



## Abundance of Birds and Variations in Physico-Chemical Characteristics of Freshwater Reservoir

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### ABSTRACT

The study illustrates physical and chemical characteristics of water in Chashma Barrage reservoir. Water sampled from 3 different locations in the reservoir during April, June and July 2015 was tested in situ and brought in laboratory for ionic estimation. The study findings showed that the reservoir water has warm water Temperature between 21 – 38°C, low to high pH i.e., 4.9 – 10, Dissolved Oxygen between 4.4 - 10.54 ppm, Total Dissolved Solids between 18 - 405 ppm, Electrical Conductivity between 21 – 396 µS, Turbidity ranging from 0 – 1000 FTU with varying Carbon dioxide concentrations in range of 1.76 – 35.8 ppm, Specific Conductance between 0 – 2.82 ms/cm, Nitrates between 0.001 – 3.32 ppm, Nitrites between 0.001 – 5.219 ppm and Phosphates between 0.001 – 11.99 ppm. The highest concentrations of nitrates and phosphates in stagnant water of sites 3 and 1 depict productive water chemistry. Sample collection, identification and laboratory population count of the aquatic flora and fauna revealed their increased production in wetland ecosystem.

### 1. INTRODUCTION

This study gives the monthly variations in physico-chemical characteristics of water at 3 sites in the left marginal reservoir of Chashma Barrage. The study period included the months of April, June and July 2015. It relates riparian flora with variations in water quality at the 3 sites. The study also relates the role of birds found in the reservoir in increasing the fertility of water for the growth of flora at the bottom of the stagnant water. The water level of the reservoir in various times fluctuates due to closure and opening of the Chashma Barrage gates. However these fluctuations are not regular. This depends on the flow of river Indus from upstream. The parameters which are discussed in this study include pH, Temperature, Specific conductivity and Dissolved Oxygen (DO) which were tested by Hydrolab. The parameters of Total Dissolved Solids (TDS), Electrical Conductivity (EC), Carbon dioxide, Nitrates, Nitrites, Phosphates, and Turbidity were analyzed in Kinnaird College Environmental laboratory. For the study,

term “Bella” has been used which is eroded path of the river, prior to the times of water harvesting by way of canal head works and dams. Vegetation grown here is called “Bella”. It grows on dry land of old river bed. It is usually very thick because of the fertility of the soil. The freshwater reservoir lies upstream of Chashma Barrage on Mianwali – Kundian - Dera Ismail Khan Road, 25 km Southwest of Mianwali, within the province of Punjab. The Chashma Barrage lies 57 km downstream of Jinnah Barrage. The barrage is used for flood control, irrigation and power production. Its reservoir lies at 32°26'12.50"N Latitude and 71°27'51.20"E Longitude [1,2]. The reservoir normally has water level up to 642 ft with an area of 139 m<sup>2</sup> [3]. The study reviews the water quality of Chashma reservoir in perspective of the aquatic resources surviving within its ecosystem. It undertakes monthly variations in its physico-chemical characteristics during a three months study performed in 2015. Field visits at the reservoir reveal moderately warm weather conditions in April, but hot atmospheric temperature in June and July reaching 38°C and 34°C respectively. Water temperature in reservoir is maximum in June, followed by July and April. In July due to turmoil in the reservoir from flood water, its temperature is

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reduced, while Dissolved Oxygen is increased. Consequently Dissolved Oxygen in reservoir water is lesser in June than April and July. Water pH is higher in April and June representing optimum water productivity. There are some studies exclusively on the flora, fauna and habitats of Chashma Barrage [4,5,6]. A study determining water quality of Chashma wetlands during February and June 2008 using hydrolab assessed the parameters of Temperature, pH, Specific Conductivity, Total Dissolved Solids and Light Dissolved Oxygen (LDO). Sampling sizes were not mentioned. The study found that water Temperature was higher in summer i.e., twice than winter season, with higher pH in both seasons (9.71-9.82 in winter; 8.88-9.21 in summer). TDS and salinity were higher in winter than in summer due to more water flow and dilution in summer. However, LDO was low in summer due to high water temperature, which is also the findings of this research [4].

## 2. METHODOLOGY

The Ramsar site of Chashma Wildlife Sanctuary, Mianwali was visited from 3 different locations as shown in the (Fig 1). These include Site 1 at Haidar colony on the western side of Chashma road going towards Kundian; and Site 2 at Bella, habitat of running water of the river Indus. Both sites were visited in April, June and July. The Site 3 at the Southern end of this reservoir nearby Pakistan Air force rest house, on western side of Chashma road was visited only in June and July to collect benthic and surface water samples individually. Sites 1 and 3 are stagnant water but Site 2 is running water due to River Indus flow. Sampling was done at multiple points in all the three sites in ascending order of water depth measured by a measuring tape bound to a 20 feet long stick such that P1-P9 correspond to Site 1, P10-P12 correspond to Site 2 and P13-P14 correspond to Site 3 (Fig 2,3). Water quality parameters of Temperature, pH, Specific conductivity and DO at each water depth were tested in situ by Hydrolab while travelling through boat. Water samples collected from each point were enclosed in plastic boxes and stored in refrigerator to preserve the dissolved gases and ions at cool temperature. Later on these were tested in laboratory through standard procedures [7,8] against the following parameters:

- Nitrate estimation by 4500NO<sub>3</sub><sup>-</sup> B: *Ultraviolet Spectrophotometric Screening Method*
- Nitrite estimation by 4500NO<sub>2</sub><sup>-</sup> B: *Colorimetric Method*
- Phosphate estimation by 4500-P C: *Vanadomolybdophosphoric Acid Colorimetric Method*

- Dissolved Carbon dioxide gas estimation by 4500-CO<sub>2</sub> C: *Titrimetric Method for Free Carbon*
- TDS and EC estimation by TDS meter
- Turbidity by Turbidity meter

The data was analyzed in excel graphs to check monthly trend and comparative variations at all the three sites. Highest observed values of these parameters at each site are discussed in Results.

## 3. RESULTS

Water Temperature in Chashma reservoir is warm with values of 24.92°C; 38°C and 32.56°C in April, June and July respectively at site 1 (Fig 2). At site 2 the recorded values are lower i.e., 22°C, 30.16°C and 28.13°C in April, June and July respectively, whereas at site 3 it is higher i.e., 33°C and 28.9°C in June and July respectively. pH is alkaline with highest values at site 1 i.e., 9.34, 10 and 9.0 during April, June and July but at site 2 it is lower i.e., 8.28, 8.8 and 8.72 in April, June and July respectively. The pH at site 3 is slightly alkaline i.e., 8.11 and 8.1 in June and July respectively. Dissolved Oxygen has peak values of 10.54 ppm, 6.84 ppm and 7.88 ppm at site 1 but slightly reduced values of 6.95 ppm, 6.12 ppm and 7.66 ppm at site 2 in April, June and July respectively. At site 3 it is higher i.e., 7.75 ppm and 7.4 ppm in June and July respectively. TDS recorded values are high i.e. 183 ppm, 167 ppm and 185 ppm at site 1 as compared to the site 2 where these are considerably lower i.e., 36.8 ppm, 26 ppm and 109 ppm in April, June and July respectively. The TDS levels at site 3 are highest i.e., 405 ppm and 132 ppm during June and July. EC recorded values are high including 290 µS, 387 µS and 328 µS at site 1, whereas at site 2 these are reduced with 45.6 µS, 54.6 µS and 36 µS in April, June and July respectively. At site 3 these are highest i.e., 396 µS and 287 µS in June and July respectively. Specific Conductance, the indicator of dissolved ions, lies up to 2.82 milli-Siemens/cm (ms/cm), 0.288 ms/cm and 0.305 ms/cm during April, June and July at site 1. The levels are lesser at site 2 i.e., 0.427 ms/cm, 0.28 ms/cm and 0.017 ms/cm during April, June and July respectively. At site 3 it is higher with 0.828 ms/cm and 0.285 ms/cm during June and July respectively. Turbidity recorded values are 298 Formazin Turbidity Unit (FTU), 1000 FTU and 1000 FTU in April, June and July respectively at site 1. It is lower at site 2 i.e., 67.9 FTU, 321 FTU and 608 FTU in April, June and July respectively. Its values are higher at site 3 with 870 FTU and 786 FTU in June and July respectively. The Nitrate level at site 1 has maximum values of 0.8 ppm, 2.98 ppm and 3.32 ppm

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during April, June and July respectively. At site 2 it is drastically reduced with 0.002 ppm, 0.005 ppm and 0.25 ppm concentrations during April, June and July respectively. It is higher at site 3 with 2.13 ppm and 2.95 ppm in June and July respectively. The Nitrite level at site 1 is high with values of 0.9 ppm, 2.99 ppm and 4.85 ppm as compared to the site 2 where it is only 0.0014 ppm, 0.59 ppm and 0.19 ppm during April, June and July respectively. The level at site 3 is highest i.e., 4.3 ppm and 5.219 ppm in June and July respectively (Fig 3). The Phosphate level at site 1 is abundantly high with values of 2.95 ppm, 7.79 ppm and 8.3 ppm. It is reduced at site 2 with 0.012

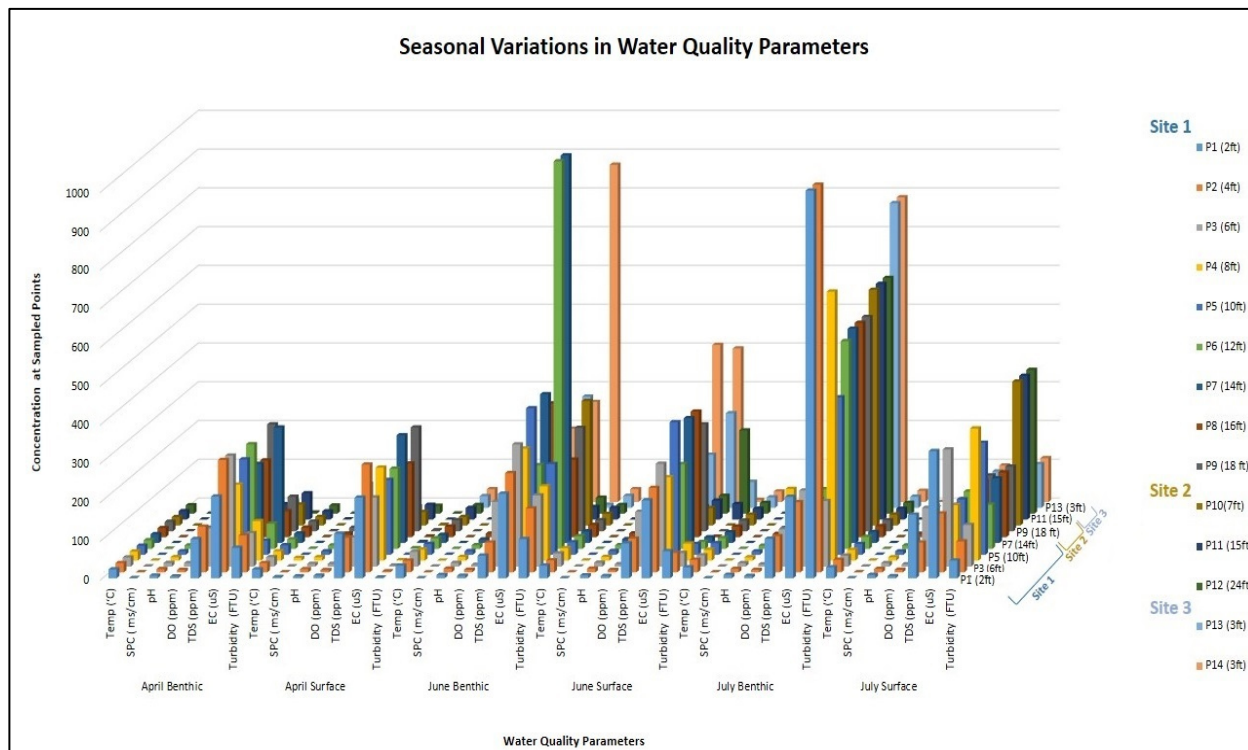
ppm, 1 ppm and 0.41 ppm during April, June and July respectively. At site 3 it is highest with 6.678 ppm and 11.99 ppm during June and July respectively. The maximum observed concentration of dissolved Carbon dioxide in water is 35.8 ppm, 26.4 ppm and 35.2 ppm during April, June and July respectively at site 1 showing increased biogas production. At site 2 it is only 3.3 ppm, 3.4 ppm and 2.3 ppm during these months symbolizing very low biogas production. The Carbon dioxide level at site 3 is 17.6 ppm throughout the study.

**Table 1.** Range of Variation and Mean of Water Quality Parameters in Chashma Reservoir during Study Period 2015

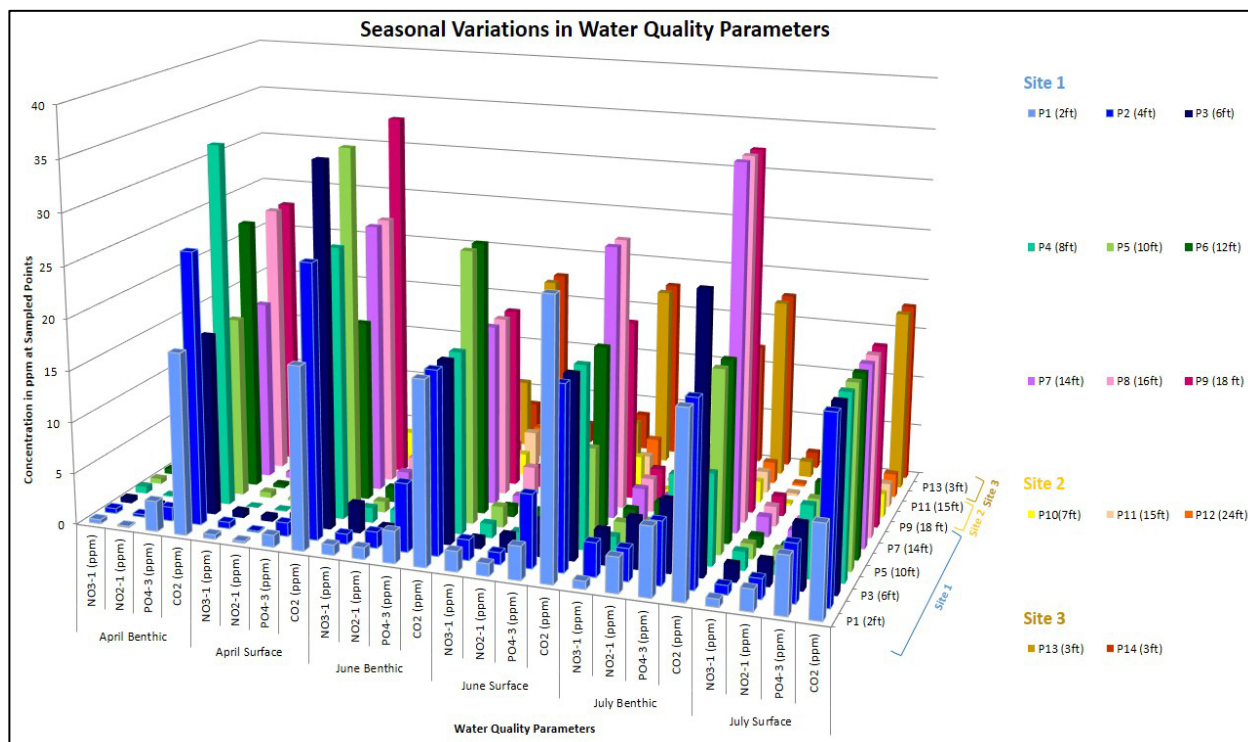
Parameters	Range of Variation		Mean
	Minimum	Maximum	
Temperature	21	38	27.33
SPC	0	2.82	0.29
pH	4.9	10	8.53
Dissolved Oxygen	4.4	10.54	6.34
Nitrates	0.001	3.32	1.18
Nitrites	0.001	5.22	1.48
Phosphates	0.001	11.99	4.01
Carbon dioxide	1.76	35.8	17.28
TDS	18	405	98.09
EC	20.6	396	208.79
Turbidity	0	1000	208.7



**Fig 1.** Location of Study Sites; Source: (Google Earth Imagery)



**Fig 2.** Concentrations of Physico-chemical parameters in Chashma Reservoir Water



**Fig3.** Results of Nitrate, Nitrites, Phosphate and Carbon dioxide Concentrations in Chashma Reservoir Water

#### 4. DISCUSSION

Water Temperature in Chashma reservoir is maximum in June followed by July and April. It is higher at site 1 due to warm ambient air, reduced riparian flora, and high water turbidity which absorbs and scatters sunlight in water [9]. But it is lower at site 2 (Fig 2) due to direct water recharge from River Indus as observed during field data collection. It is moderately warm at site 3 due to floating algal bloom which cools bottom water despite extremely warm weather. The mean value of pH is alkaline within Chashma wetlands (Table 1) endorsing [4] findings. Its maximum values during June compared to other months in contrast to dissolved Carbon dioxide which is minimum in June indicate high photosynthetic productivity, as also apparent from rich aquatic floral growth and algal bloom in this month. The highest pH levels at site 1 indicate ongoing decomposition and methanogenesis processes which make the water ecologically productive, as evident from biogas production and the presence of TDS, nitrates, nitrites and phosphate concentrations. It is neutral or slightly alkaline at site 2 ratifying very low microbial activity. The pH at site 3 is mildly alkaline verifying production of ions from organic nutrients. Research findings reveal that pH shows alkaline behavior with increase in temperature as evident at sites 1 and 3 ratifying organic decomposition at higher temperatures. Dissolved Oxygen is highest in April followed by July and June due to lowest Temperature in April. It is highest at site 1 due to enriched aquatic flora, but slightly reduced at site 2 despite cold water due to negligible aquatic flora. It is higher at site 3 than Site 1 due to lower water temperature and the surface enriched floating algae which provides shade and oxygen through photosynthesis. DO shows opposite behavior with temperature, as evident at site 3, due to more dissolution of air in water at low temperatures. However at site 1, it is high despite warm temperatures due to rich flora and the production of photosynthetic oxygen. TDS shows highest values at site 3 with maximum trend in June showing enhanced fermentation of organic waste. The sites 3 and 1 being stagnant water have maximum nutrients generated from the organic debris due to droppings of roosting birds as evident from concentrations of Nitrate, Nitrite and Phosphate. Consequently the freshwater ecological species are abundant at Sites 3 and 1 but reduced at Site 2 in Chashma wetlands [11]. EC shows highest trend in June. It is high at site 1, but considerably low at site 2 due to negligible fermentation in its running water. At site 3 its high presence verifies higher concentrations of TDS representing a linear relationship as demonstrated by earlier study findings

[6]. High EC at sites 1 and 3 affirms organic matter degradation and primary production as evident from the rich floral growth. Specific Conductance is highest in April. Its high values at site 1 depict higher ionic presence from wintering birds' dropping in water (Fig 2). The levels are negligible at site 2 whereas at site 3 its levels are high. Like TDS, the site 2 has lowest SPC values in comparison to sites 1 and 3. Turbidity highest trend in June and July depict high organic decomposition products as evident from nitrates, nitrites and phosphates. It is low at site 2 as compared to site 1 due to running water and negligible ecological resources at site 2. Sites 1 and 3 show high Turbidity because of suspended soil, planktonic communities in the floating flora, organic waste and its decomposition products. Its higher values in benthic turbid water than surface water in Chashma reservoir (Fig 2) verifies higher microbial activity and ultimately nutrients availability [9]. Nitrate, Nitrite and Phosphate are highest in July showing their less uptake by aquatic flora in the disturbed ecology after turmoil as evident from reduced algal bloom. The high Nitrate level at site 1 (Fig 3) depicts its presence richly enhanced in water due to organic deposits which is beneficial for invertebrate fauna production e.g. fish as reported by earlier research findings [10]. It is negligible at site 2 thus no significant aquatic flora or fauna were observed at this site [11]. It is considerably high at site 3 indicating microbial activity. The Nitrite level follows similar pattern i.e., high at site 1 but low at the site 2. It is highest at site 3. The Phosphate level at site 1 shows higher values which is considerably enhanced amount beneficial for floral productivity and fish growth. It is negligible at site 2 whereas its level is highest at site 3. The difference is due to the higher amount of organic debris generated from birds' droppings at sites 3 and 1 as compared to site 2 and ultimately its fermentation which leads to production of ions, growth of algae, phytoplankton and macro invertebrates coinciding with [12] findings [13]. The dissolved Carbon dioxide in water is highest in April at site 1 due to less grown flora. It is reduced at site 2 indicating negligible microbial activity. The Carbon dioxide level at site 3 is higher during June and July which neutralizes alkaline pH of water resulting from fermentation. Its presence is indicative of biogas production from decomposing organic matter in Chashma reservoir with bubbles and milky water observed during data collection. Overall water quality parameters show high range of variation within Chashma wetlands as evident from Table 1 with their mean values indicating high water productivity for inhabiting aquatic resources. Water fluctuations play important role in retaining water productivity of Chashma wetlands. Abiotic factors



impact the chemistry of water e.g. the flood and turmoil in Chashma wetland during July. Such occasional flows of flood water sweep away the old stagnant water and disturb the ecology, which creates variation in the density of the wetland biodiversity.

## 5. CONCLUSION

The study shows maximum trend of physico-chemical parameters in particular nitrates, nitrites, phosphates, carbon dioxide and TDS during July and June, while moderate trend in April which verifies enhanced organic waste fermentation during summer period. Depending on location these are highest at site 3, moderate at site 1 and lowest at site 2. The stagnant water of sites 3 and 1 have abundant nutrients in forms of Nitrate, Nitrite and Phosphate ions generated from the fermentation of organic debris due to dropping of roosting birds. The running water of site 2 has comparatively negligible nutrients. Higher UV absorption for nitrate, nitrite and phosphate ions in benthic turbid water than surface clear water of Chashma reservoir is due to fermentation of organic debris in the reservoir bottom producing decomposition products.

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## 7. CONFLICTS OF INTERESTS

The authors declare that there are no conflicts of interests regarding the publication of this article.

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