter | Bitter | Bitter | Bitter | Bitter | Bitter | Bitter | Bitter | Bitter | Bitter | Bitter | Bitter |
| 8. | Turbidity (NTU) | 76 | 79 | 75 | 45 | 39 | 40 | 38 | 44 | 49 | 56 | 61 | 66 |
| 9. | Transparency (cm) | 37 | 25 | 29 | 74 | 96 | 102 | 98 | 65 | 58 | 56 | 52 | 39 |
| 10. | pH | 8.5 | 8.4 | 8.3 | 8.2 | 8.1 | 8.2 | 8.1 | 8.1 | 8.2 | 8.2 | 8.2 | 8.4 |
| 11. | Dissolved Oxygen (mg/l) | 4 | 4.8 | 4.8 | 5.2 | 5.2 | 5.6 | 6 | 4.8 | 4.4 | 4 | 3.6 | 3.2 |
| 12. | Carbonate (mg/l) | 22 | 18 | 18 | 16 | 16 | 14 | 16 | 16 | 18 | 18 | 20 | 20 |
| 13. | Bicarbonate (mg/l) | 236 | 212 | 196 | 192 | 190 | 184 | 188 | 196 | 208 | 224 | 224 | 248 |
| 14. | Total alkalinity (mg/l) | 258 | 230 | 214 | 208 | 206 | 198 | 204 | 212 | 226 | 242 | 244 | 268 |
| 15. | Total hardness (mg/l) | 208 | 204 | 200 | 192 | 180 | 172 | 180 | 184 | 188 | 196 | 204 | 216 |
| 16. | Calcium (mg/l) | 72.14 | 68.13 | 66.53 | 64.12 | 62.52 | 60.12 | 62.52 | 64.92 | 66.53 | 68.13 | 70.54 | 72.94 |
| 17. | Magnesium (mg/l) | 6.762 | 8.224 | 8.222 | 7.741 | 5.796 | 5.320 | 5.796 | 5.311 | 5.307 | 6.280 | 6.761 | 8.228 |
| 18. | Chloride (mg/l) | 72.99 | 69.99 | 67.99 | 64.99 | 62.99 | 59.99 | 51.99 | 54.99 | 63.99 | 65.99 | 73.99 | 77.99 |
| 19. | BOD (mg/l) | 24.4 | 23.6 | 22.8 | 22.6 | 21.4 | 21.2 | 21.8 | 23.4 | 25.8 | 27.6 | 28.8 | 32.6 |
| 20. | COD (mg/l) | 70.4 | 64.6 | 60.2 | 58.4 | 54.6 | 53.8 | 55.6 | 61.4 | 67.2 | 69.8 | 75.2 | 77.4 |

Dissolved Oxygen is an important parameter which is essential to the metabolism of all aquatic organisms that posses aerobic respiration. At Sahebkhedi lake the present investigation indicated that the concentration of dissolved oxygen fluctuated between 4.4- 7.2 mg/lt (Table-1). Seasonally, the concentration of dissolved oxygen was more during monsoon and least during summer. The observation is in conformity with the observations of Reddy *et al.* (1982), Ghosh and George (1989), Swarnalatha and Narasingarao (1983) and Venkateswarlu (1993). At Undasa wetland Dissolved oxygen values range from 4-6.4 mg/lt (Table-2). Similarly at Purushottam sagar D.O. values range from 3.2 to 6 mg./l (Table-3).

BOD is a parameter to assess the organic load in a waterbody. Many researchers have recorded higher BOD values in polluted water. At sahebkhedi lake BOD values ranged between 12.4 to 21.6 mg/lt (Table-1). It was high during summer, being in conformity with the observation of Catterjee (1992). At Undasa wetland BOD values ranged from 19.2-23.8 mg/lt (Table-2). and at Purushottam sagar BOD values ranged between 21.8-32.6 mg/lt (Table-3). Similar variable physico-chemical values are recorded also in Lakes and Rivers by Ochuko *et al*. (2014); Boah *et al*. (2015) and Thomas & Abraham (2018), pointed out that the water quality in terms of physico-chemical parameters at Pamba River, Kerala is well within the limits and can be used for irrigation, bathing and domestic purposes without any treatment. But also recommended that, it is desirable to monitor water resourses regularly to prevent the outbreak of diseases. The present investigation which is helpful to determine the quality of water and the purpose of the investigation is to make the people aware about the contamination of this waterbodies.

## Conclusion

The results from the present Investigation clearly pointed out that the water quality of the Purushottam sagar is highly polluted as compared to the Undasa wetland and Sahebkhedi lake is reported moderate pollution condition. Therefore, it can be concluded through this study was to calculate the water quality index (WQI) of three water bodies in order to assess its suitability for drinking purposes. The water quality index (WQI)

is a clear indication that untreated water from the Sahebkhedi lake, Undasa wetland and Purushottam sagar is of unsuitable for drinking and must therefore be treated before use to avoid water related diseases. Water contamination by various human activities is another severe problem which had produced deteroriation in the lentic water bodies of Ujjain. Various anthropogenic activities like dumping of waste flower & other sewage material has led to an increase in various pollution indicating physicochemical parameters like hardness, calcium, chloride etc. Local people & government should be aware and should take required measure to reduce the amount of pollutant & should work to conserve these water bodies.

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