



SEASONAL AND ENVIRONMENTAL CHANGES AND THEIR EFFECTS ON SELECTED RAMSAR WETLANDS HEALTH AND BIRDS POPULATION

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ABSTRACT

One of the important known functions of wetlands is to provide a habitat for water birds. In the present study, water quality and population statistics of avifauna has been estimated from three Ramsar sites including Keenjhar Lake, Haleji Lake and Hub Dam Wildlife Sanctuary. Surveys were conducted for duration of ten months from March to December 2015. Contaminants of Organochlorines and Organophosphate pesticides were found in the water samples of Haleji Lake, while Maximum Acceptable Concentrations (MAC) level of pesticides were found in water samples of Keenjhar Lake. There were 228 species of birds recorded in the Haleji Lake, while Keenjhar Lake contains 121 species of birds and the total numbers of birds present at Hub Dam were 160 species. Biodiversity of Haleji Lake seems to have declined because of many anthropological and social activities. Bird population in Keenjhar Lake is at high risk because of illegal hunting, poaching, habitat destruction and pollution. The water contents of Hub Dam seem to be non-toxic and suitable for human consumption. The habitat is degraded due to misuse of natural resources. Decline in the number of bird's population indicates the environmental pollution, habitat quality degradation and over exploitation of natural resources.

Keywords: Haleji, keenjhar, hub dam, freshwater, water birds.

INTRODUCTION

Globally there are 2,279 Ramsar Sites (www.ramsar.org/wetland/pakistan, 2017) including 19 Ramsar sites of Pakistan with a surface area of 1,343,807 hectares. Haleji Lake is an important artificial freshwater wetland of Sindh located in Thatta district. Its total area is about 6.58km² along with the maximum depth of 5 to 6 m. This Ramsar site is situated at 24° 47'N and 67° 46'E with surface area of 1,704 ha (Khan *et al.*, 2012b, 2014). A rich variety of species of fauna and flora are inhabitant of this lake. Marsh Harrier, Pallas's Fishing Eagle, Monitor Lizards and Fishes are the species of primary importance. Haleji Lake is surrounded by lagoons which act as a roosting and foraging ground for large number of aquatic birds including Moorhens, Coots and Ducks. Many other birds like Egrets, Herons, Cotton Teal, Spot bill Duck, and Pheasant-tailed Jacana also utilize these habitat as their breeding grounds. Thousands of Night Herons used the adjacent marshes for breeding purposes. Many different species like Hog Deer (*Axis porcinus*), Marsh Crocodile (*Crocodylus palustris*), Smooth-coated Otter (*Lutrogale perspicillata*), Mallard (*Anas platyrhynchos*) and Pea Fowl (*Pavo cristatus*) are protected in captivity for breeding purposes in a Captive Breeding Centre which has been developed by the Sindh Wildlife Department, Government of Sindh near the lake.

Keenjhar Lake is the second largest lake of Thatta district placed at 24° 56'N and 68° 03'E with surface area of

13,468 ha. A water supply to Karachi city, Keti Bunder and Thatta is carried out by Keenjhar Lake which is the major resource of fresh water in Sindh. River Indus is the main channel which supplies water for this lake. The location of Keenjhar Lake from Thatta city is about 19km North to North-East. The distance between Lake and Karachi city is about 113km (Khan *et al.*, 2012b, 2014). A stony deserted habitat has also been formed in the lake as it is surrounded by many brackish seepage lagoons and marshes. Jam branch canal is the single outlet of the lake towards its northern and western sites.

Majority of migratory birds which includes winter visitors, summer visitors and vagrants stay roost and breed in this lake as it offers diversity of habitat for different species. Some important breeding birds of this lake include Night Heron (*Nycticorax nycticorax*), Pheasant-tailed Jacana (*Hydrophasianus chirurgus*) and Purple Moorhen (*Porphyrio porphyrio*) while in the last few years in some passing years Cotton Teal (*Nettapus coromondelianus*) population decreased and finally disappeared. Some important game birds have been found like Grey Partridge (*Francolinus pondicerianus*) and Chestnut-bellied Sandgrouse (*Pterocles exustus*). Predator bird's species has also been found including Pallas's Fishing Eagle (*Haliaeetus leucorhynchus*).

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Mammalian fauna includes Fishing Cat (*Prionailurus viverrinus*) and Smooth-coated Otter (*Lutrogale perspicillata*) (Khan and Abbas, 2011).

Hub Dam was developed at the junction of two provinces Sindh and Balochistan. It was constructed at 25° 15'N 67° 07'E (with surface area of 27,000 ha), from 56 km North of Karachi. The dam was constructed in 1981 on the Hub River. The length of Hub Dam is 15,640 m where Balochistan contains 5,400 m of area while Sindh contains 10,240 m of area (Begum *et al.*, 2013). Hub Dam was declared as Wildlife Sanctuary for conservation of water birds and a valuable fish Mahaseer. There are four canals emerging out of Hub dam canal including the Main Canal, Karachi Water Supply Canal, Lasbella Canal and the Bund Murad Minor. Many species of aquatic birds are inhabitant of Hub Dam water body including Grebes, Pelicans, Flamingos, Anatids, Coots and Cranes. It provides diversified habitat and ecological niches to a variety of avifauna for their staging and breeding purposes. Regular visitors and native population of birds in Hub Dam includes Black-necked Grebe (*Podiceps nigricollis*), Little Cormorant (*Phalacrocorax niger*), Tufted Duck (*Aythya fuligula*), Common Pochard (*Aythya ferina*), Dalmatian Pelican (*Pelecanus crispus*), White Pelican (*Pelecanus onocrotalus*), Coot (*Fulica atra*), and Little Tern (*Sterna albifrons*) (Begum *et al.*, 2013).

Over 45,000 birds are characterized as permanent residents or visitors of Hub dam water body on annual basis. Present study was conducted to analyze health of selected wetlands effected by seasonal and environmental fluctuations and to estimate the birds population on three Ramsar Sites: Hub Dam, Haleji and Keenjhar Lakes.

MATERIALS AND METHODS

Several surveys were conducted during the study period from March to December 2015. Water quality was analyzed by collecting random samples from different selected sites from all three wetlands. Estimation of conductivity was done by using a conductivity meter. Total Dissolved Solids, Turbidity and Salinity were determined by different approved methods. pH meter was used to measure pH, while Titrimetric methods were used for determination of Alkalinity, Carbon dioxide and Phosphates by Acid Base Titration. Complexometric Titration methods were used to estimate Total Hardness. Calcium, Magnesium and Chloride concentration was estimated using EDTA. Incubation Method-Redox Titration was used to analyze Basic Oxygen Demand. Gravimetric method was used to measure the concentration of Sulphates in water samples. Brucine Colorimetric Method was used to analyze nitrate contents in the water samples from all three wetlands (APHA, 1997).

Estimation of Birds Population

Key species of birds observed were recorded, while all other common species of birds observed were documented along with their particular habitat type. The recorded data was compared with other ecological factors including variety of vegetation, water quality, soil type, topography, environmental conditions and availability of habitat. Population estimation of birds was done by using Line transects method. The numbers of birds were recorded within a predefined survey unit continuously along a predefined route. Line Transect method is the best method adopted for a wide ranging, broad, open and homogenous consistent habitat. Highly populated and prominent species can easily be estimated and recorded by using this technique. Spotting scopes and binocular of different powered lenses were used for identification of different species of birds. Bird Identification keys were followed by using Field identification guides such as Grimmett *et al.* (1998), Snobe and Usui (1993) and Ghalib *et al.* (2013).

RESULTS

This study has been conducted to determine the effects of environmental and seasonal variations on the water quality and population statistics of avifauna in selected Ramsar sites of Sindh i.e Keenjhar Lake, Haleji Lake and Hub Dam Wildlife Sanctuaries from the month of March to December 2015. Wetlands are one of the most productive ecosystems, comparable to tropical evergreen forests in the biosphere and play a significant role in the ecological sustainability of a region (Khan and Ghalib, 2006).

Haleji Lake

Physio-chemical properties of any aquatic ecosystem support the life forms and their stability inside that ecosystem (Figs. 1 and 2). The interaction between biotic components and abiotic components in a wetland helps to maintain its good health. The external controls and internal interactions are the main factors to produce rich biodiversity in a wetland, while abundance of nutrients, seasonality and stratification plays an important role in increasing the level of primary productivity. Any change in abiotic components directly affects the biota of that wetland. Therefore, it is necessary to analyze the physiochemical characteristics of wetland in order to estimate its biodiversity richness.

Some biochemical tests were conducted to determine physiochemical properties of water for estimating the water quality. The analyzed parameters were Temperature, Conductivity, Total Dissolved Solids, pH, Turbidity, Alkalinity, Total Hardness, Salinity, Basic Oxygen Demand, Carbon dioxide, Magnesium, Sulphates, Chloride, Calcium, Nitrate, and Phosphates.



Fig. 1. A view of Haleji Lake.



Fig. 2. Another view of Haleji Lake showing eutrophication.

Temperature plays a very vital role in maintenance of ecology of a wetland. Biodiversity existing in a wetland may increase or decrease in richness by fluctuation of water temperature. Many factors like solubility of salts and gases in water, its density and its volume vary with the variation in temperature. During the present study, it was noted that water temperature fluctuated between 27 to 33°C in pre-monsoon period and it varied from 24 - 30°C in post-monsoon period.

Birds in Haleji Lake

Haleji Lake is regarded as a refuge for thousands of migratory birds coming from Siberian countries in the winter season from November to February annually. It is considered as a bird's paradise as it provides a protective wintering area for migratory birds.

Present study and literature reviewed (Khan *et al.*, 2012b) reveals the presence of some common birds in this lake including Black-headed Gull (*Larus ridibundus*), Little Cormorant (*Phalacrocorax niger*), Purple Moorhen (*Porphyrio porphyrio*), Indian Moorhen (*Gallinula chloropus*), Long-legged Buzzard (*Buteo rufinus*), Coot (*Fulica atra*), Little Grebe/Dabchick (*Tachybaptus ruficollis*), Tufted Duck (*Aythya ferina*), Pied Wagtail (*Motacilla alba*), Yellow Wagtail (*Motacilla flava*), Black Drongo (*Dicrurus macrocercus*), Pied Bush Chat (*Saxicola caprata*), Sand Martin (*Riparia paludicola*) and Wire-tailed Swallow (*Hirundo smithi*). Earlier studies by Khan *et al.* (2012a, 2012b, 2014) have reported the same species.

Keenjhar Lake

Keenjhar Lake (Figs. 3 and 4) supports and provides suitable habitat to waterbirds, mammals and reptiles (Khan *et al.*, 2017). Water temperature recorded during the conducted study varied from pre-monsoon to post monsoon period. During pre-monsoon period it fluctuated from 27 to 32°C whereas during post monsoon the water temperature varied from 15 to 20°C. Air temperature was also noted during the study period. In pre-monsoon period air temperature ranged from 30- 35°C and it fluctuated from 17 to 25°C in post monsoon timings. Conductivity test of the water ranged from 453 - 742µS/cm. Total dissolved solids in water samples ranged from 240.5 to 492.5mg/l. Salinity of water ranged from 0.20 to 1.8mg/l. pH value recorded by the pH meter from different sampling sites was varied from 6.71 to 8.11. Turbidity test values recorded ranged from 1.25 to 12.2NTU. The quantity of Carbon dioxide ranged from 1 to 1.5mg/l. Alkalinity test values were from 26 to 105mg/l. Total Hardness of water ranged from 57 to 143mg/l. Basic Oxygen Demand recorded was between 1.10 - 9.8mg/l. Calcium contents measured were from 27 to 86mg/l. Value of Magnesium ranged from 38 to 106mg. Quantity of Sulphate ions ranged from 18 to 156mg/l. Chloride ions were recorded between 35.2 to 98mg/l in water

samples. Nitrate ions were estimated to be between 0.04 and 0.37mg/l. Quantity of Phosphate ions estimated from water samples varied from 0.006 to 0.28mg/l. Khan *et al.* (2012 and 2014) also reported similar results and we have noted no major change.

Birds in Keenjhar Lake

Keenjhar Lake which is also known as Karli Lake is declared as Ramsar site and Wildlife Sanctuary. This manmade lake provides a wonderful habitat for migratory birds as a staging and wintering area. In the lake, 121 species of birds were recorded including water birds, birds of prey, passerines and game birds. The common species of birds present in the area of lake were Shoveller (*Anas clypeata*), Tufted Duck (*Aythya fuligula*), Grey Partridge (*Francolinus pondicerianus*), Striated Babbler (*Turdoides earlei*), Great Grey Shrike (*Lanius excubator*), Ashcrowned Finch Lark (*Eremopterix griseus*), Indian Robin (*Saxicoloides fulicata*), White-cheeked Bulbul (*Pycnonotus leucogenys*), Red-vented Bulbul (*Pycnonotus cafer*), Tailor Bird (*Orthotomus sutorius*), Bluethroat (*Luscinia svecica*), Lesser white-throat (*Sylvia curruca*), Bay-backed Shrike (*Lanius vittatus*), Pied Bush Chat (*Saxicola caprata*) and Crested Lark (*Galerida cristata*).

Hub Dam

Water samples were collected from different sites of Hub Dam (Figs. 5 and 6). The water samples were analyzed for ionic chemistry which plays an important role in the management of quality of water. Hub Dam is a fresh water reservoir used for supplying drinking water to Karachi city. The samples of water were found colourless, odourless and tasteless. During the study period, different parameters were checked for analyzing the water quality including Water Temperature, Air Temperature, Color, pH, Total Dissolved Solids, COD, BOD, Alkalinity, Salinity, Conductivity, Hardness, Phosphate, Nitrate, Bicarbonate, Sulfate, Chloride, Carbon Dioxide, Dissolved Oxygen, Turbidity, Calcium, Magnesium, Sodium, Potassium and Fluoride. Total annual rainfall in Hub Dam was recorded as 465.6 mm, 121.6 mm, 279.9 mm and 372.9 mm, for the year 2007, 2008, 2009 and 2010, respectively. Temperature plays a very important role in the maintenance of ecological stability in a wetland. Most of the species of fauna and flora do not survive if water temperature is high. In the month of November, the minimum mean temperature recorded was 17°C, while in the month of June the minimum mean temperature of water was 29°C. There was extreme high temperature recorded in the summer before rain, as a result of this the amount of Dissolved Oxygen decreased in water. This leads to more saline and moderately alkaline water which ultimately upsets the biodiversity levels. Standard values of parameters in aquatic regime have been given by World Health Organization. All the results obtained were compared with those standard values for analyzing the health and water quality of

wetland. The obtained results of all parameters of this reservoir indicate that the water of Hub dam is safe and

suitable for the drinking supply, domestic use and irrigation purpose by comparing to the permissible limit.



Fig. 3. A view of Keenjhar Lake.



Fig. 4. Ecology of Keenjhar Lake.



Fig. 5. A view of ecology of Hub Dam.



Fig. 6. A view of Hub Dam.

Birds in Hub Dam

The major part of Hub Dam wildlife sanctuary is in Balochistan which is unprotected, while the eastern shore and area south of the Dam is in Sindh which is protected in the Kirthar National Park and Hub Dam Wildlife Sanctuary. During the study 79 species of resident birds were recorded in which 72 winter visitors, 3 summer breeding visitors, 1 summer visitor and 6 were passage migrants. The birds included in category of passage migrants were Garganey, Demoiselle Crane, Kentish Plover, Yellow Wagtail, and Black-headed Bunting. Summer breeding visitors included Common Swift and Blue-cheeked Bee eater, while Common Tern was a summer visitor. Little Grebe, Large Cormorant, Grey Heron, Pond Heron, Large Egret, Little Egret, Pintail, Shoveller, Common Pochard, Black Kite, Marsh Harrier, Black Headed Gull, Little Tern, Ring Dove, House Swift and Indian Pied Kingfisher were recorded as common birds of Hub Dam Wildlife Sanctuary.

DISCUSSION

The relation between birds and wetlands is shaped by several important factors such as quality of water, depth, availability of food, shelter and the presence and absence of predators (Stewart, 2016). Biodiversity richness in a wetland is adversely affected by many different factors. Major factors include habitat change, invasive alien species, overexploitation, nutrient loading and habitat destruction. Anthropogenic activities including habitat loss and fragmentation due to development, ranching, agriculture and pollution has a massive impact on biodiversity which results in extinction of many aquatic and terrestrial species (Ali *et al.*, 2011). Pollutants such as acid rain, air pollution, fertilizers, herbicides and pesticides cause modification and destruction of natural habitats leading to increase mortality ratio of aquatic fauna. (Khan and Law, 2005; Khan *et al.*, 2012). Contents of Organophosphate and Organochloride were found in samples of water from Haleji Lake which indicates that contamination of wetland is from agricultural fields.

Higher concentration of Dimethoate (OP), DDT, Dieldrin (OC) and Cypermethrin (Pyrethroid) were recorded from water samples of Haleji Lake. Highest level of pesticides were found in the muscles and liver of fishes compared to other tissues of the body (Siddiqui, 1998).

The level of pesticides was found below the maximum acceptable concentrations in the water samples of Keenjhar Lake. Khan *et al.* (2017) reported that aquatic ecosystem of the Keenjhar lake is under threat due to increased input of industrial and domestic effluent. This kind of contamination is hazardous for health of human population and it also has sub-lethal effects on biodiversity of aquatic ecosystem. Turbidity values

recorded were higher compared to standard values. The concentration of dissolved oxygen was lower in the water compared to standard values. These results show the unhealthy status of wetlands.

Drinking water was supplied to Karachi directly from Haleji Lake before 2006. The main reservoir of that supplied water was Keenjhar Lake which provided water to Haleji Lake and then water was supplied to Karachi. After 2006, direct line from Keenjhar Lake to Karachi was constructed which has become polluted and deteriorated resulting in decline in water quality. The Right Bank Outfall Drain (RBOD) is constructed close in proximity i.e. 50 to 100 feet away to the Haleji Lake. It poses a direct hazard to the biodiversity of wetland health. The construction of the unlined drain is a major violation of the wildlife sanctuary. The damage was being caused by the seepage as the drains were 20 to 30 feet below the level of the wetland areas (Khan *et al.*, 2012 a, b, c).

Major source of water in the Keenjhar Lake is the River Indus which enters the lake after passing through K-B Feeder. Kalri-Baghar Feeder canal is constructed near Kotri Industrial area. These industries are dumping their effluents and contaminants through K-B feeder in Keenjhar Lake and ultimately the habitat degradation takes place due to toxicity of this sewage (Khan *et al.*, 2012a,b,c).

These industrial wastes from Kotri and Nooriabad Industrial areas cause a serious risk to biodiversity of Keenjhar Lake. Another major threat is eutrophication. Due to some agricultural practices in nearby areas, the lake is over loaded with nutrients because of seepage of agricultural waste into the lake along with fertilizers and pesticides. This has made the water contents toxic.

The present study reveals the critical and alarming situation of these wetlands. There should be some monitoring check and balance on level of pollution. The developmental projects like RBOD should be managed properly and authorities should ensure the safety and protection of valuable wetlands. The current study concluded that population statistics of water birds near both wetlands are declining to the critical levels due to lack of appropriate protective measures.

Hub Dam is characterized as dry environment with less than 200ml rain fall annually. Maximum temperature in summer is beyond 36°C. External source of pollution is insignificant but the major threat to water birds is due to social disturbances. Birds are pre-dominantly present in areas near spillway, main dam area and agriculture land/shallow water areas. The study conducted revealed that no major pollutants were observed while a little increase in the concentrations of heavy metals was

detected (Khan *et al.*, 2012a). It was observed that water contents of Hub Dam did not have any risk bearing contaminants therefore this water is safe for human consumption. Due to anthropological activities, climate and environmental changes near the wetlands, the population of birds frequently declines in Haleji and Keenjhar Lakes and health of Haleji Lake is also affected. Monitoring programmes for bird population has started near the wetlands by using banding and clipping techniques. It is required to take necessary actions to monitor the variations in bird's population at wetlands because decrease number of birds also indicates the mismanaged strategy for biodiversity conservation in fresh water resources.

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