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Study on effect of seasonal variations on water quality of Shallabugh wetland

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Abstract
The present study was aimed to determine the seasonal physical and chemical nature of water at three different sites of Shallabugh wetland, Kashmir Himalaya. Different parameters viz. water temperature, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD) and total dissolved solids (TDS) were assessed during the study period from February 2018 to November 2018. The data reveals that water temperature ranged from 5.98 to 25.88 ^{0}C, COD (40.62 to 74.77 mg/L), BOD (16.06 to 38.28 mg/L) with higher value in summer and lower in winter. On the other hand value of DO (2.41 to 11.56 mg/L) and TDS (155.0 to 324.5 mg/L) where recorded maximum in winter compared to summer. The trend of temperature, BOD, COD and TDS at different sites in all the four seasons were observed in the following descending order: Site-II>Site-III>Site-I whereas DO showed reverse trend. Site-II has been observed to be more affected by the pollution sources, experiencing high pollution load compared to Site-I and Site-III due to due to anthropogenic activities such as domestic waste water and other waste material entering into the wetland through an inlet channel near site-II. The correlation among water parameters showed both significant positive and negative trends.

Keywords: Water, shallabugh, wetland, anthropogenic activities, wastewater, correlation

Introduction
Wetlands are under severe anthropogenic pressures (Mıshra and Naraın, 2010 and Euliss *et al*., 2014) [20, 12] and around 50% of the earth's wetlands have been disappeared through conversion into industrial, agricultural and residential areas (National wetland atlas of Assam, 2010) [21]. The wetlands are increasingly receiving due attention as they contribute to the healthy environment. They provide habitat for waterfowl (Dar and Dar, 2009) [11], help in nutrient recycling, recharging groundwater by releasing water slowly, purification of water by reducing nutrients from inflow water (O'Geen *et al*., 2010; Pramod *et al*., 2011 and Sarkar and Upadhyay, 2013) [22, 23, 27] and flood control by slowing and retaining water during periods of high runoff (Minga *et al*., 2007) [19]. The most important step for conservation of wetlands is to maintain a proper water quality (Smitha and Shivashankar, 2013) [30] as it reflects the health of any water body.

Shallabugh is a shallow wetland located in Sherpathri area (1580 meters amsl, 34°10' N Latitude and 74°42' E Longitude) of Ganderbal district at a distance of about 20 km in the northwest of Srinagar city and covers an area of about 17 km^2. The wetland receives water from Anchar Lake and Sindh nallah (Siraj *et al*., 2010) [29]. The fluctuation in the water level occurs due to varying amount of water brought in by Sindh nallah and Anchar Lake (Qadri, 1989). It harbours rich diversity of resident and migratory avifaunal species as well as macrophytes of high socio-economic importance (Dar and Dar, 2009) [11]. The major source of nutrients in Shallabugh wetland are inputs from the feeding channel, mineralization of dead organic matter and the returns from sediments (Dar and Dar, 2009) [11]. Shallabugh wetland is experiencing significant bio-ecological changes due to continued anthropogenic activities viz. intense agricultural activities, pollution, encroachment and erosion in catchment and watershed areas has seriously affected the wetland (Dar and Dar, 2009) [11]. The water body is under myriad anthropogenic perturbations that threaten its survival and the problem is exacerbated by heavy silt load brought into it through various feeding channels from the Sindh Nallah

(Siraj *et al*., 2010) [29]. The concern about the overall deterioration of the wetland stimulated the need to carry out this study on water quality of Shallabug wetland of Kashmir Himalaya.

Material and Methods

Three different sites (Site-I, Site-II and Site-III) of Shallabugh wetland were selected for collection of water samples on the basis of location, vegetation and availability of nutrients (Fig. 1). The sampling site-I is situated on the western side of Anchar lake. Sampling site-II is located near the inlet channel from Sindh Nallah which enters into the wetland. At this site the wetland receives more effluents and waste water. Sampling site-III is located away from site-II near semi closed outlet.

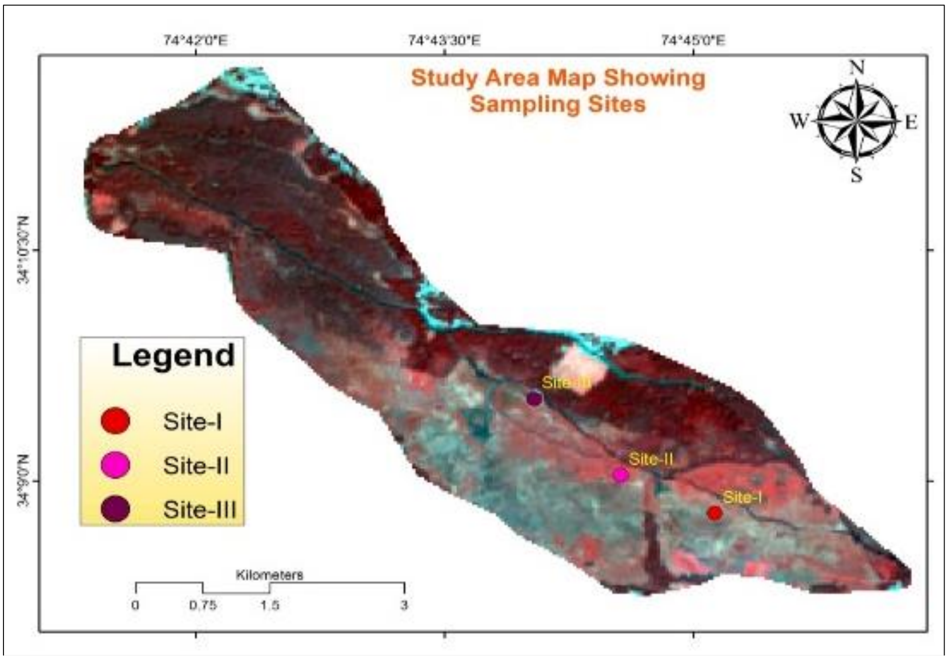

Fig 1: location of study sites

The collection of water samples from three different study sites were carried out in different seasons viz. spring, summer, autumn and winter from February 2018 to November 2018. Water samples were collected in 1 litre plastic bottles from each sampling site that were prior cleaned with detergent, washed repeatedly with distilled water, soaked in 10% nitric acid for 24 h and finally washed with distilled water. Temperature and TDS were measured on spot by mercury thermometer and TDS meter whereas for other parameters water samples were properly stored and taken to laboratory for estimation of DO, BOD and COD by employing the standard methods (APHA, 1995) [4]. Statistical analysis was carried out by using Microsoft excel 2007 and SAS9.2 software.

Results and Discussion

Water temperature plays an important role in regulating the various physico-chemical and biological activities in aquatic environments (Sawant *et al*., 2010 and Balaji, 2015) [28, 5]. Water temperature showed both seasonal as well as site variation (Fig. 2) with highest water temperature in summer (25.88 ºC) and lowest (5.98 ºC) in winter whereas site-wise water temperature was determined maximum at site-II (19.11 ℃) and minimum at site-I (17.81℃). Increase and decrease in water temperature from summer to winter is attributed to the increase and decrease in solar radiation due to changes in day length (Ahanger *et al*., 2012; Yousuf *et al*., 2015 and Baniyan *et al*., 2019) [3, 36, 6]. The highest summer and lowest winter seasonal values in the water temperature indicate that the wetland is basically temperate (Yousuf *et al*., 2015) [36]. The highest water temperature at site-II may be due to the due high microbial activity.

DO content is the most significant factor in assessing the water quality, primary production and pollution (Thirumala *et al*., 2011) [33]. DO (Fig. 3) was observed maximum in winter (11.56 mg/L) and minimum in summer (2.41 mg/L) indicating significant seasonal variation and shows an inverse relationship with the temperature (Bhat *et al*., 2013[10]). DO content was less at site-II (5.24 mg/L) and more at site-I (6.25 mg/L). Higher amount of DO in winter may be due to low temperature (Barman *et al*., 2015) [7] as solubility of oxygen increases at lower temperature (Yadavi *et al*., 2013 and Yousuf *et al*., 2015) [35, 36] and low biological activity (Idowu *et al*., 2013) [14]. Lower DO content in summer could be due to the combined effect of the addition of domestic sewage (Hazarika, 2013) [13], rise in temperature (Abubakar and Yakasai, 2015 and Baniyan *et al*., 2019) [2, 6], high metabolic rate of organisms (Barman *et al*., 2015) [7] and increased rate of decomposition of organic matter (Bhat *et al*., 2013; Yousuf *et al*., 2015 and Baniyan *et al*., 2019) [10, 36, 6]. Lower value of DO at Site-II may be due to the increased amount of organic load (Ramachandra *et al*., 2014) [25], entry of sewage and agricultural run-off (Joseph and Jacob, 2010) [15] which needs oxygen for decomposition (Bhat *et al*., 2013 and Yousuf *et al*., 2015) [10, 36].

Levels of BOD (Fig.4) differed widely during the study period with highest BOD value in summer (38.28 mg/L) and lowest in winter (16.06 mg/L), however with respect to sites highest BOD was recorded at site-II (30.97 mg/L) and lowest at site-I (27.25 mg/L). Higher value of BOD in summer may be due to rise in temperature and consumption of DO by microbes in stabilization of organic matter (Siraj *et al*., 2010 and Bhat *et al*., 2013) [29, 10]. The minimum BOD in winter, may be due to the decrease in temperature leading to decrease in microbial activity (Sachidanandamurthy and Yajurvedi, 2004 [26] and Bhat *et al*., 2013) [10]. Higher value of BOD in summer and lowest in winter were also recorded by other workers (Yadavi *et al*., 2013; Abir, 2014 and Barman *et al*., 2015) [35, 1, 7]. Increased level of BOD at site-II may be due to high organic wastes from domestic sewage and industrial effluents (Joseph and Jacob, 2010 and Barman *et al*., 2015) [15, 7].

The highest COD value (Fig. 5) was recorded during summer (74.77 mg/L) and least in winter (40.62 mg/L). Highest COD value was recorded at site-II (56.18 mg/L) and lowest at site-I (51.10 mg/L). The higher value of COD in summer and lower in winter corroborates with the findings of Barman *et al*., (2015) [7]. Higher COD value at site-II is attributed to the increased anthropogenic pressures such as inflow of agricultural runoff and domestic wastewater (Kundangar and Abubakr 2004 and Khuhawari *et al*., 2009) [18, 16] which enters into the wetland through an inlet channel near site-II.

Seasonal variation in TDS (Fig. 6) showed maximum value in winter (324.5 mg/L) and minimum in summer (155.0 mg/L) whereas site variation showed maximum TDS at site-II (245.5 mg/L) and minimum at site-I (219.9 mg/L). The highest concentration of TDS in winter could be due to less photosynthetic activity because of death and decay of macrophytes which causes accumulation of salts ions in the water (Sondergaard *et al*., 2003) [31] while the lower concentration during summer could be due to very high macrophytic cover which enhances sedimentation and counteracts resuspension of sediment particles, and therefore restricts the return of nutrients from sediments (Kufel and Kufel, 2002 and Bhat, 2010) [17, 8] as well as due to uptake of ions by macrophytes. The higher value of TDS in winter and lower in summer was also observed by Wani *et al*., (2016) [34]. Highest TDS at site-II may be due to its location in the proximity of major inflow to the wetland and due to the presence of high organic materials (Bhat and Pandit, 2014 and Sonowal and Baruah, 2017) [9, 32].

The correlation among Temperature, DO, BOD, COD and TDS in water were found statistically highly significant at ($p \leq 0.01$) confidence level depicted in Table 1. Temperature showed negative correlation with DO (-0.992**) and TDS (-0.928**), whereas positive correlation with BOD (0.988**) and COD (0.789**). Moreover, DO showed positive correlation with TDS (0.908**), whereas negative correlation with BOD (-0.983**) and COD (-0.772**). BOD showed positive correlation with COD (0.839**) and negative correlation with TDS (-0.905**). TDS showed negative correlation with COD (-0.848**).

Table 1: The correlation between water quality parameters

	Temp	DO	BOD	COD
DO	-0.992**			
BOD	0.988**	-0.983**		
COD	0.789**	-0.772**	0.839**	
TDS	-0.928**	0.908**	-0.905**	-0.848**

** Correlation is significant at the 0.01 level

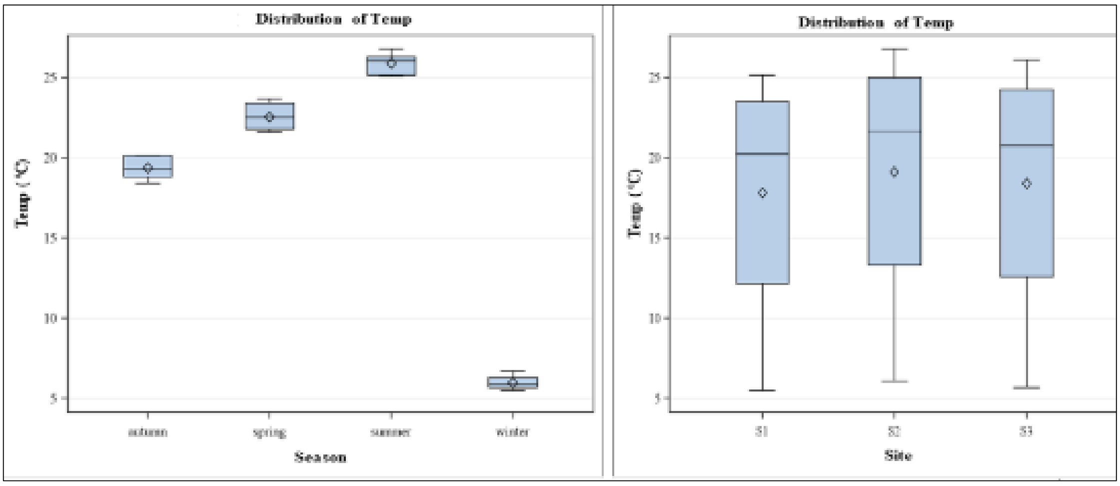

Fig 2: Distribution of water temperature with respect to season and site

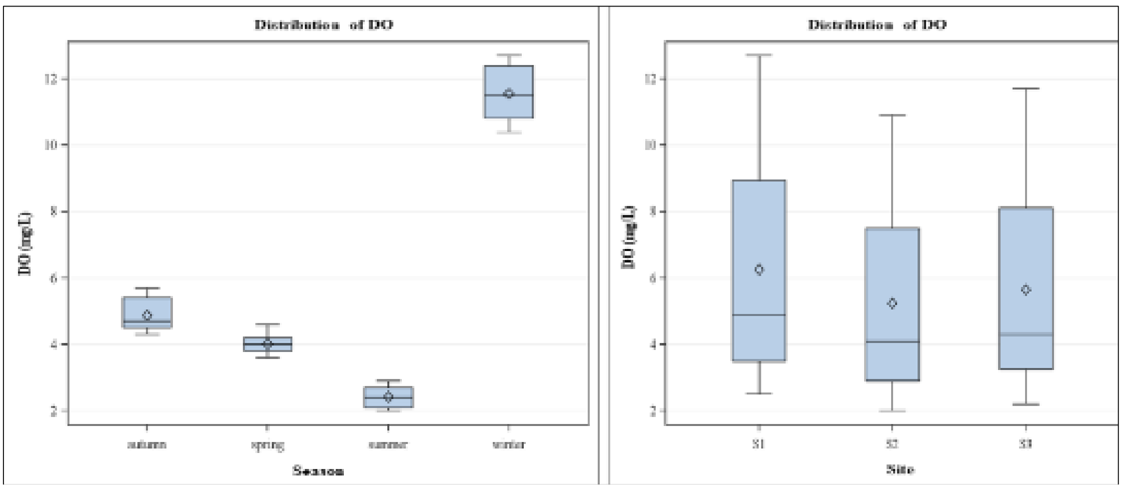

Fig 3: Distribution of DO with respect to season and site

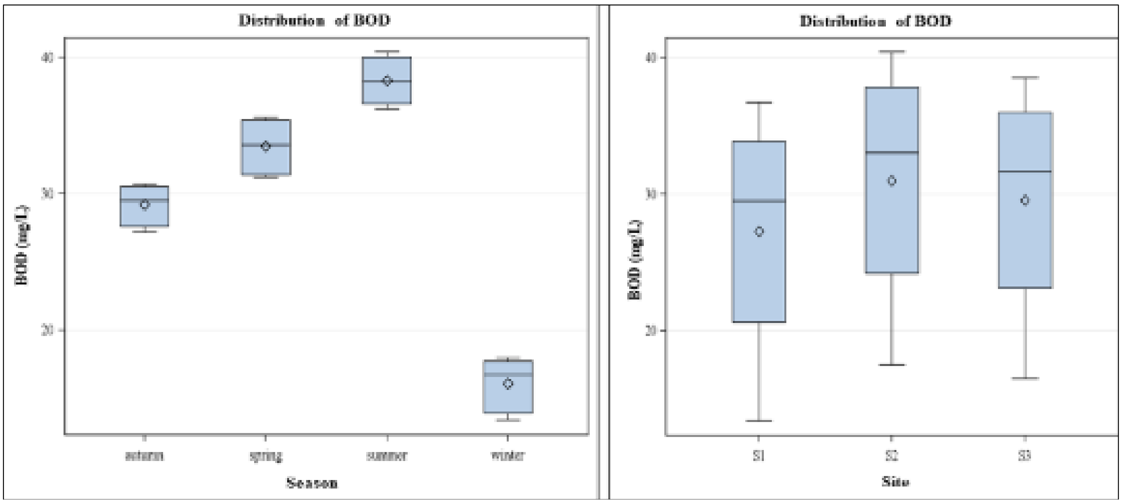

Fig 4: Distribution of BOD with respect to season and site

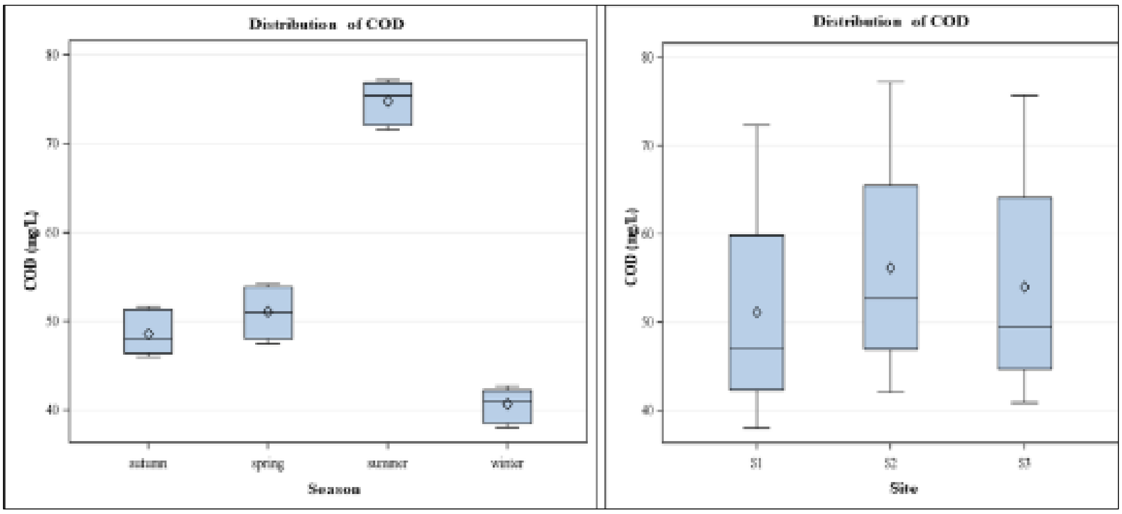

Fig 5: Distribution of COD with respect to season and site

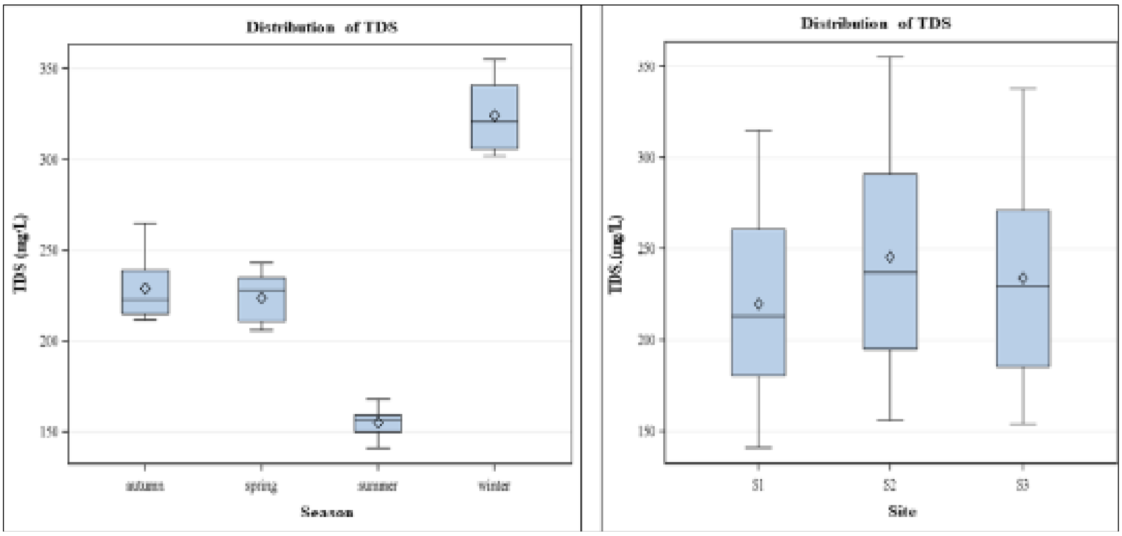

Fig 6: Distribution of TDS with respect to season and site

Conclusion

Increasing disturbances from the anthropogenic activities occurring in the vicinity like inputs from domestic sewage and agricultural runoff are responsible for the deterioration of water quality of the wetland. High values of BOD and COD indicate heavy organic load in the wetland due to decomposition of organic matter and bird droppings of migratory winter water fowl. It can be concluded that the wetland is eutrophic by reflecting high values of BOD and COD. The existence of Shallabugh wetland is threatened due to deterioration of the water quality thus the wetland needs immediate measures of restoration. For preventing and controlling the destruction of the wetland, various steps should be taken like sediment dredging, macrophyte harvesting, raising bunds and constant water supply.

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