

Research Article

Water Quality Status of Some Urban Ponds of Lucknow, Uttar Pradesh

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Abstract

This study aims to investigate the physico-chemical properties of some urban ponds in the ecological system of Lucknow which is called as the city of Nawabs in U.P. But owing to the unplanned development and urbanization, the ponds of this city are struggling for their existence. In spite of the global alarm for restoration of the water bodies, the ponds in the city are facing neglectance. For the study period ten ponds were selected. The physico-chemical parameters of the water sampled in June 2008 from ten ponds such as PH ranged from 6.55 to 7.93; Turbidity, 6.06 NTU to 8.59 NTU; Conductivity, 12.32 ms/cm to 16.84 ms/cm; D.O., 3.72 mg/l to 6.81 mg/l; B.O.D., 3.77 mg/l to 6.40 mg/l. Residual chlorine was detected only in pond A (1.09 mg/l), pond C (1.13 mg/l), pond E (1.04 mg/l) and in pond F (1.03 mg/l). Free CO₂ was found between 8.7 mg/l to 19.68 mg/l. TS, TDS, and Chlorides were found much beyond the permissible levels. Alkalinity ranges between 202.55 mg/l to 310.05 mg/l; Acidity between 10.75 mg/l to 15.48 mg/l; Total Hardness between 244.49 mg/l to 254.78 mg/l. Prominent sources of pollution are the domestic sewage, kitchen flow and street runoff *etc*. In addition, solid waste and garbage tied in polythene bags are recorded along the banks and also floating on the water surface.

Key words: Lucknow; physico-chemical; restoration; sewage; Urban ponds

Introduction

The term pond refers to a relatively shallow body of water, contained in an earthen basin, artificial or natural, retaining sewage or organic wastewaters to stabilize the waters and to make them in-offensive for discharge into receiving water body or on land through various physical, chemical and biological processes, involved therein.

Studies of urban pond ecology have mostly concentrated on physicochemical characteristics. Fresh water is a critical, finite, vulnerable, renewable resource on the earth, and plays an important role in our living environment, without it, life is impossible. Since the beginning of the industrial revolution, increasing human population, economic activities as well as shortcomings in their management have resulted in more pollutants being introduced into watercourses. An increasing number of surface water bodies have come under serious threat of degradation. The global freshwater resources are under increasing pressure (GWP Technical Advisory Committee 2000). The anthropogenic impact on aquatic ecosystems has become a crucial topic of increasing concern. These problems have led to the adoption of an integrated approach to the management of water resources, which is called Integrated Water Resources Management (IWRM). Ponds, Rivers and streams are a valuable freshwater resource, irreplaceable, priceless assets providing important habitats and corridors for nature conservation, recreation, amenity and economic growth.

Normally over any short time interval in a pond not subject to human influence there is a balance, more or less between nutrient inflow and nutrient outflow. In recent times, the faulty developmental policies and mismanagement of surrounding areas of a pond have resulted into unprecedented nutrient enrichment of water bodies causing cultural eutrophication, which is manifested by raised trophic status, increased rate of sedimentation, loss of water storage capacity, lowered retention period and deteriorated water quality. The water quality in ponds, rivers and streams may vary depending on the geological morphology, vegetation and land use (modification by human activities such as agriculture, industrialization and urbanization) in the catchment. Industries, agriculture and urban settlements produce nutrients (sewage effluent and fertilizers) and toxic substances, such as organic and inorganic pollutants, and other chemicals including heavy metals. Water pollution occurs when these substances, which degrade the water quality of river, enter the waterway and alter their natural function (Water and Rivers Commission 1997).

The physico-chemical characteristics of any aquatic ecosystem and the nature and distribution of its biota are directly related to and influenced by each other and controlled by a multiplicity of natural regulatory mechanisms. However, because of man's exploitation of the water resources, the normal dynamic balance in the aquatic ecosystem is continuously disturbed, and often results in each dramatic responses as depletion of fauna and flora, fish kill, change in physico-chemical character *etc.* Artificial changes which lead to such ecological responses are referred to as pollution and pollutional stage may reach a stage when these valuable aquatic resources are no longer safe for human use. Of all the natural resources needed for sustainable development, fresh water is one of the most essential. Fresh water resources, such as ponds, rivers and streams, have undergone human-derived changes through the last century and have been under increasing threat of pollution in recent years due to increasing anthropogenic activities. The physical and chemical characteristics of water bodies affect the species composition, abundance, productivity and physiological conditions of aquatic organisms (Bagenal 1978). Ponds, Lakes and reservoirs around the globe are critical components in the ecological system. They provide habitat, sanctuary and food for many species of fish and wildlife and are also a source of process water to a myriad of industries (Dinar *et al.*

1995) .The number of small natural and man-made lakes, ponds and reservoirs is probably in the millions. These bodies of water (although they do not make a significant contribution to the global surface area) offer the same range of important services to nearby urban and rural populations as large lakes but unfortunately are more susceptible to pollution than large lakes. Where ponds and lakes have been profoundly altered and have lost much of their value, the scientific understanding of these water bodies is being used in prescribing restoration methods (Lewis 2000). Studies on water quality mostly center on fish production and aquatic biotic integrity (Boyd 1982, Abohweyere 1990, Kingh 1998). The notable important physico-chemical parameters are transparency, dissolved oxygen, temperature, suspended solids and dissolved ions (Karr and Dudley 1981). However the usage of water by man for survival is as important as that of fish.

Methodology

Study Area

Lucknow (26°5/N latitude, 80°56/E longitude, 128 m above the sea level), the Capital of Uttar Pradesh, is spread over an area of 310 sq. km in the central plain of the Indian subcontinent, supporting a population of 36.48 lakhs (2001 Census). It has distinct tropical climate with a marked monsoonal effect. The year is divided into three distinct seasons i.e., summer (March to June), Rainy (July to October) and winter (November to February). The temperature ranges from a minimum of 5°C in winter to a maximum of 47°C in summer. The mean average relative humidity is 60%, with a rainfall of 1006.8 mm. There are number of surface water bodies (i.e., pond *etc.*) both in the rural as well as urban areas of the city.

Sampling

With a view to study the water quality of urban ponds of Lucknow, ten ponds were selected from different areas, which are permanent in nature regarding water input. Water samples were sampled in jerry canes .Standard Methods of Examination of Water and Wastewater as prescribed by American Public Health Association (APHA 2000), American Water Works Association and Water Pollution Control Federation were employed for the study. The ten permanent water bodies selected for the study have been coded as **A to J** and are listed below:

- A** – Maviyahia pond called as cheer sagar near PGI.
- B** – At Mohanlalganj.
- C** - At Telebagh in front of Rambarose Intercollege.
- D**– Machlimandi at Telebagh – Charbagh road.
- E** – At Ruchikhand near Shardhanagar.
- F** – At Aurangabad Jageer behind Ambedkar Maidan.
- G** – Chotakheda near Amausi Airport.
- H**– Sheeshmahal Talaab near Ghantaghar at Chowk Bazaar.
- I** – Ashwanagar Jeel at Kalapahar Alamnagar.
- J** - Buttler Palace at Gokhle Marag Indra Nagar road.

Results and Discussion

The study reveals a clear picture of the status of water quality of different water bodies and is tabulated in Table 1 and 2. The physico-chemical properties in water bodies vary in composition and concentration on seasonal, diurnal or even hourly basis. These variations may be related to patterns of water use and rainfall (Abel 1996, Ayoade *et al.* 2006). The higher concentration of some parameters in some ponds is probably due to heavy pollution load from the nearby domestic, commercial and other sources resulting in the deterioration of these natural water bodies.

Table 1: Mean \pm SD of Water quality of Ponds (A to E) of Lucknow city

Parameter	A	B	C	D	E
pH	7.57 \pm 0.08	7.07 \pm 0.03	7.15 \pm 0.06	7.05 \pm 0.05	7.47 \pm 0.08
Turbidity(NTU)	8.14 \pm 0.05	7.66 \pm 0.06	8.36 \pm 0.04	6.06 \pm 0.05	7.92 \pm 0.11
Conductivity(ms/cm)	16.34 \pm 0.05	13.15 \pm 0.21	16.84 \pm 0.05	15.23 \pm 0.22	14.30 \pm 0.02
Dissolved Oxygen(mg/l)	4.32 \pm 0.03	5.93 \pm 0.07	3.72 \pm 0.04	4.12 \pm 0.03	5.08 \pm 0.15
BOD(mg/l)	5.08 \pm 0.05	4.97 \pm 0.125	6.40 \pm 0.05	5.97 \pm 0.81	4.92 \pm 0.21
Residual Chlorine(mg/l)	1.09 \pm 0.01	ND*	1.13 \pm 0.04	ND*	1.04 \pm 0.06
Free CO ₂ (mg/l)	9.46 \pm 0.07	11.1 \pm 0.11	19.09 \pm 0.06	11.60 \pm 0.41	19.68 \pm 0.55
Total Solids(mg/l)	1124.25 \pm 5.51	1051.26 \pm 1.91	1307.74 \pm 5.43	1111.27 \pm 0.47	910.08 \pm 0.24
TDS(mg/l)	909.98 \pm 0.11	1008.16 \pm 0.04	1012.72 \pm 0.10	998.24 \pm 0.06	768.25 \pm 0.06
Alkalinity(mg/l)	235.07 \pm 0.13	227.06 \pm 0.07	242.36 \pm 0.04	205.64 \pm 0.05	310.05 \pm 0.04
Chloride(mg/l)	56.93 \pm 0.88	44.53 \pm 0.45	66.52 \pm 1.67	44.90 \pm 0.69	64.40 \pm 1.13
Sulphide(mg/l)	32.43 \pm 0.52	32.68 \pm 0.48	25.38 \pm 0.41	32.62 \pm 0.42	34.91 \pm 0.057
Acidity(mg/l)	11.55 \pm 0.06	11.78 \pm 0.03	13.59 \pm 0.02	12.26 \pm 0.07	15.48 \pm 0.73
Total Hardness(mg/l)	253.38 \pm 0.35	244.49 \pm 2.06	254.78 \pm 0.58	249.37 \pm 0.35	253.64 \pm 0.68

Table 2: Mean \pm SD of Water quality of Ponds (F to J) of Lucknow city

Parameter	F	G	H	I	J
pH	7.6 \pm 0.01	7.1 \pm 0.01	6.55 \pm 0.06	7.93 \pm 0.04	6.89 \pm 0.01
Turbidity(NTU)	6.59 \pm 0.01	6.35 \pm 0.05	7.93 \pm 0.03	8.59 \pm 0.01	6.33 \pm 0.06
Conductivity(ms/cm)	12.32 \pm 0.23	13.72 \pm 0.09	13.68 \pm 0.02	12.57 \pm 0.04	12.55 \pm 0.06
Dissolved Oxygen(mg/l)	6.24 \pm 0.53	6.08 \pm 0.32	4.56 \pm 0.45	6.81 \pm 0.20	6.17 \pm 0.17
BOD(mg/l)	3.77 \pm 0.29	4.05 \pm 0.17	6.03 \pm 0.06	4.32 \pm 0.48	4.15 \pm 0.16
Residual Chlorine(mg/l)	1.03 \pm 0.05	ND*	ND*	ND*	ND*
Free CO ₂ (mg/l)	10.12 \pm 0.78	8.7 \pm 1.35	13.31 \pm 0.60	12.75 \pm 0.65	12.34 \pm 0.93
Total Solids(mg/l)	1011.25 \pm 0.78	1111.76 \pm 1.43	914.36 \pm 0.17	1010.25 \pm 0.04	910.57 \pm 0.025
TDS(mg/l)	968.45 \pm 0.05	1001.45 \pm 0.12	811.51 \pm 0.33	958.54 \pm 0.08	809.7 \pm 0.34
Alkalinity(mg/l)	202.55 \pm 0.06	231.54 \pm 0.06	235.19 \pm 0.09	235.59 \pm 0.04	218.38 \pm 0.02
Chloride(mg/l)	39.55 \pm 0.06	47.2 \pm 0.21	45.33 \pm 0.23	44.49 \pm 0.15	44.47 \pm 0.17
Sulphide(mg/l)	30.69 \pm 0.69	32.59 \pm 0.36	36.14 \pm 0.66	30.47 \pm 0.59	30.23 \pm 0.08
Acidity (mg/l)	10.75 \pm 0.85	11.66 \pm 0.63	12.88 \pm 0.23	11.59 \pm 0.56	11.39 \pm 0.26
Total Hardness(mg/l)	248.61 \pm 0.96	253.53 \pm 0.58	257.44 \pm 0.53	244.53 \pm 0.87	244.91 \pm 0.74

ND* = Not detected

The mean hydrogen ion concentration (pH) for the study period ranged from 6.55 in pond H to 7.93 in pond I which may be due to high CO_3^{2-} and associated environmental factors. Hydrogen ion concentration is an important factor in maintaining the bicarbonate and carbonate system of fresh water and contribute significantly to the formation of algal blooms (Anderson 1961, Jonasson 1969, King 1972). Turbidity was recorded in the range of 6.06 NTU in pond D to 8.59 NTU in pond I. The range of electrical conductivity was between 12.32 ms/cm in pond F to 16.84 ms/cm in pond C, which shows the availability of free ions and other nutritional elements such as nitrates, chlorides and bicarbonates. The average values of D.O. and B.O.D. indicate the presence of organic pollution sources.

Since there are no major industries around the study sites, the major source of organic pollutants is the domestic and to some extent nearby agricultural runoff. Residual chlorine was detected only in ponds A, C, E and F in the range of 1.09 mg/l, 1.13 mg/l, 1.04 mg/l and 1.03 mg/l respectively during the study period. Free CO_2 ranges from 8.7 mg/l in pond G to 19.68 mg/l in pond E. The CO_2 contributes to the fitness of natural waters which is derived from various sources such as atmosphere, respiration by organisms, bacterial decomposition of organic matter etc. Unni (1972) emphasized that the rate of changes in free CO_2 concentration is considerable due to decomposition of organic matter at the bottom.

Total Solids (TS) and Total Dissolved Solids (TDS) were found maximum, above the normal range. TS in water are due to inorganic substances, organic matter, suspended solids, silt, clay and plankton etc. TDS comprises mainly of inorganic salts and small amounts of organic matter. The values of total alkalinity were found between 202.55 mg/l in pond F and 310.05 mg/l in pond E. The range of total alkalinity in Indian waters may be found between 40 mg/l to over 1000 mg/l (Jhingran 1982). Chloride content in the water bodies ranged between 39.55 mg/l (pond F) to 66.52 mg/l (pond C). Chlorides in waters are generally due to salts of sodium, potassium and calcium. It may also be contributed by sewage discharge, irrigation drainage to the natural waters.

The sulphide content was found very high between 25.38 mg/l (pond C) to 36.14 mg/l (pond H). Its presence comes partially from the decomposition of organic matter, but mostly from the bacterial reduction of sulphate. The values of acidity were found maximum in the range of 10.75 mg/l in pond F to 15.48 mg/l in pond E. All waters having PH lower than 8.5 contain acidity (Maiti 2001). The results of Total Hardness were found between 244.49 mg/l (pond B) to 254.78 mg/l (pond C). Hardness in water is predominantly contributed by Ca and Mg along with Zn, Mn, Al and Fe.

Conclusion and Recommendations

The study concludes that the water quality of ponds of Lucknow city is polluted as the results are above the permissible limits. The city sewage discharge, agriculture and urban runoff and continuous dumping of waste materials especially sanitary waste are affecting the water quality of these urban water bodies. There is considerable need for better understanding of these small impoundments so that they can be managed effectively.

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