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Water Quality Assessment and Modeling of Parameters in Pawana River for Pimpri-Chinchwad Water Treatment Plant

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Abstract: **-- This paper presents a study of seasonal and spatial variation in the water quality parameters in Pawana River of the Pimpri-Chinchwad municipal corporation area. Grab samples were collected from various points along the river from the source to the pumping station of the PCMC water treatment plant. The samples were collected twice after every 15 days over a period of 8 months. A mathematical model has been prepared by employing regression analysis of experimental data.**

Key words**: Water, water quality, WTP, PCMC, grab sample, mathematical model.**

I. INTRODUCTION

More than 80% of diseases that affect humankind are waterborne and most of these diseases can be averted by processing water used for domestic purposes through simple treatment. Thus, the need for treatment of water for supply to communities, whether it is from groundwater sources or surface water sources, cannot be overstated, especially when the same source is being used for multiple purposes, such as irrigation, navigation and domestic apart from a drinking water source. The concern for water quality can be alleviated only through adequate treatment using appropriate processes.

II. SAMPLING

The objective of sampling is to collect a portion of material small enough in volume to be transported conveniently and yet large enough for analytical purposes while still accurately representing the material being sampled. The sampling method adopted in this study was Grab Sampling. In current study, samples representing each season were collected fortnightly for experimentation and analysis. Nine samples were collected from source to WTP. Locations of the points of sampling are given below.

Sr. No	Sampling Point	Co-ordinates	Distance from Source (km)
1.	Pawana Dam	18°40'36.7"N, 73°29'48.5"E	0
2.	Kadadhe	18°41'39.2"N, 73°32'20.0"E	6
3.	Shivane	18°41'41.4"N 73°35'48.4"E	13.5
4.	Bebadohal	18°41'41.1"N 73°39'03.5"E	21
5.	Shirgaon	18°40'12.9"N 73°40'56.9"E	23.4
6.	Gahunje	18°40'07.5"N 73°41'55.6"E	25.2
7.	Salumbre	18°39'29.0"N 73°41'51.1"E	26.5
8.	Kivale	18°39'34.0"N 73°42'44.2"E	27.7
9.	Ravet	18°38'28.6"N 73°44'32.7"E	30

III. EXPERIMENTATION AND ANALYSIS

Although water quality is usually sampled and analyzed in laboratories, nowadays citizens demand real-time information about the water they are drinking. During the last years, several companies are deploying worldwide, real-time remote monitoring systems for measuring water pH, turbidity or dissolved oxygen levels. The experimentation included the chemical analysis of the parameters discussed earlier (pH, alkalinity, hardness, chloride, turbidity). In order to understand the seasonal variation in the quality parameters, the sampling and the experimentation are done every 15 days (i.e. twice a month). This helped us to obtain the database for creating the mathematical model. The experimentation was done in accordance with the IS and the obtained results are compared with those specified by IS.

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The parameters selected for this analysis were pH, alkalinity, chlorides, hardness and turbidity.

IV. OBSERVATION

The results obtained for analysis for the winter seasons is given below:

Sample	Parameters				
	pH (By pH meter)	**Alkalinity** (mg/l,as $CaCO_3$)	**Hardness** (mg/l, as $CaCO_3$)	**Chloride Concentration** (mg/l)	**Turbidity** (NTU)
Pawana Dam	7.15	6	19.42	33.333	0.4
Kadadhe	7.17	8	46.608	38.888	0.6
Shivane	7.16	8	50.492	38.888	08
Bebadohal	7.22	18	54.379	44.444	1.6
Shirgaon	7.37	22	58.26	72.22	2.1
Gahunje	7.63	34	66.028	77.777	2.2
Salumbre	7.77	36	69.912	83.332	1.9
Kivale	8.11	42	69.912	72.22	1.6
Ravet	8.13	18	58.26	66.666	2.1

V. MATHEMATICAL MODELING

A mathematical model is an abstract model that uses mathematical language to describe the behavior of a system, which, in this study, is the variation in the water quality parameters. Technique used in this project was curve fitting.

Models for Monsoon Season

A) pH

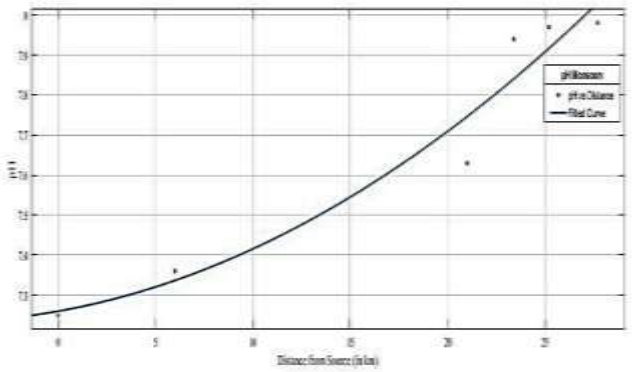
Model obtained for the pH data set of the monsoon season is a linear model of second degree or quadratic polynomial,

$$y = f(x) = p1x^2 + p_2x + p3$$

where, p1 = 0.0006896
p2 = 0.008669
p3 = 7.26

Goodness of fit:

SSE: 0.02934
R2: 0.9448
Adjusted R2: 0.9079
RMSE: 0.0989



B) Alkalinity

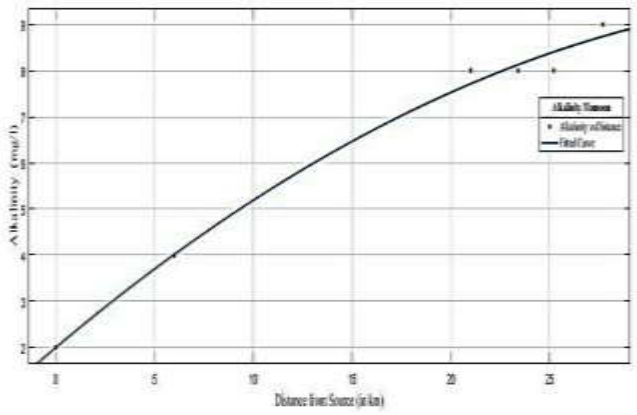
Model obtained for the Alkalinity data set of the monsoon season is a linear model of second degree or quadratic polynomial,

$$y = f(x) = p1x^2 + p_2x + p3$$

Where, p1 = -0.004286
p2 = 0.3621
p3 = 2

Goodness of fit:

SSE: 0.3274
R2: 0.9917
Adjusted R2: 0.9862
RMSE: 0.3304



C) Hardness

Model obtained for the Alkalinity data set of the monsoon season is a linear model of third degree or cubic polynomial,

$$y = f(x) = p1x^3 + p2x^2 + p_3x + p4$$

where, p1 = 0.004012
p2 = -0.1039
p3 = 1.299
p4 = 46.59

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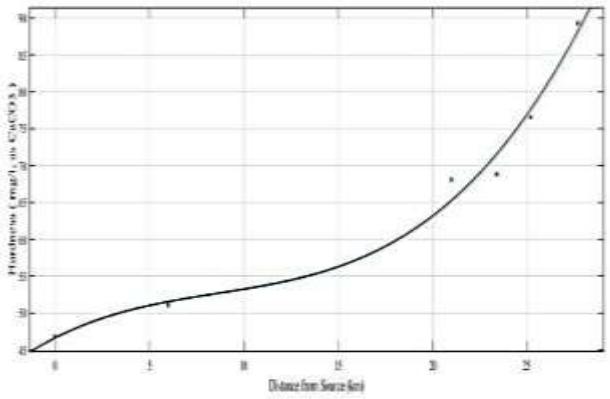
Goodness of fit:
SSE: 18.07
R2: 0.9856
Adjusted R2: 0.9641
RMSE: 3.00



D) Chloride Concentration

Model obtained for the Chloride data set of the monsoon season is a linear model of third degree or cubic polynomial,

$$y = f(x) = p1x^3 + p2x^2 + p_3x + p4$$

where, p1 = 0.0005046
p2 = 0.002153
p3 = -0.04668
p4 = 8.788

Goodness of fit:
SSE: 0.3687
R2: 0.9964
Adjusted R2: 0.9909
RMSE: 0.4294

E) Turbidity

Model obtained for the Turbidity data set of the monsoon season is a linear model of third degree or cubic polynomial,

$$y = f(x) = p1x^3 + p2x_2 + p_3x + p4$$

where, p1 = 0.002015
p2 = -0.07954
p3 = 0.9112
p4 = 3.989

Goodness of fit:
SSE: 0.5172
R2: 0.9812
Adjusted R2: 0.953
RMSE: 0.5085

VI. CONCLUSIONS

The water quality of Pawana River with respect to the chemical factors studied in this project is good. Water in the system is moderately hard, pH is near to neutral (6.5 - 8.5), and chloride is within limits. Turbidity is found to be high in the Monsoon season as the number of suspended particles in the river increases due to the soil carried by the runoff water. There is a sudden rise in the values of all the parameters after Bebadohal and it goes on increasing after this sampling location. This is due to the presence of industries and villages which dump the waste water directly into the river stream without treatment. Mathematical Models were developed with the help of curve fitting technique and MATLAB Curve Fitting Tool considering distance as an independent variable. Models were developed with fairly high coefficient of determination (R2 or r2).
Deterministic mathematical models are a powerful and useful tool for the pollution control and prevention in the system. This work has a huge potential into further research as it can predict the values of various water quality parameters without having to perform the experimental analysis.

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