Assessment of Limnological Parameters and Water Quality Indices of Harike Wetland (Ramsar Site), Punjab (India)

Onkar Singh Brraich, Navpreet Kaur*, Saima Akhter

Department of Zoology and Environmental Sciences, Punjabi University, Patiala-147002, (Punjab), India

*Corresponding author: Navpreet22kaur@gmail.com

Received April 23, 2021; Revised May 27, 2021; Accepted June 08, 2021

Abstract Study on water quality parameters of Harike Wetland, Punjab was conducted from June 2018 to August 2019 at three representative sites: Site 1, Site 2, Site 3 and mean value was calculated. The study period was divided into various seasons: Rainy (June to August), Autumn (September to November), Winter (December to February), Spring (March to Mid April) and Summer (Mid April to end June). The different water quality parameters include: water temperature, pH, alkalinity, dissolved oxygen, total dissolved solids, nitrates and phosphates. The average values of all parameters were compared with ISI, ICMR and WHO standards for drinking water quality. Correlation coefficient between various physico-chemical parameters was recorded using Pearson Correlation analysis. High Impact of pollution load from various sources on seasonal variations and water quality parameters were observed especially on pH, nitrates and phosphates. pH showed significant negative correlation with all other water quality parameters except phosphates. However, water temperature (except DO), alkalinity, TDS and nitrates represented significant positive correlation with all other physico-chemical parameters. The water quality values were observed to be 53.56 thus, it can be concluded that overall water quality at Harike wetland is “Poor” due to human activities and pollution load (industrial effluents) which affect its quality and quantity. The inadequate availability of freshwater resources can pose serious threat to aquatic biodiversity and render its unfit for human consumption.

Keywords: wetland, water quality index, seasonal variation, pollution status

Cite This Article: Onkar Singh Brraich, Navpreet Kaur, and Saima Akhter, “Assessment of Limnological Parameters and Water Quality Indices of Harike Wetland (Ramsar Site), Punjab (India).” Applied Ecology and Environmental Sciences, vol. 9, no. 6 (2021): 591-598. doi: 10.12691/aees-9-6-3.

1. Introduction

Wetlands, often referred as “Earth’s kidneys,” are transitional zone between terrestrial and aquatic system [1]. Wetlands have been playing an important role in purifying the polluted water for centuries. Majority of wetlands have been exploited for their natural cleansing capacity for assimilating various pollutants including heavy metals and pesticides [2]. Human population growth and its numerous activities directly affect the water quality. Approximately, 50,000 large and small lakes are contaminated to the spot of being considered ‘dead’ [3]. The major contaminants are agricultural runoff, sewage and industrial pollution which may enclose herbicides, fertilizers and pesticides [4]. Pollution is a major problem of wetlands and constitutes a potential threat to the health and well-being of their entire populations. Anthropogenic activities and direct discharge of industrial waste (Solid, liquid and gaseous wastes) into the freshwater resources can affect the aquatic life thus disrupting the whole systems and pose a threat to human health directly or indirectly [5]. Toxic metals present in industrial waste along with suspended solids, inorganic and organic chemicals, high biochemical oxygen demand, chemical oxygen demand, grease and oil, cause detrimental effects on the fish when released into water bodies. In order to ensure safe drinking water supply, it is therefore, mandatory to monitor the quality of water resources at regular intervals of time [2].

Hence, present research conducted to find out the water quality index of Harike wetland on the basis of physico-chemical indices. The prosperous biodiversity of the wetland plays a crucial role in maintaining the precious hydrological balance in the catchment with its vast concentration on migratory fauna of waterfowls including plenty of globally threatened species has been responsible for the recognition accorded to this wetland in 1990, by the Ramsar convention, as one of the Ramsar site in India, for development, conservation and preservation of the ecosystem. Every year during winter season approximately, 200 species of birds visit at this wetland [6]. Harike wetland also supports vulnerable, rare and endangered plants, fish and other faunal species [7]. The Ministry of Environment and Forest, Government of India,
declared it a wildlife sanctuary in 1982. From many years Harike wetland has been facing immense threats from various quarters like sewage, solid waste, industrial effluents, encroachments, poaching and reclamation, etc. The discharge of heavy metal pollutants in this wetland poses a big threat to the reproduction efficacy of various inhabitants [4,8].

Ludhiana city of Punjab state was founded on the ridge of Buddah Nullah. The rapid growth of industrialization and increasing population pressure has brought in a host of environmental problems and Buddah Nullah which enters and after passing through highly polluted city Ludhiana, drains its polluted water into the Sutlej river. The Buddah Nullah carries the industrial effluents of almost 1060 industries of Ludhiana city and another drain known as Kala Sanghian drain which carries polluted water of almost 52 industries from Jalandhar district and adjoining cities. The high concentration of industrial effluents ultimately reaches at Harike wetland (Ramsar site) which poses a serious threat to the valuable biodiversity existing there. The accumulation of toxic substances in fish and water resources due to industrialization has led to pollution of water bodies in Punjab which alter the physico-chemical parameters of water bodies [9]. Therefore, present study revealed and recorded high level of pollution at the wetland under study which can cause serious threats to valuable flora and fauna. Hence, this study recommends that continuously monitoring of this wetland should be carried out to keep its flora and fauna intact for upcoming years.

2. Materials and Methods

2.1. Study Area

This man made, riverine wetland spreads into three districts i.e. Kapurthala, Ferozepur and Taran Taran in Punjab. The wetland was formed by building the headworks across the river Sutlej and Beas in the year 1952 with the objective of storing and supplying drinking and irrigation water to neighboring state Rajasthan and to the parts of southern Punjab. This wetland (Figure 1) falls between 31° 08’N to 31° 23’N latitude and 74° 90’E to 75° 12’E longitudes [10].

2.2. Collection and Physico-chemical Analysis of Water Samples

Water samples were collected in 1 litres reagent bottle during morning hours in five different seasons of the year from July, 2018 to August, 2019 from three sites (Site 1, Site 2 and Site 3) at Harike Wetland. Physico-chemical parameters such as water temperature, dissolved oxygen, total dissolved solids and pH were analyzed on the spot with the help of water analysis kit (Merck multi-line p4 kit). Whereas, alkalinity, nitrates and phosphates were analyzed in the laboratory by standard methods [11, 12]. The recorded results were compared with standard values prescribed by World Health Organization [13], Indian Standards Institute [14] and Indian Council of Medical Research [15].

Figure 1. Map of the study area (Harike Wetland)
2.3. Water Quality Index (WQI) Computation

WQI can be defined as the index which reflects the combinational effect of various water quality parameters and provides a single number which gives information about the overall water quality of the water body under study. Six parameters namely Alkalinity, TDS, pH, Dissolved oxygen, nitrates and phosphates were detected on seasonal basis at three representative sites of Harike wetland to calculate WQI especially at, site 1, site 2 and site 3, because site 1 area is on the right side of the wetland which receive the water of river Beas. Hence, due to less pollution lot of biodiversity exist here and considered safe for wildlife. The occurrence of biodiversity reflects that it is less polluted as compared to other two sites, consequently, it is considered as safe zone for flora and fauna. Site 2 area is a confluence point of both the rivers, i.e. Beas and Sutlej. At this site, polluted water of river Sutlej mixes with the water of river Beas. Site 3 is highly polluted, reservoir area because polluted water from the river Sutlej being stored here.

Weighted arithmetic water quality index method classified the water quality according to the degree of purity by using the most commonly measured water quality variables. The method has been widely used by various scientists and the calculation of WQI was made by using the following equation [16]:

\[
WQI = \frac{\sum Qi Wi}{\sum Wi}
\]

The quality rating scale (Qi) for each parameter is calculated by using this expression

\[
Qi = 100 \times \left(1 - \frac{Vi - Vo}{Si - Vo}\right)
\]

Where, Vi is estimated concentration of ith parameter in the analyzed water Vo is the ideal value of this parameter in pure water Vo = 0 (except pH = 7.0 and DO = 14.6mg/l), Si is the recommended standard value of ith parameter. The unit weight (Wi) for each water quality parameter is calculated by using the following formula:

\[
Wi = K / Si
\]

Where, K = proportionality constant and can also be calculated by using the following equation:

\[
K = 1 / \sum (1 / Si)
\]

2.4. Statistical Analysis

The statistical calculations such as: average, standard deviation and range were done in Microsoft Excel version MSO (12.0.4518.1014). Pearson correlation coefficient in PAST software version 4.03 was calculated for the determination of relationship between various physico-chemical parameters of this wetland.

3. Results and Discussion

The average results of the water quality parameters of collected water samples are depicted in Table 1. The average values of water temperature (°C), recorded in the present course of study, at the three selected sites were 26.5±0.7, 24.0±1.31, 22.23±0.25, 23.7±0.81 and 27.5±0.5, respectively during rainy, autumn, winter, spring and summer seasons. Highest value (28.0°C) of water temperature was observed in summer at site 3 and lowest value (22.0°C) was reported in winter season at site 1. These recorded values in the present work were found to be higher than those reported by other workers [17] and close to those reported by other scientists [18]. The mean values of pH recorded at three different studied sites were 8.76±0.32, 7.3±0.1, 8.13±0.25, 7.73±0.15 and 7.53±0.05, respectively in rainy, autumn, winter, spring and summer seasons. Highest pH value (9.0) was found at site 3 (S3), during rainy season and lowest pH value (7.2) at site 1, during autumn season. The highest pH value (9.0) recorded at site 3, in the present research was found very close to those reported by other researchers [19, 20] and higher than those recorded by other workers [17,18,21]. In the present work conducted during rainy, autumn, winter, spring and summer seasons the detected mean values of alkalinity (mg/l) were 60.06±1.00, 58.1±1.9, 61.33±1.15, 64.1±0.75 and 70.2±1.21, respectively. In the present course of work, maximum value of alkalinity (71.3 mg/l) at Site 2 and minimum value (56.2 mg/l) at site 1 were detected during summer and autumn seasons, respectively which were found to be very higher than those reported by other limnologist [20,22]. In the present study period, the average values of dissolved oxygen (mg/l) were 7.83±0.05, 7.9±0.1, 8.23±0.05, 8.13±0.11 and 7.9±0.1, respectively during rainy, autumn, winter, spring and summer seasons. Maximum value (8.3 mg/l) of dissolved oxygen was detected at site 2 during winter and minimum value (7.8mg/l) was reported at site 1, during rainy and autumn seasons. These recorded dissolved oxygen values in the present research were found to higher than research conducted by other researchers [20,23]. The mean values of total dissolved solids (mg/l) in the present results observed at diverse sampling sites were 218.3±2.08, 220±4.0, 224.6±2.51, 227±1.67 and 232.2±1.5, respectively in rainy, autumn, winter, spring and summer seasons. Highest total dissolved solids value (233.4 mg/l) at site 2 in summer and lowest value (216 mg/l) at site 1 in rainy and autumn season was observed. These recorded values were found to be lower than earlier studies [24,25]. In the present research, average values of nitrates (mg/l) recorded at different sampling sites were 7.69±1.99, 2.57±1.29, 4.36±0.6, 21.07±13.56 and 14.74±4.07, respectively in rainy, autumn, winter, spring and summer seasons. Maximum nitrate value (28.92 mg/l) was recorded during autumn season. These recorded values in the present work were found to be higher than those reported in another researches [24,25]. Average values of phosphates (mg/l) calculated from presently three studied sites were 10.05±0.24, 6.65±1.07, 3.83±3.00, 10.27±0.01 and 10.64±0.52, respectively in rainy, autumn, winter, spring and summer seasons. Maximum nitrate value (11.24 mg/l) at site 3 during summer and minimum value (0.058mg/l) at site 1 were recorded during winter season (Table 1). In another researches, these values were found to be highest than those reported by other scientists [24,25,26].
Table 1. Mean±S.D. and seasonal variation in physico-chemical parameters from June 2018 to August 2019 of Harike Wetland

| Parameters                  | Site 1 | Rainy   | Autumn  | Winter  | Spring  | Summer  | June 2018 to August 2019 |
|-----------------------------|--------|---------|---------|---------|---------|---------|--------------------------|
| Water Temperature (°C)      |        | 26.8    | 22.6    | 22.0    | 23.5    | 27.5    | 24.78±2.10               |
|                             | Site 2 | 25.7    | 24.2    | 22.2    | 23.0    | 27.5    |                          |
|                             | Site 3 | 27.0    | 25.2    | 22.5    | 24.6    | 28.0    |                          |
| Mean±S.D.                   |        | 26.5±0.7| 24.0±1.3| 22.23±0.25| 23.7±0.81| 27.5±0.5|                          |
| pH                          | Site 1 | 8.4     | 7.2     | 7.9     | 7.6     | 7.6     | 7.89±0.55                |
|                             | Site 2 | 8.9     | 7.4     | 8.1     | 7.9     | 7.5     |                          |
|                             | Site 3 | 9.0     | 7.3     | 8.4     | 7.7     | 7.5     |                          |
| Mean±S.D.                   |        | 8.76±0.32| 7.3±0.1 | 8.13±0.25| 7.73±0.15| 7.53±0.05|                          |
| Alkalinity (mg/l)           | Site 1 | 59.0    | 56.2    | 60      | 63.3    | 68.9    | 62.76±4.47               |
|                             | Site 2 | 61.2    | 58.1    | 62      | 64.2    | 71.3    |                          |
|                             | Site 3 | 60.0    | 60.0    | 62      | 64.8    | 70.4    |                          |
| Mean±S.D.                   |        | 60.06±1.00| 58.1±1.9 | 61.33±1.15 | 64.1±0.75| 70.2±1.21|                          |
| Dissolved Oxygen (mg/l)     | Site 1 | 7.8     | 7.8     | 8.2     | 8.0     | 7.9     | 8.0±0.17                 |
|                             | Site 2 | 7.8     | 7.9     | 8.3     | 8.2     | 7.8     |                          |
|                             | Site 3 | 7.9     | 8.0     | 8.2     | 8.2     | 8.0     |                          |
| Mean±S.D.                   |        | 7.83±0.05| 7.9±0.1 | 8.23±0.05| 8.13±0.11| 7.9±0.1 |                          |
| Total dissolved solids (ppm) | Site 1 | 216     | 216     | 222     | 226.0   | 230.5   | 224.64±5.69              |
|                             | Site 2 | 219     | 220     | 225     | 228.8   | 233.4   |                          |
|                             | Site 3 | 220     | 224     | 227     | 229.0   | 232.9   |                          |
| Mean±S.D.                   |        | 218.3±2.08| 220.4±0.0 | 224.6±2.51 | 227.9±1.67| 232.2±1.5|                          |
| Nitrates (mg/l)             | Site 1 | 6.54    | 1.688   | 4.073   | 28.890  | 10.252  | 10.09±8.96               |
|                             | Site 2 | 6.54    | 1.971   | 4.450   | 28.924  | 18.196  |                          |
|                             | Site 3 | 10.00   | 4.066   | 4.583   | 28.924  | 18.196  |                          |
| Mean±S.D.                   |        | 7.69±1.99| 2.57±1.29 | 4.36±0.26 | 21.07±13.56 | 14.74±4.07 |                          |
| Phosphates (mg/l)           | Site 1 | 9.837   | 6.040   | 0.058   | 10.250  | 10.396  | 8.29±3.07                |
|                             | Site 2 | 10.00   | 6.040   | 4.541   | 10.280  | 10.288  |                          |
|                             | Site 3 | 10.324  | 7.894   | 6.915   | 10.285  | 11.242  |                          |
| Mean±S.D.                   |        | 10.05±0.24| 6.65±1.07 | 3.83±3.00 | 10.27±0.01| 10.64±0.52 |                          |

Table 2. Range of selected different physico-chemical parameters of Harike Wetland from June 2018 to August 2019, compared to other prescribed standards values for drinking water

| Parameters                  | Range | WHO 1992 | ISI 1973 | ICMR 1975 |
|-----------------------------|-------|----------|----------|-----------|
| Water Temperature (°C)      |       | -        | -        | -         |
| Ph                          |       | 7.2-9.0  | 6.5-8.5  | 6.5-8.5   | 7.74     |
| Alkalinity (mg/l)           | 56.2-71.3 | 120     | 200      | 120       |
| Dissolved Oxygen (mg/l)     | 7.8-8.3 | 5.0      | -        | 5.0       |
| Total dissolved solids (ppm) | 216-233.4 | 500     | 500      | 500       |
| Nitrates (mg/l)             | 1.688-28.924 | 10  | -        | -         |
| Phosphates (mg/l)           | 0.058-11.242 | 1    | -        | -         |

Table 3. Water quality rating and water quality index of Harike Wetland from June 2018 to August 2019

| Parameters                  | Observed Value (Vi) | Standard Value (Si) | Unit Weight (Wi) | Quality Rating (Qi) | WiQi   |
|-----------------------------|---------------------|---------------------|------------------|---------------------|--------|
| pH                          | 7.89                | 6.5-8.5             | 0.8702           | 39                  | 33.9379|
| Alkalinity (mg/l)           | 62.76               | 120                 | 0.7452           | 52.3                | 38.9738|
| Dissolved Oxygen (mg/l)     | 8.0                 | 5.0                 | 3.6845           | 68.75               | 253.3093|
| Total dissolved solids (ppm) | 224.6               | 500                 | 368.45           | 44.92               | 16550.774|
| Nitrates (mg/l)             | 10.09               | 10                  | 55.281           | 100.09              | 5533.0752|
| Phosphates (mg/l)           | 8.29                | 1                   | 0.7369           | 829.0               | 610.8901|

Σwi=429.7678 Σwiqi=23020.9603  
Water Quality Index = ΣW/Qi / Σwi = 53.56

It has been concluded from the observed values of all the parameters during the present course of study that they were lie under tolerable limits of drinking water standards except pH, nitrates and phosphates (Table 2). Therefore, water quality value calculated from these parameters is 53.56 which fall under poor water category (Table 3). Correlation matrix among the various physico-chemical parameters of Harike Wetland from June 2018 to August 2019 is represented in Table 5. Graphical representation of the average values of various physico-chemical parameters recorded during different seasons at Harike Wetland are depicted in Figure 2, Figure 3 and Figure 4.
Water Temperature: Water resources play a crucial role for sustaining life on earth and human development. The physico-chemical properties represent the state of an aquatic environment and their abundance corresponds to the good water quality [27]. Water temperature (°C), ranged between 22.0-28.0 (24.78±2.10) and recorded maximum value 27.5±0.5 in summer and minimum (22.23±0.25) in winter season. Similar results have been recorded at Ropar wetland [28]. Water temperature in the present course of study showed significant positive relationship with pH (0.10861), alkalinity (0.52854), TDS (0.20072), nitrates (0.079723), phosphates (0.77917) and significant negative relationship with dissolved oxygen (-0.81584) which were commensurate to the earlier findings [29].

pH: Mostly the aquatic organisms are very sensitive to pH variation and any alteration in pH can change the metabolic activities of aquatic organisms [30]. During the
present study period, pH varied from 7.2-9.0 (7.89±0.55) which was observed highest (8.76±0.32) in rainy and lowest (7.3±0.1) in autumn. Our results are contradictory to a study conducted on Ranjit Sagar Wetland as Harke wetland receives high load of pollution from various quarters [30]. pH during the present study period shows positive relationship with phosphates (0.039041) and significant negative relationship with alkalinity (-0.26302), DO (-0.04678), TDS (-0.46167), nitrates (-0.05077). Similar observations were also recorded in earlier studies [31].

Alkalinity: Water alkalinity is due to the presence of various bicarbonates, hydroxides and carbonates in water, it is the ability of an aqueous solution to neutralize a strong acid [32]. Alkalinity (mg/l) ranged between 56.2- 71.3 (62.76±4.47) recorded maximum (70.2±1.21) in summer and minimum (58.1±1.9) in autumn. Average values during all the seasons as compare to the present study were reported higher by other scientists [32]. During the study period, alkalinity of water showed significant positive relationship with TDS (0.93019), nitrates (0.48125) and phosphates (0.52833) which were dissimilar than those reported by other authors [33].

Dissolved Oxygen: Amount of life sustaining oxygen available in the water is referred as DO. Natural waters contain dissolved oxygen concentrations varied approximately from 5 to 14.5 (mg/l) depending on the physical and chemical characteristics of water body. The amount of DO present in water reflects atmospheric dissolution, as well as autotrophic and heterotrophic processes that produce and consume oxygen. [34]. Dissolved oxygen ranged between 7.8-8.3 (8.0±0.17) recorded maximum (8.23±0.05) in winter and minimum (7.83±0.05) in rainy. Other workers reported DO value which was ranged between 6.5-15 mg/l and 7.29 to 8.30 at Narmada river and Ganga river, respectively [32,35]. In the present study, DO showed significant positive relationship with TDS (0.3061), nitrate (0.24788) and significant negative relationship with phosphates (-0.5577).

TDS: Solid materials dissolved in the water such as salts and other material (Nutrients to toxic materials) is termed as TDS. The nature and amount of dissolved matter occurring in liquid materials fluctuate significantly [36]. Total dissolved solids have been ranged between 216-233.4 (224.64±5.69), the value was recorded maximum in summer (232.2±1.5) and minimum (218.3±2.08) in rainy. In our results, higher values were observed as compared researchers [37]. In our results, TDS shows significant positive relationship with nitrates (0.52733) and phosphates (0.30916).

Nitrate: Natural water bodies pose the most highly oxidized form of nitrogen compound referred to as nitrates formation due to the decomposition of organic nitrogenous matter in the presence of oxygen. In the present study, nitrates have been ranged between 1.68- 28.92 (10.09±8.96) and recorded maximum (21.07±13.56) in spring and minimum value (2.57±1.29) in autumn which were found to be higher than those reported by other workers [27,30]. In the present findings, nitrates showed significant positive relationship with phosphates (0.64734).

Phosphates: In natural water bodies phosphorus is present either as undifferentiated organic phosphate or orthophosphate. Phosphorus plays a crucial role in biological metabolism. It gets into the water via plenty of sources for instance leached or weathered soils from igneous rocks, run-off from fertilized land-farms, industrial effluents and domestic sewage. In the present study, phosphates have been ranged between 0.05-11.24 (8.29±3.07) and recorded maximum value (10.64±0.52) in summer and minimum value (3.83±3.00) in winter.

3.1. Analysis of Water Quality on the Basis of WQI

Six physico-chemical parameters such as Alkalinity, TDS, pH, Dissolved oxygen, nitrates and phosphates were recorded at the three selected sites of the wetland under study and their average values and standard deviations were calculated during each season to find out the WQI. The WQI value was recorded to be 53.56 which represents water quality at Harke Wetland falls under “Poor” according to the values gives in Table 4 [38]. The water quality index value recorded in the present course of research was found to be higher than those reported by other limnologists at S1 site (Ropar Head Works), close to S2 site (Budha Nallah in Phillaour) and lower than S3 site (Budha Nallah in Ludhiana) of Sutlej River around Ludhiana city, Punjab [39].

| Parameters | Water Temperature (ºC) | pH | Alkalinity (mg/l) | Dissolved Oxygen (mg/l) | Total dissolved solids (ppm) | Nitrates (mg/l) | Phosphates (mg/l) |
|------------|------------------------|----|------------------|------------------------|-----------------------------|----------------|------------------|
| Water Temperature (ºC) | 0 | | | | | | |
| pH | 0.10861 | 0 | | | | | |
| Alkalinity (mg/l) | 0.52854 | -0.26302 | 0 | | | | |
| Dissolved Oxygen (mg/l) | -0.81584 | -0.04678 | 0.008123 | 0 | | | |
| Total dissolved solids (ppm) | 0.20072 | -0.46167 | 0.93019 | 0.3061 | 0 | | |
| Nitrates (mg/l) | 0.079723 | -0.05077 | 0.48125 | 0.24788 | 0.52733 | 0 | |
| Phosphates (mg/l) | 0.77917 | 0.039041 | 0.52833 | -0.5577 | 0.30916 | 0.64734 | 0 |

Table 3. Correlation matrix among the various physico-chemical parameters of Harike Wetland from June 2018 to August 2019

| Parameters | Water Temperature (ºC) | pH | Alkalinity (mg/l) | Dissolved Oxygen (mg/l) | Total dissolved solids (ppm) | Nitrates (mg/l) | Phosphates (mg/l) |
|------------|------------------------|----|------------------|------------------------|-----------------------------|----------------|------------------|
| Water Temperature (ºC) | 0 | | | | | | |
| pH | 0.10861 | 0 | | | | | |
| Alkalinity (mg/l) | 0.52854 | -0.26302 | 0 | | | | |
| Dissolved Oxygen (mg/l) | -0.81584 | -0.04678 | 0.008123 | 0 | | | |
| Total dissolved solids (ppm) | 0.20072 | -0.46167 | 0.93019 | 0.3061 | 0 | | |
| Nitrates (mg/l) | 0.079723 | -0.05077 | 0.48125 | 0.24788 | 0.52733 | 0 | |
| Phosphates (mg/l) | 0.77917 | 0.039041 | 0.52833 | -0.5577 | 0.30916 | 0.64734 | 0 |
4. Conclusion

The seasonal variation of physico-chemical parameters of Harike wetland was conducted during five seasons: rainy (June to August), autumn (September to November), winter (December to February), spring (March to Mid April) and summer (Mid April to end of June). In our findings, the fluctuation in water quality parameters have been reported which may be due to inflow variation, seasonal variation, variation in the temperature, sewage addition, and direct release of untreated industrial effluents into this water body from nearby industries. Harike wetland received high concentration of pollutants (heavy metals, nitrates and phosphates), industrial effluents from textile, leather and chemical industries reached via Buddha Nullah at this wetland. Buddha Nullah carries industrial waste of almost 1060 industries of Ludhiana city. Hence, WQI of wetland under study was observed to be “Poor” water quality and unsafe for human consumption which can have detrimental effects on its entire ecosystem, if not dealt on time. Thus overall present study revealed that anthropogenic activities must be reduced and regular monitoring of water bodies should be done in order to supply receive safe water in the upcoming years as well as to stop its further deterioration.

Acknowledgements

The author would like to acknowledge the University Grants Commission, New Delhi for their financial support (NFSC fellowship) and also to the Head, Department of Zoology & Environmental Sciences, Punjabi University, Patiala for providing necessary facilities to carry out the research work.

References

[1] Clarkson, B.R., Ausise, A.E. and Gerbeaux, P., Wetland ecosystem services: Ecosystem services in New Zealand--conditions and trends, (Ed. Dymond, J.R.) Manaaki Whenua press, Lincoln, New Zealand, 2013.
[2] Joyce, C., “Preface: Wetland services and management”, Hydrobiologia, 692: 1-3. 2012.
[3] Bassi, N., Kumar, M.D., Sharma, A. and Saradhi, P.P., “Status of wetlands in India: A review of extent, ecosystem benefits, threats and management strategies”, Journal of hydrology: Regional studies, 2: 1-19. 2014.
[4] Chopra, R., Verma, V.K. and Sharma, P.K., “Mapping, monitoring and conservation of Harke Wetland ecosystem, Punjab, India through remote sensing”, International Journal of Remote Sensing, 22: 89-98. 2001.
[5] Pappa, J.S.S., Lenin, T., Sundaram, A.A and Kumar, S.P., “Biochemical Changes in estuarine fish Mugil cephalus exposed to industrial effluent”, International Journal of Advanced Multidisciplinary Research, 3(1): 46-49. 2016.
[6] Halls, A.J. Wetlands biodiversity and Ramsar convention: The role of convention on wetland in the conservation and wise use of biodiversity. Ramsar convention Bureau, Gland, Switzerland, 1997.
[7] Ladhar, S.S., “Status of ecological health of wetlands in Punjab, India”, Aquatic Ecosystem Health Management, 5: 457-465. 2002.
[8] Braich, O.S. and Jang, S., “Some aspects of reproductive biology on effect of heavy metal pollution on the histopathological structure of gonads in Labeo rohita (Hamilton-Buchanan) from Harke wetland, India”, International. Journal of Fisheries and Aquatic Studies, 7: 9-14. 2015.
[9] Jaidka, A., “Impact of Buddha Nullah pollution on reproductive health of fish in river Sutlej”, M.Sc. Thesis, Punjab Agricultural University, Ludhiana, India, 2017.
[10] Mawooga, S.O. and Thukral, A.K., “Characterization of change in the Harke Wetland, a Ramsar Site in India, using landsat satellite data”, Springer plus, 3(576): 1-11. 2014.
[11] Tivedi, R.K. and Goel, P.K., Chemical and biological methods for water pollution studies, Environmental Publications, India, 1984.
[12] APHA, Standard methods for the examination of water and waste water, 21st (ed.). New York: American Public Health Association, American Water Works Association & Water Environment Federation, 2012.
[13] WHO, International Standards for Drinking Water, Geneva, World Health Organization, 1992.
[14] ISI, Indian standard methods for sampling and test (physical and chemical) for water used in industry, Manak Bhawan, Indian Standard Institute, India, 1973.
[15] ICMR, Manual of standards of quality for drinking water supplies, New Delhi: ICMR, 1975.
[16] Brown, R.M., Me Cleland, N.J., Deininger, R.A. and Connor, M.F, A water quality index- crossing the psycho- logical barrier, (Ed. Jenkins, S.H.), in International Conference on water Pollution Research, Jerusalem, 6: 787-797.1972.
[17] Barman, D., Ray, B. and Roy, S, “Seasonal variation of physico-chemical characteristics of wetland in the West Garho Hill, Meghalaya, India”; International Research Journal of Biological Sciences, 4(1): 60-65. 2015.
[18] Ansari, N.A., “Seasonal variation in the physico-chemical characteristics of water samples of Surajpur wetland, national capital region, India”, International Journal of Current Microbiology and Applied Sciences, 6(2): 971-987.2017.
[19] Barot, C. and Patel, V., “Comparative study of seasonal variation in physico-chemical properties of selected wetlands of Mhsarsa districts, north Gujrat, India”, Indian Journal of Applied Research, 4(7): 44-47.2014.
[20] Ora, A.E.L., Abuom, P.O., Owiti, D.O. and Malala, J.O., “Influence of artisanal fishing gears on physico-chemical parameters of Ferguson’s Gulf in lake Turkana, Kenya”, Scholar Academic Journal of Biology, 3(12): 1005-1013. 2015.
[21] Nauli, S., Boucheker, A., Gherib, A., Djelloul, R. and Lazli, A., “Seasonal variation in physico-chemical characteristics and load contamination of lake Tonga and their effects on waterbird populations”, Ukranian Journal of Ecology, 11(1): 103-112. 2021.
[22] Kumar, S.R., Radhakrishnan, K., Aanana, S and Rajaram, R., “Influence of physico-chemical water quality on aquatic macrophyte diversity in seasonal wetlands”, Applied Water Science, 9(12): 2-8. 2019.
[23] Vidy, V., Sumathy, K. and Prasad, G., “The effect of Sea-food processing discharge on nearby wetland in Cherthala, Arzon-Edakochi coastal belt of Kerala, India”, Nature Environment and Pollution Technology, 13(2): 235-244.2014.
[24] Tadesse, M., Seguye, T. and Girma, G., “Assessment of the level of some physico-chemical parameters and heavy metals of Rebu river in Oromia region, Ethiopia”, Biology and Medicine, 3(5): 99-118. 2018.
[25] Chatanga, P., Nulii, V., Mugomere, E., Keketsi, T. and Chikwore, N.V.T., “physico-chemical, biochemical and microbiological quality of water along Mohokare river, Lesotho”, Egyptian Journal of Aquatic Research, 45(1): 45-51. 2019.
[26] Rout, K.S., Shinde, S.E. Pathan, T.S. and Sonawane, D.L., “Seasonal variation in physico-chemical characteristics of Ravivar Peth lake at Ambajogai district Beed Marathwada region, India”, Journal of Research in Biology, 4: 258-262. 2011.
[27] Akhter, S. and Braich, O.S, “Saptal and temporal distribution of phytoplankton from Ropar Wetland (Ramsar Site) Punjab, India”, Applied Ecology and Environmental Sciences, 8(1): 25-33. 2020.
[28] Akhter, S. and Braich, O.S, “Physico-chemical analysis of fresh water of Ropar Wetland (Ramsar Site), India”, Current World Environment, 15(1): 117-126. 2020.
[29] Braich, O.S. and Kaur, R., “Assessment of physico-chemical parameters and water quality index of Nangal Wetland, Punjab (India)”, Journal of Environmental Bio-Science, 29(1): 33-39. 2015.
[30] Braich, O.S. and Saini, S.K., “Water quality index of Ranjit Sagar Wetland situated on the Ravi river of Indus river system”, International Journal of Advanced Research, 3(12): 1492-1509. 2015.
[31] Sen, S., Paul, M.K. and Borah, M, “Study of some Physico-Chemical Parameters of Pond and River water with reference to Correlation Study”, International Journal of ChemTech Research, 3(4): 1802-1807. 2011.

[32] Kamboj, N. and Kamboj, V, “Water quality assessment using overall index of pollution in riverbed-mining area of Ganga-River, Haridwar, India”, Water Science, 33(1): 65-74. 2019.

[33] Dhembare, A.J, Statistical approaches for computing diversity and density of zooplankton with water factors in Mula Dam, Rahuri, MS, India, European Journal of Experimental Biology, 1(2): 68-76. 2011.

[34] Parmar, K. and Parmar, V, “Evaluation of water quality index for drinking purposes of river Subernarekha in Singhbhum District”, International Journal of Environment Sciences, 1(1): 77-81. 2010.

[35] Sharma, S., Dixit, S., Jain, P., Shah, K. W. and Vishwakarma, R, “Statistical evaluation of hydrobiological parameters of Narmada River water at Hoshangabad City, India”, Environmental Monitoring and Assessment, 143, 195-202. 2008.

[36] Nollet, L.M.U., Handbook of Water Analysis, Marcel Dekker, New York, Basel, 2000.

[37] Khadade, S.A. and Mule, M.B, “Studies on physicochemical parameter of pundit water reservoir from Tasgaon Tashil”, International Journal of Environmental Protection, 23(9): 1003-1007. 2003.

[38] Chatterji, C. and Raziuuddin, M, “Determination of water quality index (WQI) of a degraded river in Asanol Industrial area, Raniganj, Burdwan, West Bengal”, Nature Environment and Pollution Technology, 1(2): 181-189. 2002.

[39] Jindal, R. and Sharma, C, “Studies on water quality of Sutlej river around Ludhiana with reference to physico-chemical parameters”, Environment Monitoring Assessment, 174: 417-425. 2011.

© The Author(s) 2021. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).