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RESEARCH ARTICLE

COMPARATIVE ACCOUNT ON PHYSICO-CHEMICAL PARAMETERS OF TWO WETLANDS OF KASHMIR, VALLEY

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ABSTRACT

Comparative studies on physico-chemical parameters of two important wetlands of valley, viz. Hokersar and Hygam were carried out to ascertain their health and status. The study revealed eutrophic conditions in both wetlands with Hygam wetland being comparatively more eutrophic than Hokersar. Higher similarity was observed between the inlet and open water sites of wetlands than macrophytic infested sites and least between outlet sites. The outcome of study has an implication on the long term management of these wetlands.

INTRODUCTION

Wetlands are very productive ecosystems that help in the regulation of hydrological cycles, maintenance of water quality, nutrient movement and support for food chains. Wetlands are the areas wherein water is the primary factor controlling the environment and the associated plant and animal life. These are the areas where the water table is at or near the surface of land or where the land is covered by shallow water under the text of their arms or convention, as such these are the ecosystems that depends on constant or recurrent shallow inundation or saturation at or near the surface of substrates (Committee on Characterization of Wetland, 1995) .The essence of a wetland being its relative shallowness, hydric soil and hydrophytic vegetation. Their important functions include biodiversity reserves for threatened and endangered species, nutrient recycling, purification of water and ground water recharge. (Pramod, *et al* 2011and Sarkar and Upadhyay, 2013). The value of world wetlands are increasingly receiving due attention as they contribute to the healthy environment. The most important step for conservation of wetlands is to maintain a proper water quality(Smitha and Shivashankar 2013).Water quality directly reflects the health of any water body. Water levels in wetlands fluctuate on a seasonal basis in response to different factors like rainfall, evaporation, ground water movement and surface water inflow.(Kinnear and Garnett,1999)Considering the manifold contributions of wetlands (Bedford *et al.*, 2001 and Brinson and Malvarez, 2002), their conservation and management have been of paramount importance.The conservation of any wetland is possibly only when we have a considerable knowledge of its ecology vis-à-vis its health and status with respect to trophic /pollution level.

The wetland resources of India are estimated at 58.2 million hectare (Prasad *et al.*, 2002).The valley of Kashmir harbors a chain of wetlands occupying an area more than 7,000 hectares. Since the Kashmir valley wetlands are of great importance as biodiversity resources, waterfowl habitats and have a great educational, research and recreational value, the present study was undertaken to ascertain the health and status of two important wetlands of valley, viz. Hokersar and Hygam for their effective conservation and management. The data collected for a period of two years, from 2005 to 2007 on various ecological parameters of all the three aquatic habitats are described in this paper.

MATERIAL AND METHODS

Study area

The Valley of Kashmir is a lacustrine basin of the intermountain depression existing between the lesser and Greater Himalayas characterized by numerous aquatic ecosystems of great ecological and economic importance. Freshwater bodies of Kashmir Himalayas have important multistage components like source of drinking water, irrigation, navigation, fishery, agriculture, socioeconomic development and recreation. However, in recent decades, aquatic ecosystem has changed drastically and came under exacerbated trend because of disturbances in the catchment areas. As a result of heavy anthropogenic pressures, the area is

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shrinking and water quality has deteriorated. The main problem of these aquatic ecosystems is nutrient enrichment from catchment area in the form of domestic wastewaters near residential areas and runoff from agricultural fields.

Hokersar Wetland

Hokersar one of the renowned wetlands in Kashmir valley is situated on outskirsts of Srinagar on Srinagar-Baramulla National Highway at an altitude of 1585m (a.s.l.) at 34°04′50″N latitude and 74°44′25″E longitude (Figs. 1)with an area of 4.5km^2.It has been declared as Ramsarsite and is under the control of Wildlife Protection Department of Jammu and Kashmir. Four sampling sites (A-inlet; B-macrophyte infested region, C-open water and D-outlet) were selected on the basis of location, water depth, vegetation and other related characteristics.

Hygam Wetland

Hygam wetland is situated in district Baramulla, 44km north-west of Srinagar city. It is oval in outline and has an area of about 7.23km^2. The wetland is located between 34°13′30″—34°16′4″N latitudes and 74°30′27″ - 74°32′33″E longitudes at an altitude of 1585m asl on the flood plains of river Jhelum with a maximum depth of 1.2m (Fig. 2). The major part of the wetland is dominated by extensive reed-beds with boat channels, 1-4 m in width, in between the belts and pools of open water areas scattered in the reeds. Four sampling sites were chosen in this wetland also .Site A –Inlet site,Site - B macrophyte infested site,Site C Open water site and Site D Outlet site.

METHODS

Survey of the study area and collection of samples from the study sites was carried out on monthly basis from September 2005 to August 2007.The samples were collected between 10.00 to 15.00hrs on monthly basis with the help of Ruttner Water Sampler and brought to laboratory in polythene bottles of one litre capacity hat were prior cleaned with metal-free soap, rinsed repeatedly with distilled water, then soaked in 10% nitric acid for 24 h and finally rinsed with distilled water. All water samples were properly stored and taken on the same day to laboratory and stored at 4^{o}C until processing and analysis (APHA, 1995). The temperature, transparency, depth, pH and conductivity were recorded on the spot, while analysis of other parameters was done in the laboratory on the next day as per methods given in CSIR (1974) and APHA (1998).

Statistical analysis

The measured parameters varied over the years. The arithmetic means of each parameter were therefore calculated for each basin to obtain representative values for use in statistical analyses. Cluster analysis (CA) is a group of multivariate technique, which allows assembling objects based on the characteristics. CA classifies objects, so that each object is similar to the others in the cluster with respect to a predetermined selection criterion. Hierarchical agglomerative clustering is the most common approach, which provides intuitive similarity relationships between any one sample and the entire data set and is typically illustrated by a dendrogram (tree diagram). The dendrogram provides a visual summary of the clustering processes, presenting a picture of the groups and their proximity with a dramatic reduction in dimensionality of the original data (Shrestha and Kazama, 2007).

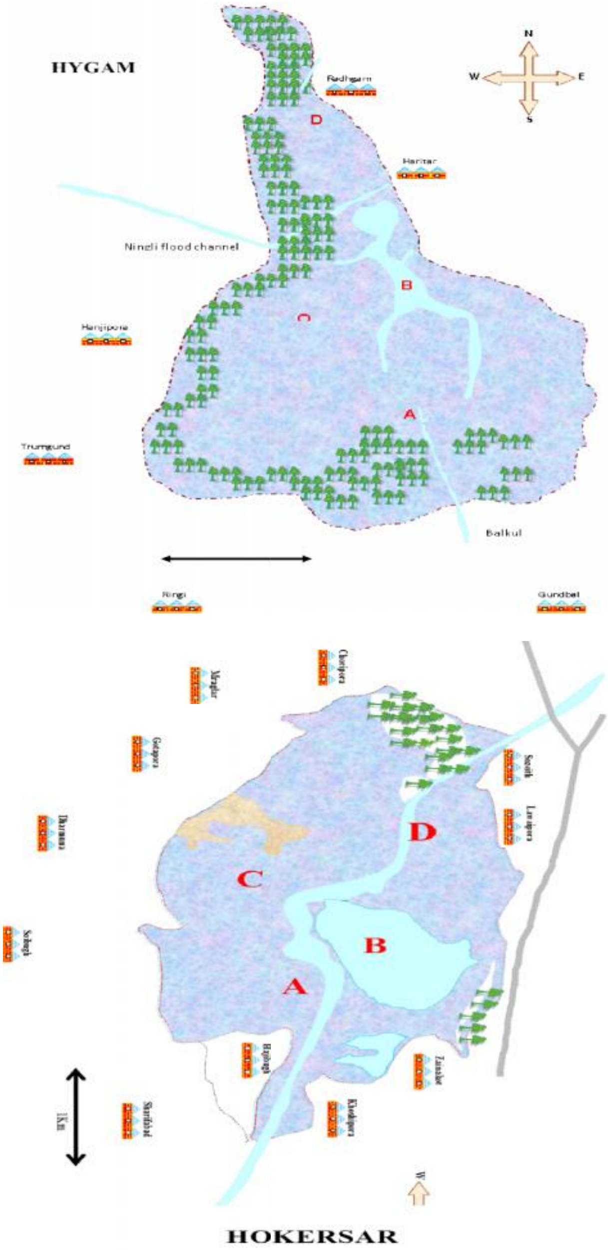


Fig. 1 Maps showing study sites in Hygam and Hokersar wetlands.

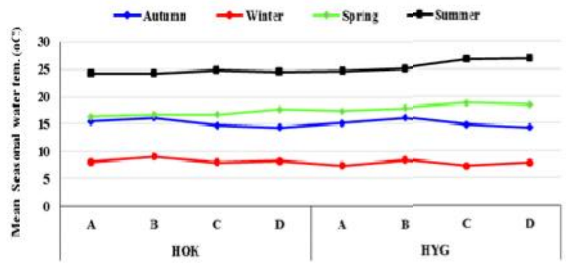
RESULTS AND DISCUSSION

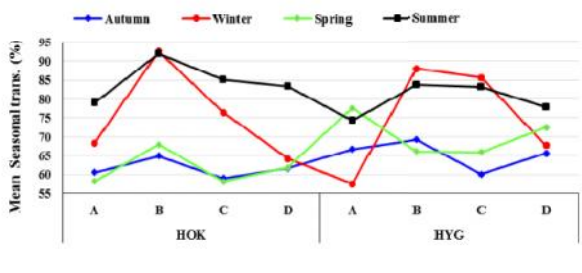
Water-quality characteristics of natural wetland systems are a result of both allochthonous and autochthonous processes. The physico-chemical characteristics including concentration of major nutrient of the wetlands showed both spatial and temporal variations. Significant differences were found within the wetlands at different sites viz. inlet sites, macrophyte infested sites, open and outlet sites. The seasonal variations in various physico-chemical parameters of two wetlands are presented in Fig. 2. The water temperature of the two wetlands showed a close relationship with the atmospheric temperature showing a unimodel oscillation. Similar results were also observed by Ramana *et al.,* (2008). No major difference was found amongst the two water bodies in the fluctuation pattern of water temperature. The highest summer and lowest winter seasonal values in the water temperature indicate that all the three wetlands basically are of temperate. Both wetlands depicted a distinctive rise of water level in spring and summer and the differences in water levels. During the other two seasons a stabilized water level was observed in Hokersar and Hygam wetlands, hence a hydrolitoral sequence prevailed in them. Highest percent transmittance values were recorded in the summer season followed by winter and lowest values in autumn in both wetlands. Higher percentage transparency might be attributed to influence of anthropogenic activities. Similar results were also reported by Mushtaq *et al*., (2013). Lower values during spring can be attributed to the silt and sand laden water, while the low values during autumn are attributable to the higher biogenic activities, lower water mass and decomposition (Saxena*et al.*, 1966). Relatively lower transparency values at inlet sites of all the three wetlands is related to large quantities of suspended material brought from the catchment. Applying specific conductivity as an index of enrichment, all the three wetlands can be placed in β-mesotrophic type. The higher values were recorded in the Hygam wetland which specify their higher trophic status than Hokersar wetland. Seasonal data on conductivity during the present course of investigation showed highest values during autumn. Serruya and Serruya (1972) held low temperature and instability of water masses to be favorable for physical enrichment of oxygen and the same seems to prevail in the present wetlands, which recorded higher amounts of dissolved oxygen during winter. In shallow wetland systems like the presently studied ones, the levels of oxygen, falling below 2 mg/l during summer are attributable to the addition of agricultural and domestic affluent containing oxidizable matter and subsequent biodegradation and decay of vegetation leading to consumption of oxygen present in water (Jammel, 1998).The lower values of dissolved oxygen at outlet sites than the inlet sites can be attributed to the oxygen utilization in the decomposition of organic materials both of allochthonous and autochthonous origin within the wetland (Jones and Bachman, 1974 and Joo and Frankco, 1995). Free CO_2 was recorded in the wetlands round the year, with higher concentration during winter and lower during summer and springwhich is attributable to the rate of photosynthetic activity in these systems. Similar findings were also recorded by (Kushlan and Hunt, 1979 and Qadri and Yousuf, 1978). The lower CO_2 values at macrophyte infested region are a direct result of greater utilization of CO_2 during photosynthesis. The differences between the wetlands.

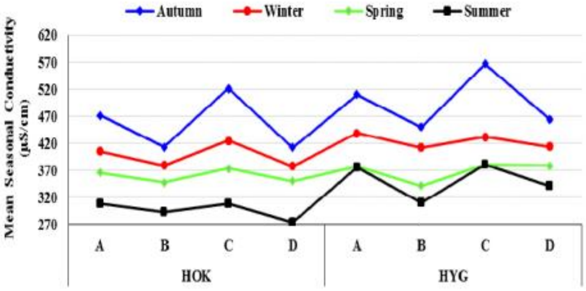
The waters of both the wetlands were generally alkaline with pH values ranging between 6.9 and 8.2. The pH values depicted the waters to be well buffered as the values greater than 7 were recorded on seasonal basis during the entire period of investigation in both wetlands. In both Hokersar and Hygam wetlands, the macrophyte infested sites recorded lower pH than the other study sites. The low pH is directly associated with the decomposition of organic material ordinarily the photosynthetic acting in the macrophytic zone would lead to increase in pH. On the whole summer period evinced higher pH than the colder season and are related to photosynthetic activity of phytoplankton and macrophytes resulting in CO_2 utilization and shifting of equilibrium between the carbonic acid and bicarbonates and mono-carbonates (Brose and Bhave, 2000, Satpathy*et al.,* 2007, Bhat, 2009 and Kumar *et al*,. 2009) and low photosynthetic activities and the dominance of decomposition over photosynthesis during winter result in the liberation of CO_2 causing lowering of pH (Otsuki and Wetzel, 1974; Nasar and Munshi, 1975; Cole, 1994 and Bass and Potts, 2001). A predominance of bicarbonates and calcium over chloride and magnesium as is true for all fresh water bodies. According to the classification of Moyle (1945) both wetlands are typical hard type (>90mg/l). A seasonal trend with an increase of bicarbonates during winter and autumn and a decrease during summer was observed .A fall in the amount of total alkalinity was observed during spring as compared to that in winter. Total hardness, on account of calcium and magnesium content, studied together as total hardness, varied from 110-380mg/l suggesting the wetlands to be quite rich in calcium and magnesium hardness. The highest values of total hardness were recorded during winter and lowest values during the summer in both wetlands which is in conformity with findings of Sathya and Sharma (2009). The amount of calcium, remained generally high (29.4 - 98.4 mg/l) placing the wetlands in Ca^{++} rich type (Ohle, 1934). The calcium content increases consistently from early autumn reaching the maximum in winter, after which the high concentration was maintained till the end of spring following the same seasonal fluctuations as were observed for alkalinity. The decrease in concentration of calcium during summer is attributable to use of bicarbonates as a source of carbon in the absence of CO_2 and consequent precipitation of carbonates of calcium. (Berner 1965; Wetzel, 1972 and Wetzel *et al.,* 1972). The increased content during winter and autumn is related with a decrease in pH, which results in the conversion of insoluble $CaCO_3$ to bicarbonates. A ratio of 4:1 for calcium and magnesium was recorded which is in conformity with earlier reports on valley lakes (Zutshi and Khan, 1978; Kaul*et al.*, 1980; Zutshi*et al.,* 1980 and Pandit, 1999). Higher Mg^{++} values during winter have been found to be due to release of this cation from macrophytes by decomposition (Choe and Kwak, 1971; Wetzel, 1975 and Kumar, 1990), while its low content during summer is possibly due to its uptake for the formation of chlorophyll-magnesium-porphyrin metal complex and in enzymatic transformations (Wetzel, 1975). The chloride content during the present study of three wetlands ranged from 8mg/l to 60mg/l. on seasonal basis autumn depicted highest chloride content while in summer low chloride concentration was recorded. The high chloride content of water has been related to the organic pollution of animal origin (Thresh *et al.*. 1976 and Unni, 1985) and indicative of degree of pollution (Kataria*et al.* 1995), Chandrasekhar *et al.* (2003) and organic pollution Bhat *et al.* (2001).

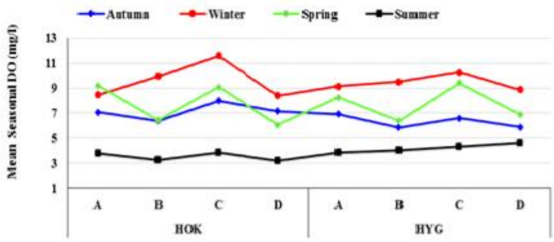
The higher concentration of total phosphate in Hygam (82.7/412.2 µg/l) than Hokersar (56.6/346.1 µg/l) reveals their higher productivity than the later and, therefore, the trophic status of the wetland. The high concentration during autumn and winter in the present wetlands can be attributed to decay and subsequent mineralization of dead organic matter and surface run-off (Cole, 1975), while low concentration during summer to the utilization by autotrophs (Kaul *et al.,* 1978). Relatively higher values were recorded at vegetative sites in the present wetlands during autumn and winter but lower values were recorded in summer from the same sites as rooted macrophytes often obtain phosphorus from the sediments and release large amounts into the water both during active growth and upon senescence and death. The inlet sites having high anthropogenic pressure, contaminated with sewage and other polluted effluents, recorded high concentration of phosphorus as is also advocated by Bhat *et al*. (2001) and Panditand

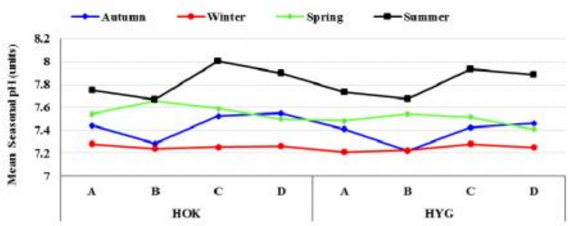
Yousuf (2002).The concentration of nitrogen recorded higher values in the Hygam than the Hokersar wetland reflecting nutrient enriched condition of the former. However, NO_3-N was present in higher concentration than the NH_4-N and NO_2-N in all the wetlands under study. The winter and spring high values may be attributed to the decomposition of autochthonous and allochthonous organic matter in addition to surface run-off while the lower concentration in summer may be due to the photosynthetic assimilation by autotrophs during their growth in late spring and early summer. Though NH_4-N was reported to be in low quantities as compared to NO_3^-, yet appreciable quantities of NH_4-N were found that indicated the higher pollution status of the wetlands. The concentration of nitrogen compounds was in the progression of NO_3-N>NH_3-N>NO_2-N.Nitrate concentration could be due to the surface run off of nitro-phosphate fertilizers from nearby farm fields into the lake as well as domestic sewage from nearby residential areas (Mushtaq, *et al*., 2013). The overall high concentration of nutrients, both P and N, in both the wetlands during autumn and winter may be as a result of the bird droppings as well since these wetlands are visited by large number of migratory water fowls, ducks and geese that arrive in autumn and reside till the end of winter. These high nutrient levels during periods of peak bird densities, attributable to bird droppings, is also supported by Manny *et al.* (1975), Scherer *et al.* (1995) and Post *et al.* (1998), Fleming and Fraser (2001), Sathya and Sharma (2009), Zuber and Sharma (2007) and Parray*et al.* (2010). The data on sulphate conc. do not reveal any marked pattern of fluctuations present study. Further in both the wetlands Hokersar and Hygam outlet site recorded relatively lower values in the sulphate concentration as compared to other sites.

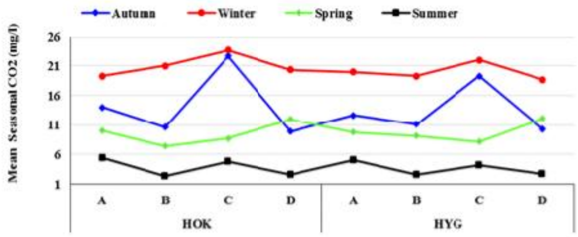


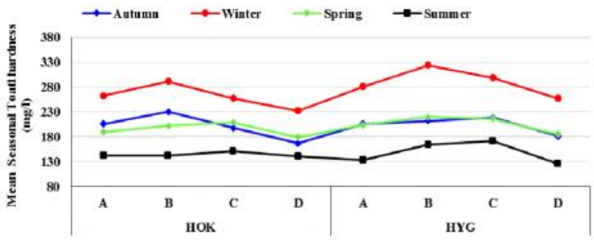


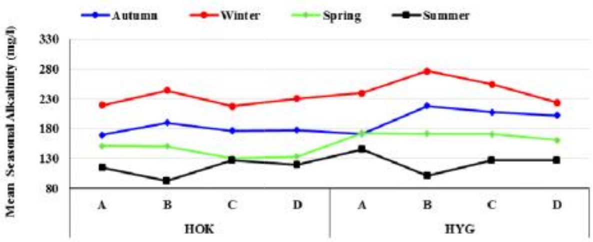


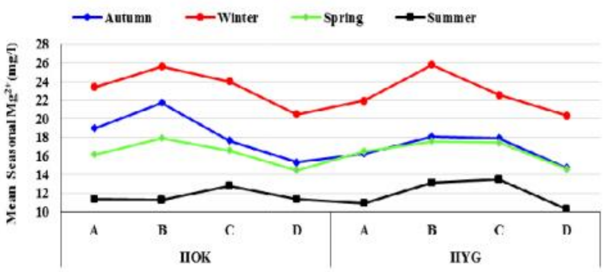


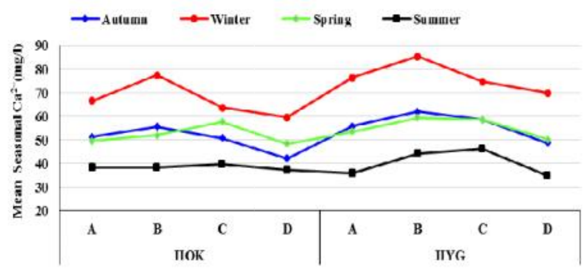












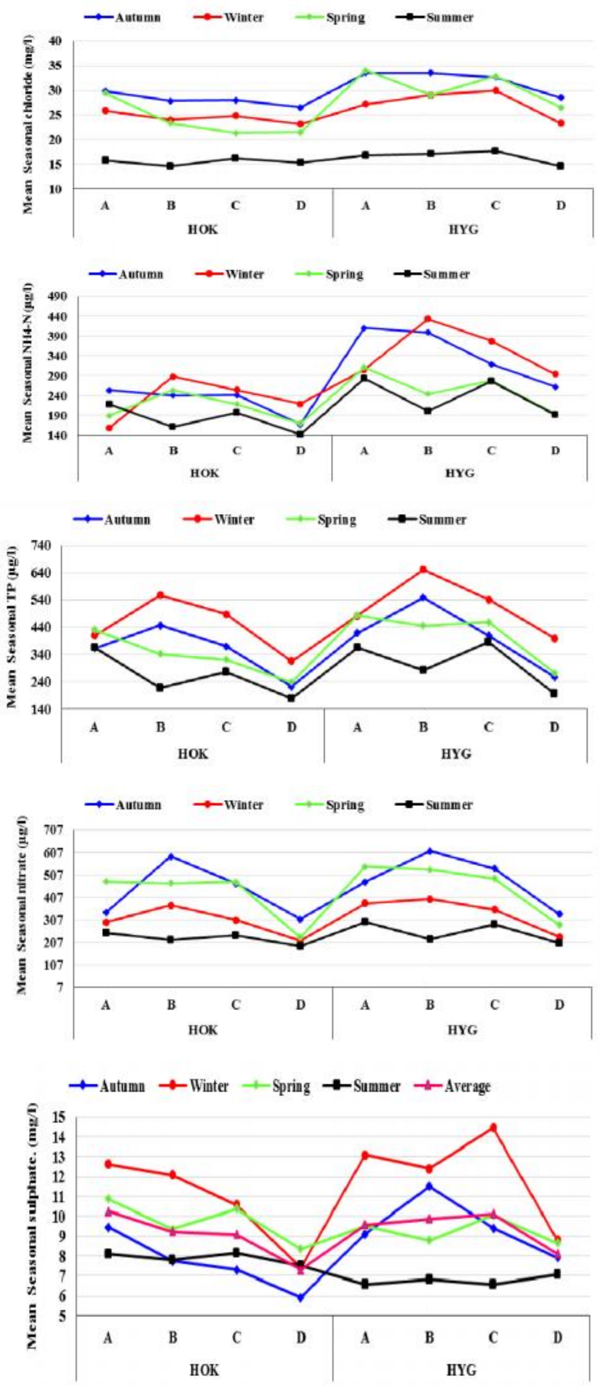


Fig.2 Seasonal variation in different physico-chemical parameters in Hokersar and Hygam Wetlands

Cluster Analysis

Cluster analysis was utilized to see the similarity between different physico-chemical parameters of the wetlands and also between sites on the basis of various physico-chemical parameters. The dendrogram consists of three main groups, the highest similarity percentages groups constitutes first and second group while third group composed of least similar sites. During whole study period in both wetlands (Hokersar and Hygam) highest similarities were observed between Inlets and open water sites followed by macrophytes dominated sites. In contrast outlet sites of both wetlands depicts lowest similarity with other sites (Fig. 3).

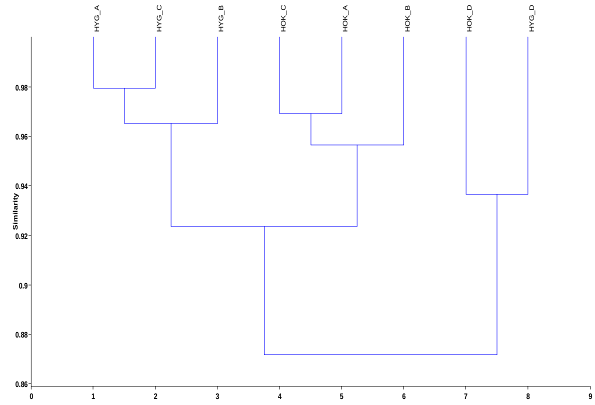


Fig. 3 Similarity percentage between various sites of Hokersar and Hygam wetlands on the basis of physico-chemical parameters

CONCLUSION

Based on the results of present studies of the three wetlands it can be concluded that Hokersar is moderately eutrophic than Hygam as reflected by more various parameters viz. conductivity, chloride, ammonical nitrogen, nitrate and phosphate levels. As such management and restoration on international guidelines for Hokersar and Hygam is recommended like checking the entry of excessive silt and nutrients, ensuring constant water supply, monitoring adjacent land use and creation of buffer zones. Further it was pointed out in present study that water quality of both the wetlands were deteriorated due to various human activity occurring in their vicinity .Complete dryness of wetlands needs to be avoided since it leads to easy human access and interference, loss of habitat as well as faunal diversity some area of Hygam wetland during the present study Hence constant supply of water relieved of excessive silt (by detention centers constructed at inlets) and nutrients (by treatment plants) needs to be ensured.

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