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# Water quality of two important Inland Wetlands (Pariej and Kanewal) in the Neighbouring Districts of Central Gujarat, India

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## Abstract

*Present study deals with the physico-chemical parameters of water quality of two well-known man-made inland wetlands of Central Gujarat, viz. Pariej and Kanewal. This study was conducted to ascertain their overall water quality status and to understand seasonal dynamics of various water quality parameters. To understand water quality profile of the two wetlands, water samples were seasonally collected for analyzing 16 physico-chemical parameters during the three seasons (monsoon, winter and summer) of the year 2016-17. The parameters included temperature, pH, electric conductivity, turbidity, total dissolved solids (TDS), dissolved oxygen (DO), acidity, alkalinity, total hardness, chlorides, salinity and some nutrients like nitrates, nitrites and phosphates which were analyzed by standard methods for comparative study of them.*

**Keywords:** Central Gujarat, Kanewal, Pariej, physico-chemical parameters, water quality, Wetlands.

## Introduction

Wetlands are defined as 'marshes, fens, peatland or water, whether natural or artificial, permanent or temporary with water that is stationary or flowing, fresh, brackish or salt, including marine water areas, where the depth at low tide does not surpass six meters'[1]. The most important step for maintenance of wetlands is to sustain proper quality of water[2]. But unfortunately, water quality of many wetlands has been deteriorating due to discharge of untreated effluents from industries, domestic sewage and agricultural run-off. Pollutants originating from these sources may deplete dissolved oxygen (DO), cause nutrient over-enrichment leading to cultural eutrophication, raise turbidity and increase suspended solids in surface water sources[3]. These, in turn, may affect the biotic communities inhabiting the wetlands being polluted. Pollutants from industrial, agricultural and domestic sources can have considerable effect on water quality and in turn, aquatic life and various ecosystem services facilitated by wetlands[4]. Kanewal and Pariej irrigation reservoirs are the two very important man-made wetlands that are located in the neighboring districts Anand and Kheda respectively that are located in Central Gujarat. They are located at the distance of just 23 km from each other. Both of them are the Important Bird and Biodiversity Area (IBA) sites)[5] and Pariej is a Nationally Important Wetland too. Additionally, they are the wetlands having high conservation value with Rank-1 as per Salim Ali Centre for Ornithology and Natural History-SACON (2004). Additionally, they have been the source of drinking water for some areas in Saurashtra [6,7]. Considering these factors, these two wetlands were selected for seasonal water quality monitoring from July 2016 to March 2017 (covering monsoon, winter and summer seasons of the year 2016-17).

**Study area:** The study was carried out on two important inland wetlands of Central Gujarat namely; Pariej irrigation reservoir and Kanewal irrigation reservoir.

**Pariej Wetland:** Pariej (22°33′05.69″ N and 72°36′52.69″ E) in Kheda district is a freshwater reservoir on the plains to the north of the Gulf of Khambhat and lies in a natural depression surrounded by an embankment. It covers an area of about 5 sq.km with a circumference of about 12 km with water depth varying between 1.2m to 3.0m. Water is supplied to this reservoir through the Narmada and Mahi canals to maintain its level round the year. Drinking water to villages around Pariej and some villages in Saurashtra is supplied from this lake through the pipelines. It is rich in aquatic vegetation and functions an abode of a variety of residential as well as migratory birds[6,7]. More than 65 aquatic bird species are recorded. It is one of the eight Nationally Important wetlands from Gujarat[8].

**Kanewal Wetland:** Kanewal (22˚28'00" N and 72˚32'00" E) in Anand district is located at the distance of about 60 kms from Anandand 80kms from Ahmedabad. It is situated 30 km north of the tip of Gulf of Khambhat and around 50 km south east of the southern portion of NalSarovar the only Ramsar site in the state. The reservoir, under the control of State Irrigation Department, is spread over 6.25 sq. km. Its maximum depth is of about 12 m. The northern side of the reservoir is relatively shallow and supports aquatic vegetation[6,7]. It is one of the Rank-1(top ranking) wetland of the country from biodiversity view-point as per SACON's wetland prioritization. Almost more than 180 aquatic bird species with an average density of about 42,000 waterfowl visit during peak winter months[9] which shows the importance of the wetland. Kanewal reservoir is a source of drinking water for 57 villages too[10].

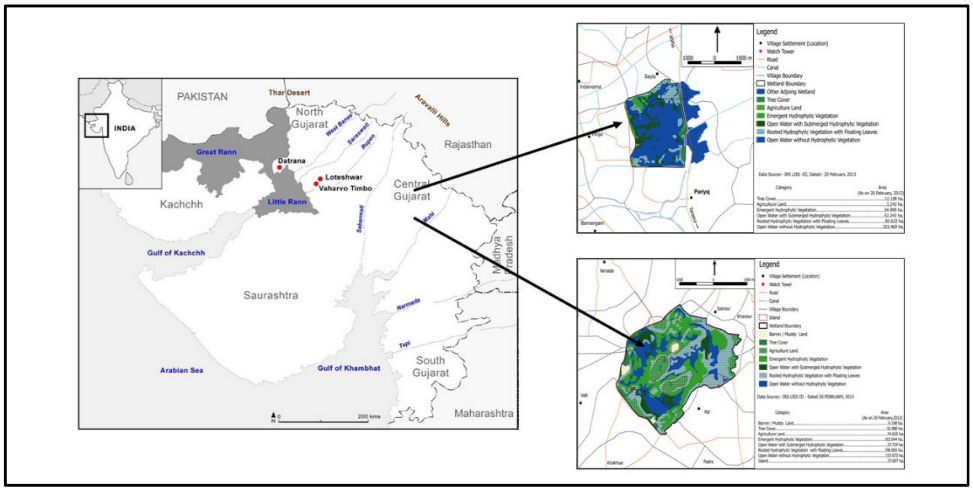


**Figure-1:** Maps showing Pariej and Kanewal wetlands.

## Material and methods

**Water Sampling and Analyses**: Stratified random sampling strategy was used for *in situ* water quality assessment or water sample collection for the laboratory based analysis. Thus, care was taken to collect water samples from randomly determined spatial points falling in each of the major habitat component of both the wetlands. In situ water quality was done on water samples that were collected from six wetland habitat components, with one sampling point randomly determined in each habitat component for Pariej and Kanewal wetlands. The habitats for water sampling or in-situ assessment included (a) Open Water (O) (b) Emergent Hydrophytic Cover (EC), (c) Water with *Nymphaea/Nelumbo* cover(NC), (d) Water with decomposing vegetation mat (DM), (e) Inlet (I) and (f) Outlet (O). The sampling/in situ water quality assessment was done between July 2016 and March 2017 in such a way that all the important seasons (i.e., monsoon, winter and summer) of the year 2016-17 got covered. The water samples were collected by grab sampling approach and unstable parameters like pH, temperature, turbidity, total dissolved solid (TDS), dissolved oxygen (DO), electrical conductivity were analyzed at the sites. Water samples were brought to the laboratory for analysis of other parameters like acidity, alkalinity, chlorides, salinity, total hardness, calcium hardness, magnesium hardness, as per standard methods[11].

## Results and discussion

Seasonal variations for various physico-chemical parameters of the water quality of the two wetlands are presented in Figure-2 to Figure-17.

**pH:** Aquatic organisms are affected by pH since most of their metabolic activities are pH dependent[12]. pH of the surface water of Pariej and Kanewal wetland ranged from 8.05 to 9.07 and 6.90 to 9.70 respectively. The waters of both the wetlands were found to be alkaline though the range of its variation was larger for Kanewal (i.e., 6.90 and 9.70) than that for Pariej (i.e., 8.05 to 9.07). The values of pH of both the wetlands had remained greater than 7 irrespective of seasons, which indicated that the waters of these wetlands were well-buffered. The upper limit value of pH of Kanewal wetland (i.e., 9.70) was found to be higher than that of the Pariej wetland (i.e. 9.07). This might be due to the greater abundance of submerged hydrophytic vegetation and rooted hydrophytes with floating leaves (e.g., *Nymphaea* and *Nelumbo*) (and probably, algae too) in Kanewal leading to greater photosynthetic activity during day-time (when sample was taken) resulting in greater utilization of free $CO_2$ in water and in turn higher value of pH. The lower limit of the pH of the (i.e., 6.9) was recorded at Kanewal during winter at the inlet of Kanewal wetland. This might be due to less abundance of submerged hydrophytes and *Nymphaea/Nelumbo* leading to low photosynthetic activity and ultimately resulting into the pH value as low as 6.9[13-15].

According to CPCB water quality standards the pH level should be between 6.5 to 8.5 for the propagation of wildlife and fisheries. All the sites for both Pariej and Kanewal wetlands fall under CPCB standards.

**Water Temperature:** Water temperature plays a significant role for regulating the physico-chemical and biological characteristics of water. It is considered as one among the most essential factors in the aquatic environment particularly for freshwater[16]. In Pariej wetland the temperature ranged from 16.50ºC to 36.40ºC, whereas in Kanewal wetland it varied from 23.40ºC to 33.00ºC. Between the two wetlands, the highest water temperature was recorded in monsoon (i.e., 36.40°C) in Pariej wetland in *Nelumbo* covered area, which might be due to trapping of heat by large *Nelumbo* leaves and obstruction to dilution of wetland water in this micro-habitat by relatively cooler rain-waters. The lowest value of water temperature was recorded during winter season was 16.50°C at Pariej wetland in inlet portion which might be due to cold low ambient temperature and shorter photoperiod[17,18].

**Turbidity:** Turbidity of water can be associated with the water clarity as to the light scattered by the particles present in the water body which decreases the passage of light through the water[11]. In Pariej wetland the turbidity ranged from 0.95 NTU to 137.40 NTU whereas in Kanewal wetland it varied from 0 NTU to 135 NTU (Figure-4). The high turbidity value (137.40 NTU) was recorded in Pariej wetland in the inundated portion of the wetland with decomposing mat of submerged aquatic vegetation which might be due to release of decomposed vegetation particles in that portion. High value of turbidity [as high as that for decomposing mat portion (137.4 NTU)] was also observed in the inlet of Pariej wetland, which might be due to some allochthonous material[19]. Low turbidity (0 NTU) was recorded in an open water area of Kanewal wetland during winter which might be due to trapping of turbidity particles by luxuriant underwater hydrophytic vegetation in the open water area of this wetland. In fact, this is a well-known ecosystem function of the hydrophytic vegetation growing in wetlands.

**Electrical Conductivity (EC):** Water capability to transmit electric current is known as electrical conductivity and serve as a tool to assess the purity of water[20]. In Pariej wetland, the Electrical Conductivity(EC) varied from 24.47mS to 373.8 mS (excluding inlet) and in Kanewal wetland it varied from 0.98 mS to 371.30 mS. It was interesting to note that the highest EC for both the wetlands was recorded in winter and that too in the Emergent vegetation cover portion of the wetlands. This might be due to greater amount/concentration of debris entangled/ trapped in the emergent vegetation area. Though highest EC between both the wetlands was recorded in the inlet of Pariej wetland (i.e., 378.10 mS), which might be due to allochthonous particles brought to this wetland. The lowest EC (i.e. 0.98 mS) was recorded in Kanewal wetland during monsoon, which might be due to flushing out of dissolved solids due to monsoon water influx into the wetland (Figure-5). It may be noted that Kanewal has many multiple outlets apart from a major outlet that was sampled during the study and that might have helped in efficiently flushing out the stored waters (with dissolved solids).

**Total Dissolved Solids (TDS):** In Pariej and Kanewal wetlands, the Total Dissolved Solids (TDS) was recorded from 21.23 to 252 mg/l and 3.21 to 254.30 mg/l respectively. The highest value was recorded during the monsoon season (254.30 mg/l) at Kanewal wetland and the lowest TDS was also recorded (3.21 mg/l) during summer season at Kanewal wetland (Figure-6)

**Dissolved Oxygen (DO):** In Pariej wetland the Dissolved Oxygen (DO) was recorded from 3.00 to 9.60 mg/l and in Kanewal it ranged from 0.66 to 15.27 mg/l. The highest value of DO was noted during the monsoon (15.27 mg/l) which may be due to high photosynthetic activity during the rainy season however the lowest value of DO was noted as 0.66 mg/l at Kanewal wetland (Figure-7) during the summer season which can be due to the addition of sewage and other wastes besides the high temperature that drastically decreased DO in the wetland.

As per CPCB water quality standards for propagation of wildlife and fisheries the DO level of 4 mg/l or above is safe for aquatic life as well as drinking. Sites with vegetation cover of *Nelumbo/ Nymphaea* and *Typha* and decomposing vegetation mat in Kanewal wetland revealed low content of dissolved oxygen which do not fall under CPCB standards.

**Acidity:** In Pariej and Kanewal wetlands the Acidity ranged from 20 to 110 mg/l as $CaCO_3$ and 20 to 140 mg/l as $CaCO_3$ respectively. The highest value of acidity was reported during monsoon 140 mg/l as $CaCO_3$ at Kanewal wetland and the lowest value of acidity was also reported at Kanewal wetland during summer season as (20 mg/l as $CaCO_3$) (Figure-8).

**Alkalinity:** Alkalinity of water is due to the presence of certain ions: carbonates, bicarbonates, and hydroxides in water. The highest value of alkalinity was reported during monsoon (330 mg/l as $CaCO_3$) at Pariej wetland which may be due to the addition of household detergent products in the wetland only in monsoon season due to flooding of channels after their saturations in summer. The lowest alkalinity was reported during summer season (130 mg/l as $CaCO_3$) at this wetland (Figure-9).

**Chlorides:** The highest amount (12.50 ppt) of chloride was recorded at Pariej wetland during winter season and minimum value (0.02 ppt) of chlorides was also recorded at Pariej wetland during summer season. High chloride quantity in freshwater is an important indicator suggesting organic pollution[21].

**Salinity:** Salinity is an important factor in determining many aspects of the chemistry of natural waters and of biological processes within it. In the present investigation, the maximum salinity (22.57 ppt) was observed in winter season at Pariej wetland and minimum salinity (0.05 ppt) was also observed in Pariej wetland during summer season. High salinity enhances the nutrient status of a wetland that results into their eutrophication[16]. A minor change in salinity will reflect on other physical, chemical and biological parameters[22,23]. Throughout the study the salinity was low at both the wetlands during summer and maximum during winter (Figure-11).

**Total Hardness:** Total Hardness of water is mainly due to the presence of calcium and magnesium ions, and is an important indicator of the toxic effect of poisonous elements[24]. Highest value of total hardness was recorded during monsoon as (650 mg/l) at Pariej wetland probably due to regular addition of large quantities of sewage and detergent into lake from the nearby residential areas[25]. Low values (100 mg/l) of total hardness was recorded during summer season at Pariej wetland (Figure-12).

**Calcium Hardness:** High concentration of calcium content in water was recorded at Kanewal wetland (210 mg/l) during monsoon season. Calcium concentration might have increased due to the addition of sewage.

The lowest calcium concentration (21 mg/l) in Pariej wetland (Figure-13) was noted during summer season which may be due to large number or aquatic organisms absorbing calcium.

**Magnesium Hardness:** Magnesium is essential for photosynthesis of chlorophyll bearing plants and therefore it can act as a limiting factor for the growth of phytoplankton. The highest value for magnesium hardness (545 mg/l) was recorded during the monsoon season at Pariej wetland. The lowest concentration of magnesium was 45 mg/l (Figure-14) that was recorded during the winter season at Kanewal wetland.

**Nitrates:** Nitrates are oxidation products of organic nitrogen by bacteria present in soil and water where sufficient oxygen is present[26]. High level of nitrates was observed after onset of rains, which might be due to rain-water run-off that are known to bring fertilizer residues into wetlands from surrounding agricultural lands. Higher concentrations of nitrates represent higher pollution load[27] and higher chances of eutrophication. High concentration of nitrates (44 mg/l) observed during monsoon season at Pariej wetland might be due to the heavy rainfall, land drainage and input of fertilizers from the adjacent agricultural fields and oxidation of ammonia[28,29]. In the present study, nitrates concentration was comparatively high at inlet which may be due to the direct discharge of sewage into the wetland. Most of the nitrate might have been derived from the decomposition of organic wastes[30].

**Nitrites**: Nitrites are unstable and their presence indicates fresh input of organic load into a water system[31]. The concentration of nitrites was high (0.49 mg/l) during summer season in Kanewal wetland and low (0.0 mg/l) during winter and summer in Pariej wetland at most of the sites (Figure-16). Low values of nitrites at both the wetlands were observed during summer as well as winter seasons. It might be due to the decreased amount of freshwater influx and increased utilization by plankton in the waters during these seasons as compared to that in monsoon season[32-34].

**Phosphates:** Phosphates are considered to be one of the major nutrients responsible for eutrophication of wetlands, as it is the primary initiating factor. High concentration of this nutrient in fresh water indicates pollution through sewage and industrial wastes[35]. Large quantities of phosphate indicate higher extent of pollution[36]. Higher concentration of phosphate was recorded in Kanewal wetland (6 mg/l) than Pariej wetland (4 mg/l). Thus, productivity of Kanewal might be higher than that of Pariej and more luxuriant under water vegetation and other hydrophytic vegetation at Kanewal wetland can be considered to be the indicator of the higher productivity of this wetland. Higher concentration of phosphate in the inlet of Kanewal during summer can be associated with the influx of domestic sewage and/or residues of agricultural fertilizers from the nearby villages/agricultural lands[37,38]. Low concentration of phosphate (0 mg/l) during winter season at Pariej wetland which might be due to less influx of fresh water, biological utilization and removal by absorption on to sediment and suspended particles[39-43] (Figure-17).

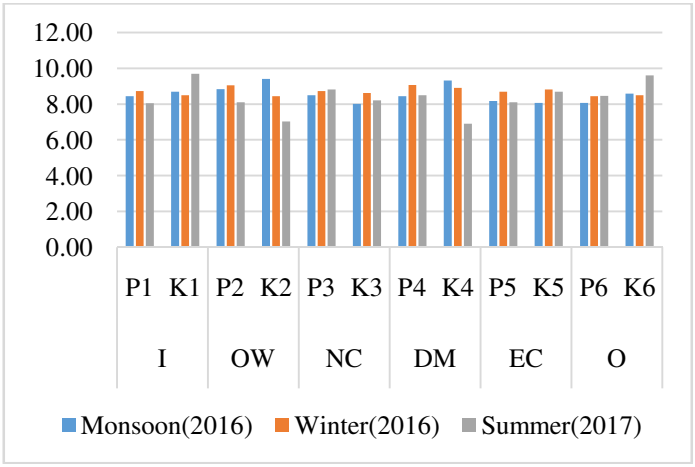


**Figure-2:** Seasonal variation in pH for Pariej and Kanewal wetlands 2016-17.

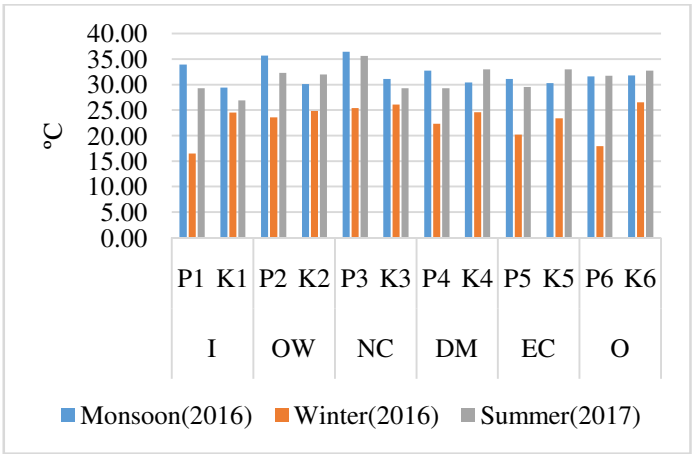


**Figure-3:** Seasonal variation in Temperature for Pariej and Kanewal wetlands 2016-17.

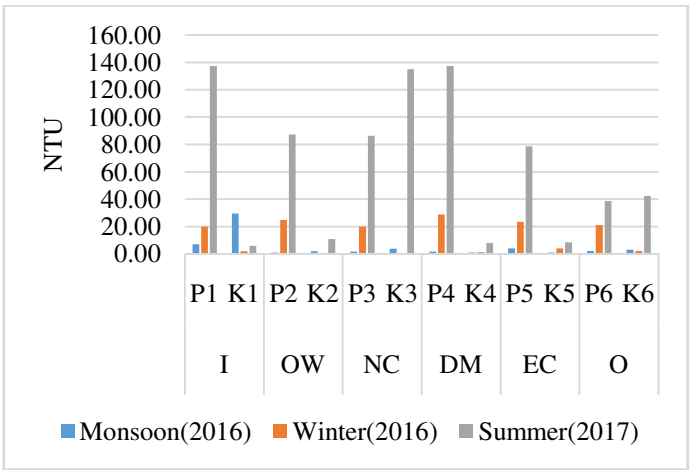


**Figure-4:** Seasonal variation of Turbidity for Pariej and Kanewal wetlands 2016-17.

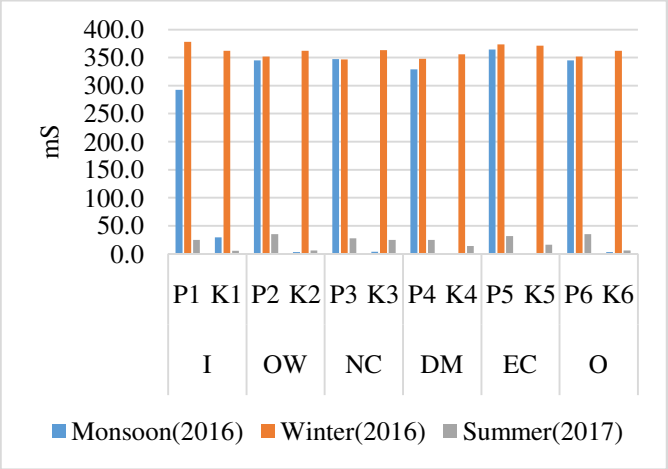


**Figure-5:** Seasonal variation of Electrical Conductivity for Pariej and Kanewal wetlands 2016-17.

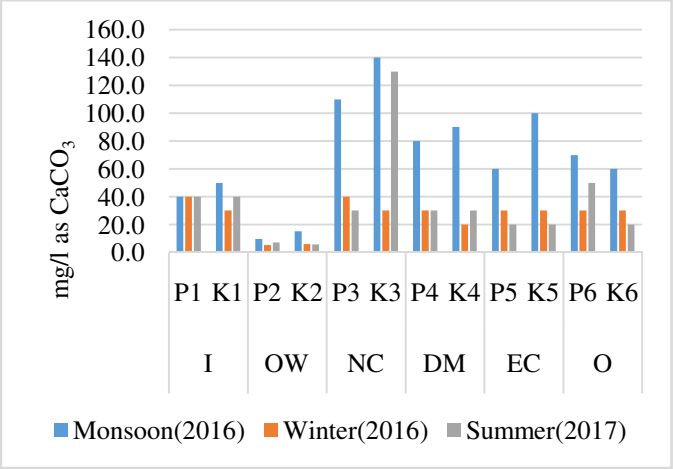


**Figure-8:** Seasonal variation of Acidity for Pariej and Kanewal wetlands 2016-17.

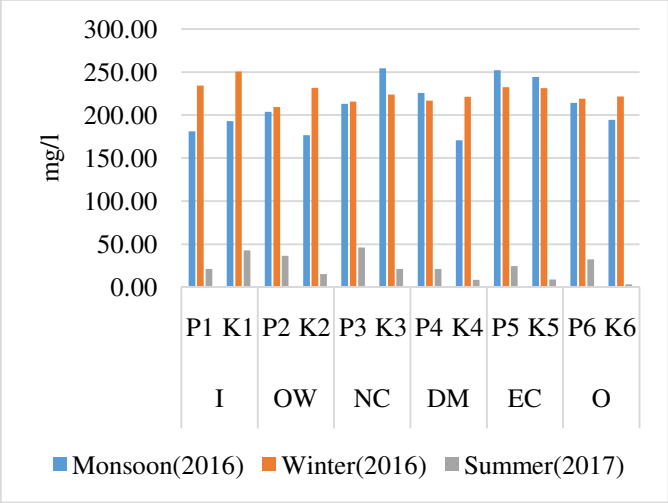


**Figure-6:** Seasonal variation of Total Dissolved Solids for Pariej and Kanewal wetlands 2016-17.

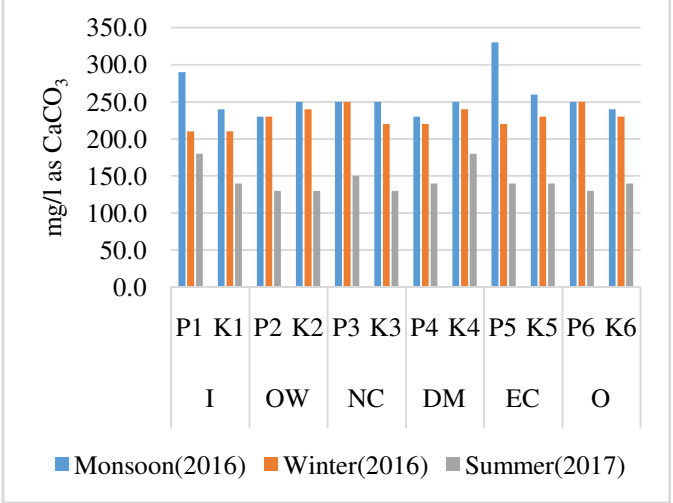


**Figure-9:** Seasonal variation of Alkalinity for Pariej and Kanewal wetlands 2016-17.

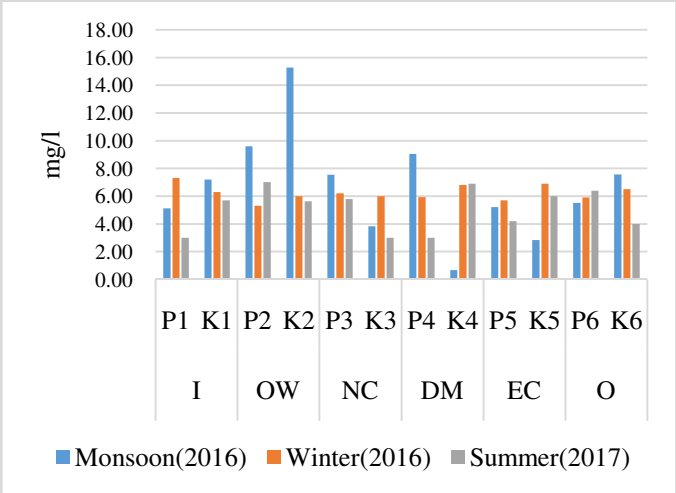


**Figure-7:** Seasonal variation of Dissolved Oxygen for Pariej and Kanewal wetlands 2016-17.

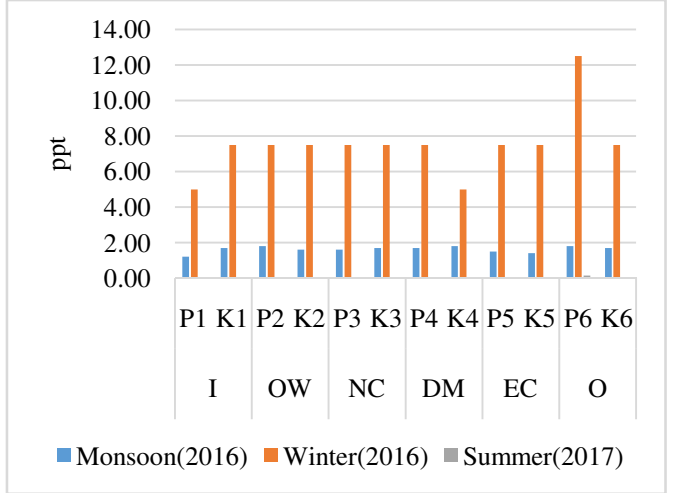


**Figure-10:** Seasonal variation of Chlorides for Pariej and Kanewal wetlands 2016-17.

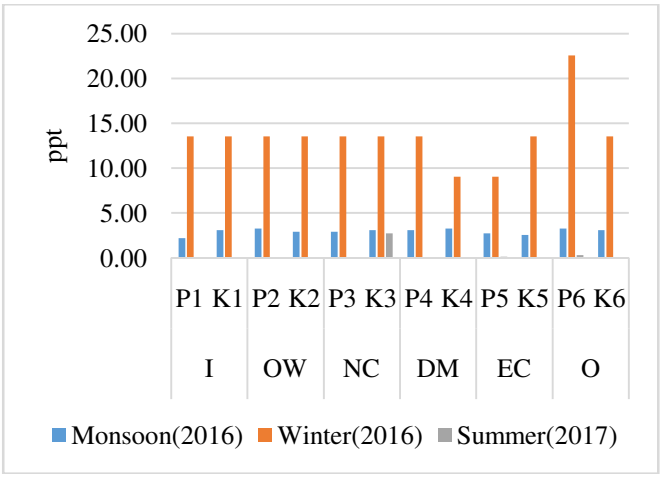


**Figure-11:** Seasonal variation of Salinity for Pariej and Kanewal wetlands 2016-17.

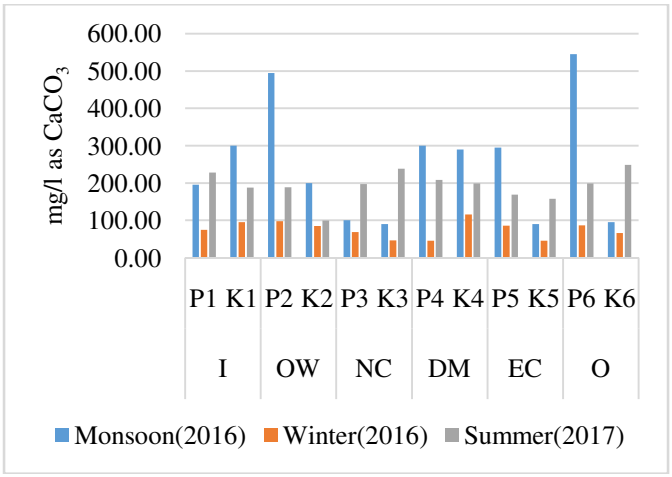


**Figure-14:** Seasonal variation of Magnesium Hardness for Pariej and Kanewal wetlands 2016-17.

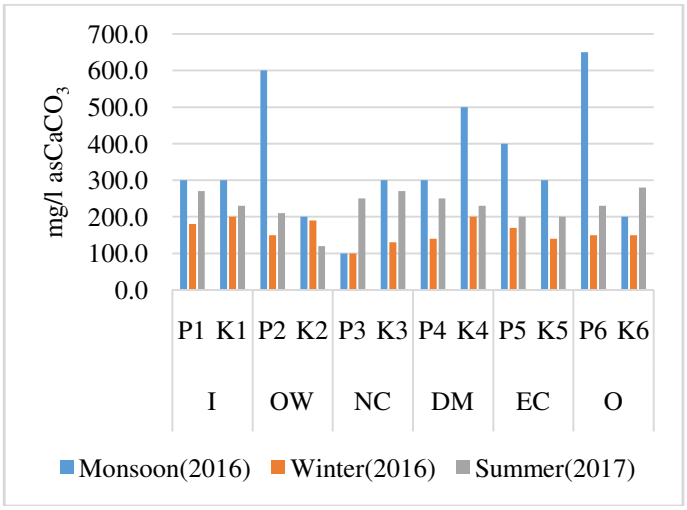


**Figure-12:** Seasonal variation of Total Hardness for Pariej and Kanewal wetlands 2016-17.

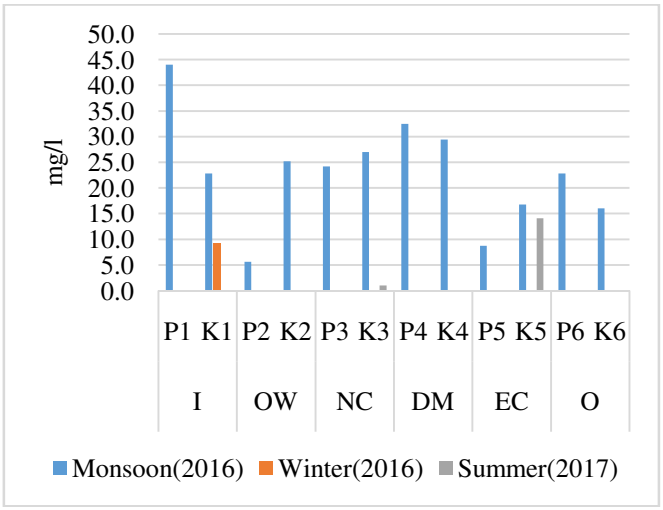


**Figure-15:** Seasonal variation of Nitrates for Pariej and Kanewal wetlands 2016-17.

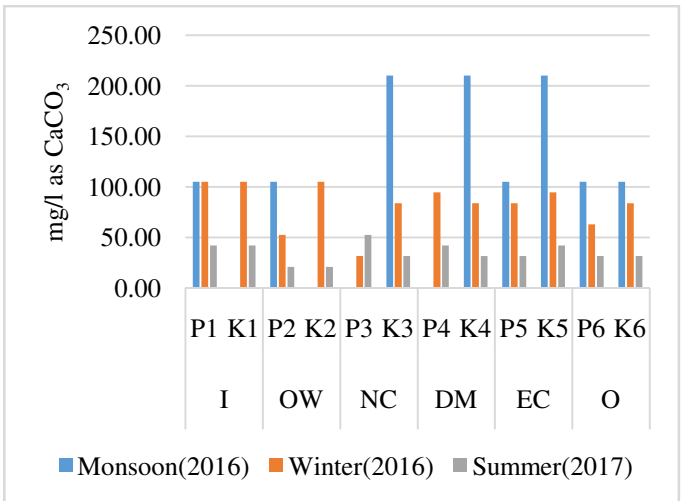


**Figure-13:** Seasonal variation of Calcium Hardness for Pariej and Kanewal wetlands 2016-17.

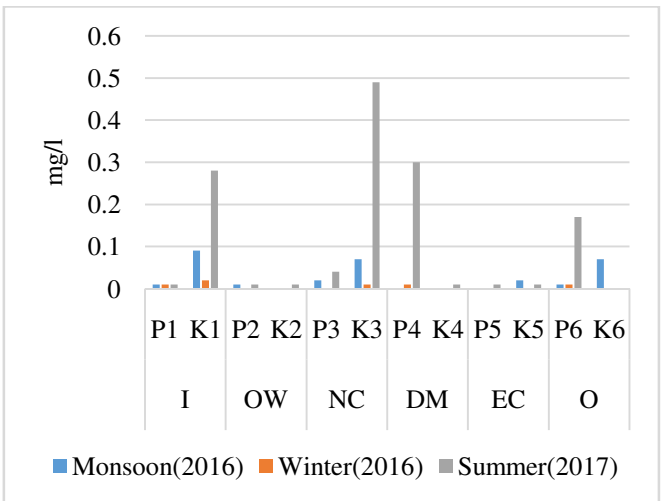


**Figure-16:** Seasonal variation of Nitrites for Pariej and Kanewal wetlands 2016-17.

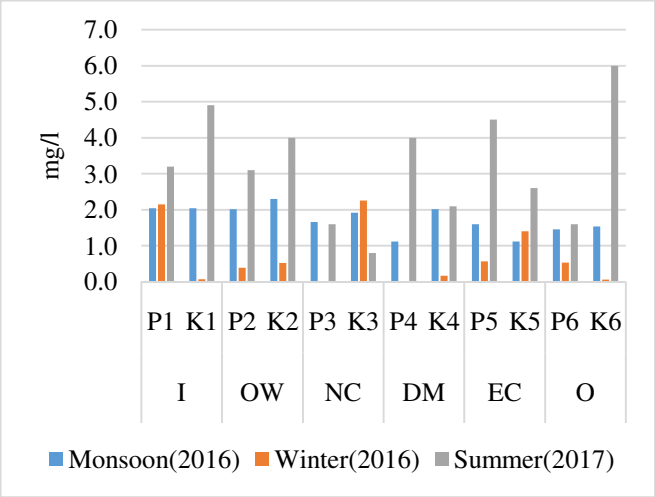


**Figure-17:** Seasonal variation of Phosphates for Pariej and Kanewal wetlands 2016-17.

Water Samples from Pariej wetland were denoted as P1, P2, P3, P4, P5 and P6 and for Kanewal wetland as K1, K2, K3, K4, K5 and K6. Habitats covered included-(a) Inlet (I), (b) Open Water (OW), (c) Water cover with *Nymphaea/Nelumbo* cover (NC), (d) Water with decomposing vegetation mat (DM), (e) Emergent hydrophytic cover (EC) and (f) Outlet (O).

## Conclusion

Based on the comparative study of the physico-chemical characteristics of the two wetlands *viz.* Pariej and Kanewal reveals that as the season changes there is a fluctuation in the physico-chemical characteristics of the water of both the wetlands. Based on the results it can be concluded that Pariej wetland is moderately eutrophic than Kanewal wetland. The water of Pariej wetland shows higher values of turbidity, electrical conductivity, total hardness, nitrate, etc. High concentration of nitrate indicates that the wetland is moderately eutrophicated.

In addition, it was also noted that the water quality of both the wetlands was getting deteriorated due to various human activities occurring in their vicinity. This study may be helpful for proper management and optimum utilization of both the wetlands.

## Acknowledgements

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