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Thermal Regime in Tropical Wetlands of Northern India-A Case of Limnological Study of Aligarh Region

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Abstract
Wetlands are extremely important resources for humans and all other forms of life. Northern India represents a typical monsoon type of tropical climate broadly having four seasons, the winter, summer, monsoon and post-monsoon. Various changes in thermal regimes were studied in the present investigations. The pattern of seasonal fluctuations in air and water temperatures broadly agrees with solar radiations and photoperiods of the seasons. Thermal regime studies have become need of the hour. Thermal properties of wetlands and seasonal fluctuations have corresponding relationships in maintaining fitness of wetland ecosystems.

Keywords: *Wetlands, Thermal Regime, Solar radiations, Photoperiods and Seasonal fluctuations.*

I. INTRODUCTION

From the ecological point of view, the thermal properties of water and corresponding relationships are most important features in maintaining fitness of the water in an ecosystem. The temperature of the surface waters governs to a large extent, the biological species present and their rate of activities. A slight change in surface water temperature may affect the biology of the organism present in that ecosystem such as growth, development, reproduction and other life processes (Goldman and Horne, 1983; Wetzel, 1983; Untoo *et.al.*, 2011) thus knowing the temperature profile is important.

The thermal regime of water directly affects the growth rate of all cultivable species, development of density gradient in the water body and other water quality parameters, such as dissolved oxygen (D.O), pH and alkalinity (Boyd, 1990; Losordo and Piedrahita, 1991). The distribution of gases and nutrient cycle along with other biogenic processes get affected by the changes in the temperature of the environment (Welch, 1952). It also governs the water mixing, turbulence and production of currents (Ruttner, 1963; Cole, 1983). Solar radiations are the main source of heat energy to any aquatic ecosystem and the energy that distributes heat in the environment is derived from wind (Birge, 1916).

The temperature of the natural water system responds to many factors, the ambient temperature being the most universal. Generally swallow water bodies are most affected by ambient air temperature than are deeper water bodies (Efford, 1967; Moss, 1969). Heat is taken up directly through the transfer of heat from the air or from the bottom in the water body. The sources of incoming water and the nature of drainage patterns also determine the thermal properties of water (Reid, 1969). Transport of heat is most effective in the ponds, as the temperature difference between surface and bottom are not found to be great (Ruttner, 1963).

(Fisher and Fabrils, 1982; Imber, *et. al.*, 1985; Zhou and Wangershy, 1985) have also reported that algal physiology is highly dependent on the temperature, salinity and light. Water bodies frequently undergo diel thermal cycles and chemical vertical stratification and de-stratification under hot and quiescent weather conditions (Boyd, 1990; Szyper and Lin, 1990; Losordo and Piedrahiat, 1991). Heat transfer by turbulent diffusion regulates the fish movement along with plankton distribution (Zhu *et. al.*, 2000). Large amount of work has been done on the thermal properties of freshwater ecosystems within and outside India. Some contributions are those of Webb and Parsons (1988), Khan *et. al.*, (2000), Gaur *et. al.*, (2001) and Untoo *et. al.*,(2001 & 2003) and many more.

II. MATERIAL AND METHODS

Atmospheric and surface water temperature were recorded by a mercury thermometer graduated upto 100º C between 9:00 am to 10:00 am at regular intervals during August, 2013 to December,2014 at three wetlands Chaarat Pond-1, Chaarat Pond-2 and Medical Pond (CP-1, CP-2 and MP) of Aligarh region in Northern India. The surface water temperature was measured by immersing the thermometer bulb into water body for about 2 to 3 minutes following a procedure and precautions given by Welch (1948), Trivedi and Goel (1948).

III. RESULTS AND DISCUSSIONS

Table – 1 Monthly variations in Air and Surface Water Temperatures (^{0}C) in Three Wetlands of Aligarh region of northern India

CP-1: Chharat Pond 1 CP-2: Chharat Pond 2 MP: Medical Pond

Months↓ Wetlands→	**Air Temperature**			**Water Temperature**		
	CP-1	***CP-2***	***MP***	***CP-1***	***CP-2***	***MP***
August,2013	30.0	30.0	32.0	29.0	29.0	30.0
September,2013	30.0	29.0	32.0	28.0	28.0	28.0
October,2013	29.0	29.0	28.0	28.0	28.0	26.0
November,2013	28.0	29.0	28.0	27.0	27.0	25.0
December,2013	22.0	21.0	19.0	21.0	20.0	18.0
January,2014	18.0	17.0	15.0	17.0	16.5	14.0
Febuaray,2014	20.0	20.0	18.0	19.0	19.0	17.0
March,2014	23.0	23.0	21.5	21.5	21.0	20.0
April,2014	25.0	25.0	23.0	23.0	29.0	22.0
May,2014	33.0	34.0	26.0	29.0	30.0	23.0
June,2014	33.0	34.0	32.0	30.0	32.0	30.0
July,2014	32.0	32.0	36.0	30.0	31.0	32.0
August,2014	32.0	34.0	31.0	31.0	32.0	32.0
September,2014	32.0	33.0	22.0	30.0	31.0	30.0
October,2014	30.0	28.0	32.0	28.0	27.0	25.0
November,2014	20.0	22.0	19.0	17.0	19.0	18.0
December,2014	17.0	20.0	19.0	15.0	16.0	18.5

Monthly surface water and air temperature in CP-1, CP-2 and MP wetlands of Aligarh region have been given in (Table 1) and illustrated in (Fig. 3). Apparent seasonal and monthly changes were found in both air and water temperatures. The water temperature was found to be closely related to the air temperature.

The air temperature varies from 17º C to 33ºC at CP-1 it was found to be varied from 17º C to 34ºC at CP-2 and at MP it shows variation in temperature between 15ºC to 36ºC.

The water temperature of the surface water also showed wide variations from 15º C to 31ºC at CP-1; 16º C to 32ºC at CP-2 and 14º C to 32ºC at MP wetlands of Aligarh region of northern India.

In all the three wetlands, the high surface temperature was recorded during summer as water gets rapidly heated during the day time having long photoperiods and clear sky. It was also recorded high during monsoon months because of high humidity and higher temperature. The lower water temperature was recorded during the winter months, as the warm effect of the solar radiations over this period was low in all the three wetlands that brings drop in water temperature (Table 1& Fig.3). Since the investigated wetlands are distributed within a radius of 8 Kms, seasonal variability of atmospheric temperature would affect the system temporally rather spatially. Temperature fluctuations in these wetlands were the result of addition or loss of heat.

The heating and cooling greatly depends upon air temperature regulated by relative humidity, solar radiation, photoperiods and cloud cover etc. (Fig.1). However, the assessments of all meteorological parameters have affected the atmospheric temperature, which is essential in determining the energy budget of a wetland (Fig.2). In the present study, these wetlands being small in size and shallow eutrophic water bodies get quickly changed with ambient conditions and thus show more fluctuation of temperature (Fig.3). The surface area and volume of the wetlands are extremely important to assess fluctuation of temperature (Anderson, 1964). Most of the months show wide fluctuations in air temperature than in the surface water temperature. The statistical results also depict the same pictures (Fig. 1 & Fig. 2).

Thermal regime of these wetlands appear to be related to the morphometry, as these three wetlands are shallow, fluctuations in temperature results in convection currents, which lead to complete turn over (Ruttner,1963). The complete mixing of water is regulated by the thermal changes along with the wind action, which agitate the water and the heat is transported quickly to various depths in these shallow wetlands of Aligarh region of northern India. Such mixing of water is not possible in deeper lakes and deeper central basin of lakes while complete mixing occurs in shallow margins of the lake (Anderson, 1968).

In all the three wetlands under study, homogeneity of temperature at different levels was observed and no thermal stratification was noted (Fig. 1). Berst and Mc Crimmon (1966) have also reported no thermal stratification in similar water bodies. The frequent mixing of water in these wetlands ensures the better aeration at depths and continuous replenishment of upper water layers with nutrients, which increases the productivity of wetlands (Reid, 1969). The pattern of seasonal fluctuations in air and water temperatures broadly agrees with the solar radiations and the photoperiods of the seasons. Surface water temperature is closely reflected to ambient air temperature (Efford, 1967 and Moss, 1969). A cold, dry and hot wind wave brings variations in air temperature in different seasons. The winter being usually cold whereas summer quite hot. The months of April and November are found to be moderate. Physico-chemical and biological properties also trigged with the changes in air temperature (Table 1) Statistical analysis also show a very significant positive correlation between monthly air and water temperatures (Figures 1, 2 & 3).

IV. CONCLUSION

Temperature also plays an important role in dynamics and biology of an aquatic ecosystem. In these three wetlands of Aligarh region of northern India, maximum temperature was recorded during summer months as the water gets rapidly heated during the day time having long photoperiods and clear sky. It was also recorded high during monsoon months because of high humidity and higher temperatures. While as, lower water temperature was recorded during the winter months, as the warm effects of solar radiations over this period was low in all the three wetlands that brings drop in water temperature. It was observed that seasonal variability of atmospheric temperature would affect the system temporally rather spatially.

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