

Study of Water Quality Parameters of Pawana River, PCMC, Pune Maharashtra, India

Priya P. Joshi¹, Rameshwar Mortale², Muhafij Naikawadi³

^{1,2,3} Dept of Applied Sciences and Humanities

^{1,2,3} Pimpri Chinchwad College of Engineering, Pune, Maharashtra, India

Abstract- Analysis of water quality is of prime importance in environmental pollution monitoring. Bad quality of water poses a great threat not only to living organism, but to surrounding ecosystem as well. Due to ever-increasing urbanization of Pimpri Chinchwad Municipal Corporation (PCMC) area in Pune, a systematic physicochemical analysis of water quality was needed. In the present study, seven water samples have been collected from Pawana River from various locations during February to March 2022. Collected water samples belong to surface water. Physicochemical analysis of the sample included determination of pH, Conductivity, total hardness (in terms of CaCO₃ mg/liter or ppm) and alkalinities (in terms of CaCO₃ mg/liter or ppm). The water exhibited exceptionally high total hardness (from 200-300ppm) with high Bi-carbonate alkalinity (100 – 200 ppm). The pH of these samples was in the range from 6.7 to 7.8 and conductivity was as low as 0.12 mS and as high as 0.38 mS which is indicative of moderate conductivities due to high salt concentration. The obtained results indicate moderate hardness and alkalinities in different locations of Pawana river which directly is non-consumable for drinking and Industrial usage without municipal corporation treatment.

Keywords- BIS, pH, Pawana total hardness, total alkalinity, electrical conductivity, PCMC.

year for many purposes like household, industrial, agricultural usage etc. More stress on groundwater coupled with high population and disproportionate demand, urbanization, and industrialization have put considerable stress on water management.^{1,2} This has led to the depletion of water level in India in underground continuously and its purity being degraded due to large-scale discharge of industrial and agricultural contaminants and toxic metals.³ Pimpri Chinchwad is one of the fastest-growing suburb in Pune district and is rightly called as abode for automobile and IT industries in recent years. Growth rate of Pune for the last 40 years has been at least 40% and it's estimated that population will hit 5.6 million by 2031 if this trend continues. The migration of skilled labours from other states could be one of the important reasons. However due to increased urbanization of Pimpri Chinchwad area in past couple of years, it has been a real challenge for the corporation to deliver clean and sufficient amount of water to all the people of its jurisdiction. The use of pesticides in Maharashtra is on higher side⁴ as compared to other states which is prevailing cause of pollution of underground and surface water sources. The main goal of the study was to access the quality of Pawana river (a major water body in Maval taluka of PCMC⁵ for irrigation and drinking purpose) from dam region to Pimpri (a suburb in PCMC region of Pune district) covering 7 locations.

I. INTRODUCTION

Water is an essential part of our life and without good quality water sources survival of human life and industries is crucial. Chemical contaminants from nature or human interference render water unsafe for human consumption and also prove detrimental to industries using raw water.

Typically the water quality is determined by comparing the physical and chemical parameters of water bodies with standard guidelines set by Bureau of Indian standard (BIS) in our case. Providing safe drinking water to the common man is an priority of government. In that direction municipal corporation setup has state of the art water treatment plant to cater to the needs of safe water of its people. Due to ever-increasing demand for potable water, ground water sources have been exploited by citizens throughout the

II. MATERIALS AND METHODS

A. Study Area

Pimpri Chinchwad is an extension of Pune and rapidly grown into a giant industrial hub post independence. It is home for automobile industries, many medium and small-scale industries and IT hub in recent years. It is located at 53m (1,740ft) above sea level, about 15km from Pune center in northwest direction.⁶ The city is situated approximately at 18° 37' North latitude and 73° 48' East longitude. Three rivers Pawana, Mula and Indrayani flow through this area. The base rock found throughout the city is a Deccan trap basalt. Building stone is the only commercially important mineral found in the area^{7,8}. The summer season soars the city temperature from 35°C to 42°C. The Average rain fall is 722mm in monsoon season from June to September. Winter

season comprises of October to January where temperature lies between 12°C (min) to 30°C (max).

The Pimpri Chinchwad urban area Development Authority (PCNTDA) is that the urban planning authority. Pawana dam located at 35 km distance is currently the only water supplying body. Pawana dam has capacity of 241million cubic meters. The water after initial screening is pumped in from Pawana river at Ravet pumping station and then transported to Water Treatment Plant (WTP) at Appu Ghar, Nigdi, PCMC for treatment and then distributed to the entire PCMC area from there. There are two plants at WTP Nigdi PCMC with capacity of 114 mld each and phase III and IV of 100 mld each⁹ Approximately 420 MLD (million litres per day) is purified, disinfected and distributed to the entire PCMC area on daily basis. The city is divided into 32 electoral wards and 47 ESR (elevated service reservoir) zones for water supply.¹⁰

B. Sample Collection and Method

Samples were collected from different parts of Pawana river area during February and March 2022 (fig. 1). The samples were collected in PET bottles which were cleaned with double distilled water and air-dried. The analysis of these samples included determination of pH, electrical conductivity (EC), Total hardness (CaCO₃ equivalent in mg/liter or ppm) and total alkalinity (CaCO₃ equivalent in mg/liter or ppm). pH of 7 water samples were determined on digital display with electrode (equiptronics EQ 610) pH Range 0 to 14, electrical conductivity (EC) were determined on (digital display with conductivity cells make Equiptronics and displayed in mS (milliSiemens) per cm. Total hardness of samples were found out by titration against standardized Na₂EDTA using EBT (Erichrome Black-T) as indicator in basic pH maintained by using NH₄OH-NH₄Cl buffer. Total alkalinities were determined by performing neutralization titration of samples against standard 0.02N HCl using phenolphthalein and methyl orange as indicators.



Fig. 1: Location of all the sampling points

III. RESULTS

The results of various physico-chemical parameters recorded during analysis is given in table 1. This study suggests that the samples (S1-S6) collected from river are of bad quality. Extreme high hardness (approx. 300 ppm) is on the higher side of the permissible limit set by Bureau of Indian Standards; (BIS) which is between 200-600 ppm (IS-10500 2012). First and second locations near to the dam area of Pawana river are well within permissible limit and as river flows through suburb region of PCMC, its quality starts deteriorating as evident from the data. Possible reasons could be poor sanitation and mixing of industrial sewages.

Table 1: Different parameters for analysis

	Locations	Hardness	PH	Alkalinity	Conductivity
1	Pavnada	180	6.74	185	0.381
2	Urse Gaon	180	6.82	195.5	0.366
3	Kiwale	190	6.88	120	0.376
4	Ravet	210	6.96	150	0.373
5	Chinchwad Nagar	220	7.01	130	0.290
6	Pimpri	280	7.68	150	0.343
7	Municipal Corporation	240	7.75	160	0.122

IV. DISCUSSION

A. pH

pH can be defined as number of hydrogen ion concentration in given solution. pH scale is a measure to detect nature of solution whether acidic, basic or neutral. According to scale acidic range is less than 7, basic solution has range more than 7 and neutral solution has pH 7. Apart from pH scale nature of solution can also be determined by litmus paper. pH is very useful for determining concentration of acids and alkalies in water sample. pH is a measure of alkalinity and hardness of water sample.¹¹

Effect of pH of water supplied to agriculture is of prime importance. The pH of rain water is in the range of 5 to 6 which tends to be acidic in nature. River water pH is in the alkaline range between 6.5 and 8.5. pH of underground water drifts towards alkaline levels with in the range of 7 to 8.5. In rainy seasons, the alkalinity of river water decreases slightly.¹² In India, only 40% of the cultivation depends on rain water, while the remaining is supplied either from rivers by canal system or from underground through submersible pumps.

If the land having soil pH more acidic and if furnished with water more acidic or the other way around, then extreme acidity or alkalinity will have adverse effect on overall growth of crops. Therefore pH monitoring of water supplied for cultivation is mandatory. pH usually found out by using pH meter. Initially standardization of electrode is important. The standardization of a pH-meter is vital to make sure that the readings returned from that meter are accurate. Digital & analog pH meters offer calibration buttons or dials that are required to adjust the sensitivity of the meter.

B. Conductivity

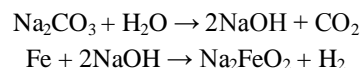
Conductance is defined as the ease with which current flows. Conductivity is the measure how well water can transmit electric current. When water containing salts like Ca, Mg and other metal ions present in water, it shows conductance. Organic and inorganic salts like chlorine, sulfate, nitrate present in excess amount shows high conductivity. Conductivity increases as the concentration of salts in water increases.¹³

Conductivity measurements are rapid and non-destructive way to measure salt content in the sample. The conductivity measurement is determined with an electronic sensor or meter and displays the result in micro/milli-Siemens per centimeter. Conductivity increases with increasing salt concentration, which means that in most it is an indicative of the total TDS content approximately. Conductivity is temperature sensitive and is usually standardized at 25°C. The presence of hardness in water is conveniently suggested by high conductance. But it does have the disadvantage of combining all ions in the measurement, including those that do not contribute to the water's hardness.

C. Alkalinity

Alkalinity is because of presence of high concentration of alkaline salts like hydroxide (OH⁻), carbonate (CO₃²⁻) and bicarbonate (HCO₃⁻). These salts make water highly alkaline which further imparts caustic embrittlement. Alkaline salts may present individually or in combined form.

If alkaline water is feed to the boiler it leads to caustic embrittlement.¹⁴ It is a type of corrosion which deteriorates boiler slowly by formation of sodium hydroxide followed by sodium ferroate.¹⁵



In caustic embrittlement metal becomes brittle. In agricultural field, alkalinity leads to kill many useful microbes. Underground water has natural filter process as it passes through layers of rocks containing salts which results in eutrophication.¹⁶

Alkaline water is not good for drinking purpose, cooking purpose due to high concentration of salts in it. In thermal power plant maintenance cost increases due to use of highly alkaline water sample.¹⁷ Alkalinity can be determined using neutralization titration where it is treated with hydrochloric acid, where amount of basic salts can be determined. Phenolphthalein and methyl orange are two indicators used for titration respectively.

D. Hardness

The net amount of impurities present in water sample is known as hardness. These impurities are of different types like suspended, biological, colloidal etc. Hardness in water affects quality and applications of water. If hard water is feed to the boiler for steam generation it causes corrosion of metal, scale, sludge formation which are bad conductors of heat. Boiler corrosion is the destruction of metal by forming pitting (holes) corrosion.

In industrial field, underground pipes, cable lines corrodes due to impurities present in water. In rainy season rate of corrosion increases as increase in the concentration of humidity can be observed.¹⁸ Acidic water is not safe for drinking purpose as it contains many pollutants in it. Acidic water also not safe for cultivation as high concentration of salts adversely affect proper growth of plants.¹⁹ Hardness can be determined by complexometric titration using Disodium salt of Ethylene Diamine Tetraacetic acid (Na₂EDTA). It forms a complex with salts causing hardness and thereby removes them from water by giving soft water. Erichrome Black T indicator is used for this titration.

V. CONCLUSIONS

An analysis of samples from Pawana river was carried for the assessment of water quality. The results found that as we move from from Pavna Dam area to Pimpri the

hardness of water of river increases as well as the pH also increases .But alkalinity of water doesn't change much.

VI. ACKNOWLEDGMENTS

The authors are thankful to Pimpri Chinchwad Education Trust, Direcotr, Pimpri Chinchwad College of Engineering for providing necessary laboratory facilities to carry out these investigations.

REFERENCES

- [1] Jain, S.K. , Sharma, A. , Kumar, R., Freshwater and its management in India, *Int. J. River Basin Manag.*, 2, 2004, 259–270.
- [2] Sabater, S. , Bregoli, F. , Acuna, V. , Barcelo, D. , Elosegi, A. , Ginebreda, A. , Marce, R. , Munoz, I. , Sabater-Liesa, L., Ferreira, V., Effects of human-driven water stress on river ecosystems: a meta-analysis. *Sci. Rep.* 8, 2018 ,pp. 11462.
- [3] Nayak, S., Distributional Inequality and Groundwater Depletion: an analysis across major states in India. *Ind. J. Agri. Econ.* 64, 2009, 90–107.
- [4] 4.Yadav, I.C. , Devi, N.L. , Syed, J.H. , Cheng, Z. , Zhang, G. , Jones, K.C., Current status of persistent organic pesticides residues in air, water and soil and their possible effect on neighbouring countries: A comprehensive review of India. *Sci. Total Environ.* 511, 2015, pp. 123–137.
- [5] R. Sabale, M. Shinde, J. Pagar, S. Adsule, . Shaikh, K. Bhadke, S, Joshi and P. Kolhe, Quality Analysis of Drinking water: A case study of PCMC, Pune, *IJRASET*, volume 6 (V), May 2018.
- [6] “PCMC/CITY LOCATION” www.pcmcindia.gov.in. Archived from the original on 6 August 2017. Retrieved 5 May 2018.
- [7] “Development plan-2021” Official website of PCMC. May 2000. pp.23–24 of 389. archived (PDF) from the original on 31 March 2019.
- [8] Kadam, Anushri D. Application of GIS in urban landuse changes in the PCMC (Pimpri Chinchwad Municipal Corporation): Ph.D. Thesis submitted to S.N.D.T. Women's University, Mumbai. Pune: Shodhganga: a reservoir of Indian theses. 2013., pp 15–16.
- [9] Sanjay Rode, Sustainable drinking water supply in pune metropolitan region:alternative policies Theoretical and Empirical Researches in Urban Management, January 2009, 4(1S), pp. 48-59.
- [10] Pimpri chinchwad water supply system including intra city distribution of water and control of ufw, Presentation to Working Group on Urban and Industrial Water Supply and Sanitation by Mr Pravin Ladkat Executive Engineer, Water Supply Department Pimpri Chinchwad Municipal Corporation, 2011.
- [11] Xinlei Sun Yaolin Yi, pH evolution during water washing of incineration bottom ash and its effect on removal of heavy metals, *Waste Management*, vol 104, ,1 March 2020, pp. 213-219.
- [12] India Water Portal Safe, Sustainable water for all.<http://www.indiawaterportal.org/>.
- [13] Ernesto Serrano-Finetti Carles Aliau-Bonet Oscar López-Lapeña Ramon Pallàs-Areny, Cost-effective autonomous sensor for the long-term monitoring of water electrical conductivity of crop fields, *Computers and Electronics in Agriculture*,165, October 2019, pp. 104940.
- [14] K.Abouswa F.Elshawesh A.Abuargo, Stress corrosion cracking (caustic embrittlement) of super heater tubes, *Desalination*, Volume 222, Issues 1–3,1 2008, pp. 682-688.
- [15] R.K.Singh Raman, Role of caustic concentration and electrochemical potentials in caustic cracking of steels, *Materials Science and Engineering: A*, Volume 441, Issues 1-2, 15 December 2006, pp. 342-348.
- [16] L.Serrano M.Reina X.D.Quintana S.Romo C.Olmo .M.Soria S.Blanco C.Fernández-Aláez M.Fernández-Aláez M.C.Caria S.Bagella T.Kaletka M.Pätzigh, A new tool for the assessment of severe anthropogenic eutrophication in small shallow water bodies, *Ecological Indicators*, Volume 76, May 2017, pp. 324-334.
- [17] Y.-S.Kim, W.-C.Kim, J.-G.Kimb, Bulging rupture and caustic corrosion of a boiler tube in a thermal power plant, *Tunnelling and Underground Space Technology*, Volume 104, October 2019, pp. 560-567.
- [18] Guoyang Fu, WeiYang, Chun-QingLi, Wenhai Shi, Reliability analysis of corrosion affected underground steel pipes considering multiple failure modes and their stochastic correlations, *Tunnelling and Underground Space Technology*, Volume 87, May 2019, pp. 56-63.
- [19] Anamika Singh, Sabeela Beevi Ummalyama, Dinabandhu Sahoo, Bioremediation and biomass production of microalgae cultivation in river water contaminated with pharmaceutical effluent, *Bioresource Technology*, Volume 307, July 2020, pp. 123233.