Assessment of Impact of Sewage, Industrial Drains and Juke Piles on Krishna River Canal Networks using MATLAB in Vijayawada, Andhra Pradesh, India.

T. Preethi Rangamani[a], Prof. T. Srinivas[b]

[a] Assistant Professor, P.V.P Siddhartha Institute of Technology, Kanuru, Vijayawada, India. coppisetty.preethi@gmail.com

[b]Director, Centre for Distance Learning, GITAM University, Visakhapatnam, India.

Article History: Received: 10 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 20 April 2021

Abstract: A systematic study was carried out to assess the water quality at downstream of Krishna river canal networks, which are now facing a severe problem of pollution in Vijayawada. Deterioration of Krishna River canal networks was observed because of the disposal of untreated municipal and industrial sewage through various sewers. During the field visit and sample collection, we observed that time and money for labour force and huge investments for chemicals were needed for continuous sampling laboratory work. Literature reviews state that using systems analysis techniques to plan water pollution control is the foundation for water quality management. Here an attempt was made to develop a water quality model for Krishna River canal networks in Vijayawada by applying Quadratic regression using curve fitting in MATLAB. The result showed that the stimulation is well with the analytical observation, and this model can be used to study other parameters, as well as to reduce the time for laboratory analysis.

Keywords: MATLAB Software; Krishna River canal network; Pollution control; Simulation.

1. Introduction

Water plays an essential role in ecological functions and different ecosystems. Water stresses for various zones were fulfilled with the help of surface and groundwater. India is the one country facing a serious problem of clean water. According to CPCB 2015 report, more than half of the rivers in India were contaminated by the toxic organic, and inorganic pollutants. The largest source of water pollution in India is the release of untreated sewage from urban areas, industries, and organic runoffs from the agricultural fields. When contaminated elements enter into the surface or ground water, they get dissolved and deposited on the bottom of the water bodies and leads to The Deterioration of Water Quality.

2. Krishna River Canal Networks

Vijayawada often called as the commercial capital of Andhra Pradesh, is on the banks of Krishna river covered by hills and canals. Bandar canal, Eluru canal and Ryves canal originating from the north side of the Prakasam barrage flows through the city and irrigates more than 4.5 lakh hectares of agricultural lands. These canals also serve as a drinking water source in downstream areas of Krishna district. For the stimulation of Krishna river canal networks, six sampling stations on Bandar canal and Ryves canal, two sampling stations on Eluru canal was selected to carry out the laboratory work. Nearly 60 to 70 sewers were identified releasing the domestic and industrial wastes directly into the canal networks during the manual method of sample collection. To regulate and monitoring pollution of canal networks, it is important to carry out frequent laboratory testing of water samples. This process is time-consuming and builds up more expenditure on labour and chemicals. Developing water quality modelling using the software may be highly beneficial to overcome these types of problems.

3.Matlab Platform

In the present days MATLAB is using for modelling the river water quality with independent and dependent variable models. MATLAB is communicative software that allows the application of algorithms, graphics and creates border with other computer languages. MATLAB helps to predict water quality with present laboratory analysis data and helps to save time, manpower and other costs which required for continuous analysis. The present work is aimed to develop water quality prediction model by using MATLAB with laboratory analysis samples collected from Krishna river canal network areas. MATLAB signal processing toolbox is utilised with linear, non-linear algebra equation solutions.

4. Materials and Methods

Water samples are collected from sampling stations and subjected to physical, chemical and heavy metals analysis. The samples are collected in clean high density polythene bottles. The bottles are prewashed with laboratory grade detergents, washed with sample water and dried. Samples collected in each sample sites are acidified with nitric acid and subjected for analysis using water analyser and atomic absorption spectroscopy.

5. Result and Discussion

The analytical data of water samples indicates the high levels of

- Physical-chemical parameters like Alkalinity, Chloride, Fluoride, Sulphate, Total dissolved solids, Total hardness and Turbidity.

- Heavy metals like Aluminium, Calcium, Iron, Lead, Magnesium, Manganese, Mercury and Nickel. All these parameters crossed the threshold limits, according to WHO and BIS.
- These analytical reports are calibrated using MATLAB. And correlation coefficients were developed between the Total dissolved solids and Parameters that crossed the BIS limits using Quadratic regression equation with curve fitting.

QUADRATIC REGRESSION USING CURVE FITTING METHOD:

Let x and y be the two functions. The unknown coefficients a, b, c are computed by minimizing the sum of the squares of the deviations of the data from the model (least-squares fit).

Quadratic Regression Equation

$y = ax^2 + bx + c$

Where coefficients can be calculated as

$$a = \frac{[S(x^2y)\times S(xx)]-[S(xy)\times S(xx^2)]}{[(S(xx)\times S(x^2x^2)] - [S(xx^2)]^2}$$

$$b = \frac{[S(xy)\times S(x^2x^2)]-[S(x^2y)\times S(xx^2)]}{[S(xx)\times S(x^2x^2)]-[S(xx^2)]^2}$$

$$c = \left[\frac{(Syi)}{n}\right] - \left\{b \times \left[\frac{(Sxi)}{n}\right]\right\} - a \times \left[\frac{S(xi^2)}{n}\right]$$

QUADRATIC REGRESSION STATISTICAL EQUATIONS:

$$S(xx) = (Sxi^2) - \left[\frac{(Sxi)^2}{n}\right]$$

$$S(xy) = (Sxiyi) - \left[\frac{(Sxi)\times(Syi)}{n}\right]$$

$$S(xx^2) = (Sxi^3) - \left[\frac{(Sxi)\times(Sxi^2)}{n}\right]$$

$$S(x^2y) = (Sxi^2yi) - \left[\frac{(Sxi^2)\times(Syi)}{n}\right]$$

$$S(x^2x^2) = (Sxi^4) - \left[\frac{(Sxi^2)^2}{n}\right]$$

yi = individual values for each dependent variable
xi = individual values for each independent variable
n = number of pairs of data

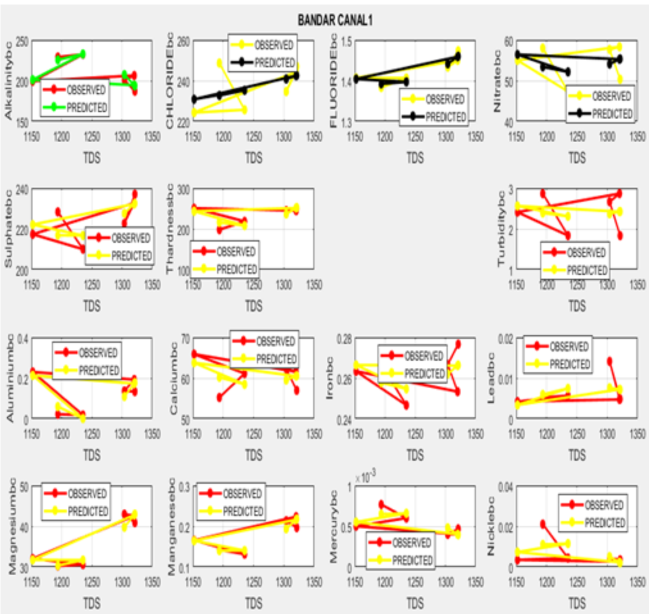

Fig. 1 Bandar Canal Observed and Predicted values of Physical- Chemical and Heavy metals.

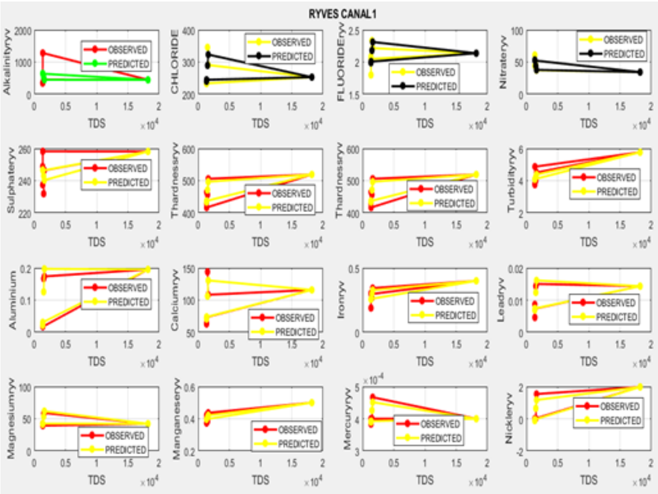

Fig. 2 Ryves Canal Observed and Predicted values of Physical- Chemical and Heavy metals

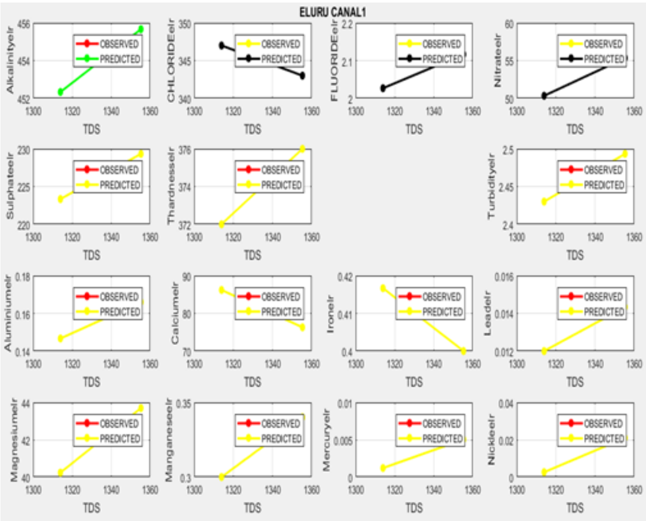

Fig. 3 Eluru Canal Observed and Predicted values of Physical- Chemical and Heavy metals

I. Bandar Canal Regression Equations

Parameters pairs	Regression Equations
TDS & Alkalinity	$Y = 0.00494\ (x^2) + 12.17301\ (x) - 7.27E^{+03}$
TDS & Aluminium	$Y = 2.71E^{-05}(x^2) - 0.06733\ (x) + 41.7661$
TDS & Calcium	$Y = 5.21E^{-04}(x^2) - 1.3081\ (x) + 8.79E^{+02}$
TDS & Chloride	$Y = 1.86E^{-04}(x^2) - 0.39188\ (x) + 4.35E^{+02}$
TDS & Fluoride	$Y = 4.83E^{-06}(x^2) - 0.01162\ (x) + 8.378905$
TDS & Iron	$Y = 1.63E^{-06}(x^2) - 0.00403\ (x) + 2.747512$
TDS & Lead	$Y = -3.07E^{-07}(x^2) + 7.82E^{-04}(x) - 0.49016$
TDS & Magnesium	$Y = 7.80E^{-04}(x^2) - 1.86253\ (x) + 1.14E^{+03}$
TDS & Manganese	$Y = 7.03E^{-06}(x^2) - 0.01708\ (x) + 10.50564$
TDS & Mercury	$Y = -2.56E^{-08}(x^2) + 6.25E^{-05}(x) - 0.03743$
TDS & Nickel	$Y = -9.43E^{-07}(x^2) + 0.002302\ (x) - 1.39293$
TDS & Nitrate	$Y = 5.23E^{-04}(x^2) - 1.29893\ (x) + 8.59E^{+02}$
TDS & Sulphate	$Y = 0.001465\ (x^2) - 3.56275\ (x) + 2.38E^{+03}$
TDS & Total Hardness	$Y = 0.005555(x^2) - 13.6866\ (x) + 8.64E^{+03}$
TDS & Turbidity	$Y = 2.62E^{-05}(x^2) - 0.06568\ (x) + 43.41599$

II Ryves Canal Regression Equations

Parameter pairs	Regression Equations
TDS & Alkalinity	$Y = 4.36E^{-05}(x^2) - 0.86477\ (x) + 1.73E^{+03}$

TDS & Aluminium	$Y = -3.87E^{-08}(x^2) + 7.67E^{-04}(x) - 0.93803$
TDS & Calcium	$Y = -1.32E^{-05}(x^2) + 0.261617\ (x) - 2.57E^{+02}$
TDS & Chloride	$Y = -1.85E^{-05}\ (x^2) + 0.36213\ (x) - 2.13E^{+02}$
TDS & Fluoride	$Y = -7.14E^{-08}(x^2) + 0.001405\ (x) + 0.232271$
TDS & Iron	$Y = -1.55E^{-08}(x^2) + 3.13\ E^{-04}(x) - 0.13608$
TDS & Lead	$Y = -2.03E^{-09}(x^2) + 4.02\ E^{-05}(x) - 0.04341$
TDS & Magnesium	$Y = -4.54E^{-06}(x^2) + 0.088907\ (x) - 69.7947$
TDS & Manganese	$Y = -5.14E^{-09}(x^2) + 1.07E^{-04}(x) + 0.262496$
TDS & Mercury	$Y = -1.39E^{-11}(x^2) + 2.72E^{-07}(x) + 4.92E^{-05}$
TDS & Nickle	$Y = -2.80E^{-07}(x^2) + 0.005594(x) - 7.12348$
TDS & Nitrate	$Y = 3.35E^{-06}(x^2) - 0.06675(x) + 1.37E^{+02}$
TDS & Sulphate	$Y = 1.46E^{-06}(x^2) - 0.02798(x) + 2.82E^{+02}$
TDS & Total Hardness	$Y = -1.38E^{-05}(x^2) + 0.275115(x) + 89.04611$
TDS & Turbidity	$Y = -6.15E^{-08}(x^2) + 0.001303\ (x) + 2.444306$

III Eluru Canal Regression Equations

Parameter pairs	Regression Equations
TDS & Alkalinity	$Y = -1.94E^{-04}(x^2) + 0.599799(x) + 0$
TDS & Aluminium	$Y = 2.63E^{-07}(x^2) - 2.34E^{-04}(x) + 0$
TDS & Calcium	$Y = -2.25E^{-04}(x^2) + 0.361413(x) + 0$
TDS & Chloride	$Y = -2.66E^{-04}(x^2) + 0.613928(x) + 0$
TDS & Fluoride	$Y = 4.69E^{-07}(x^2 + 9.27E^{-04}(x) + 0$
TDS & Iron	$Y = -5.31E^{-07}(x^2) + 0.001015(x) + 0$
TDS & Lead	$Y = 3.49E^{-08}(x^2) - 3.67E^{-05}(x) + 0$
TDS & Magnesium	$Y = 3.93E^{-05}(x^2) - 0.02101(x) + 0$
TDS & Manganese	$Y = 7.03E^{-06}(x^2) - 0.01708(x) + 10.50564$
TDS & Mercury	$Y = -2.56E^{-08}(x^2) + 6.25E^{-05}(x) - 0.03743$
TDS & Nickle	$Y = -9.43E^{-07}(x^2) + 0.002302(x) - 1.39293$
TDS & Nitrate	$Y = 6.10E^{-05}(x^2) - 0.04184(x) + 0$
TDS & Sulphate	$Y = -1.83E^{-05}(x^2) + 0.194011(x) + 0$
TDS & Total Hardness	$Y = -1.37E^{-04}(x^2) + 0.463753(x) + 0$
TDS & Turbidity	$Y = -2.34E^{-07}(x^2) + 0.002157(x) + 0$

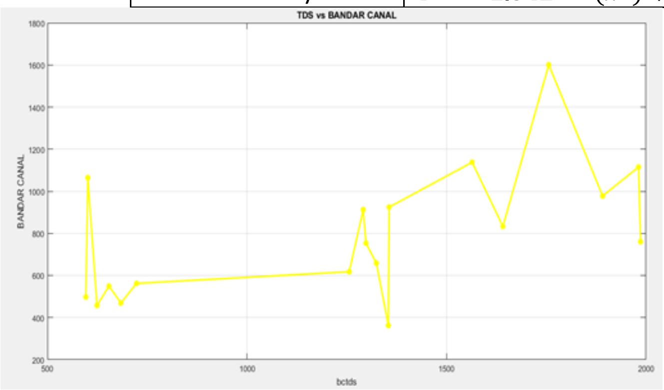

Fig. 4 Curve Fitting between TDS and other Parameters in Bandar Canal.

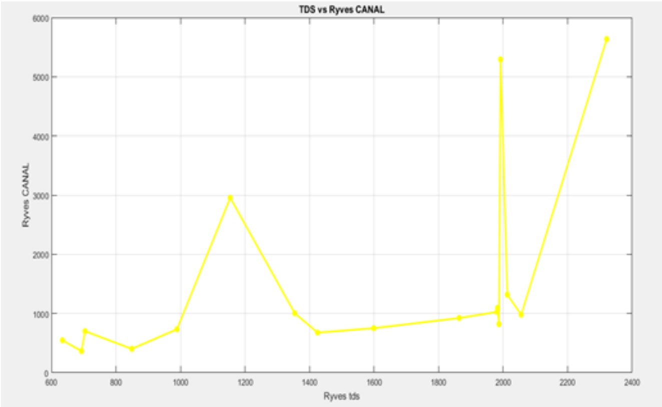

Fig. 5 Curve Fitting between TDS and other Parameters in Ryves Canal.

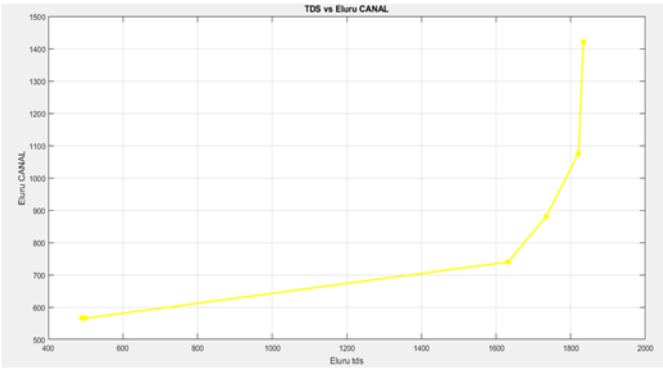

Fig. 6 Curve Fitting between TDS and other Parameters in Eluru Canal

6. Conclusion

In the present study, the physical- chemical and heavy metal analysis shows that the Krishna River canal networks are polluted with release of untreated sewage waste and juke piles. All the canals in the Krishna river canal networks are showing high ionic concentrations at TDS 1600 mg/L and above, which is highly threshold to use this water for both domestic and irrigation. The present paper briefly explains how MATLAB programming tool can be used to predict water quality of rivers by calibrating observed and predicted values with almost negligible errors. High degree of pollution was observed at Ryves canal because of huge effluents from Auto Nagar casting and electro plating units carried by Guntathippavagu in to the canal. Pollution of Eluru canal may be due to accumulation of juke piles dumped near by the canal embankments. Concentration of pollutants in Bandar canal was due to domestic sewers. This study clearly reveals that how MATLAB helps to predict water quality with present data by observing the concentrations of TDS and save time, manpower and cost of laboratory analysis.

7.Recommendations

1. Sewers carrying waste water from domestic and industrial areas should not be released directly in to the canal networks without prior treatment.
2. Disposals near by the canal and canal embankments should be strictly restricted.

References

1. APHA – AWWA and WPCF, "Standard Methods for the Examination of Water and Wastewater", 16th Ed.
2. Washington D.C, APHA, pp.1268, 1984.
3. Khanna, D.R. and Bhutiani, R. (2005). "Water Analysis at a glance". Published by ASEA Rishikesh 1–
4. 108pp.
5. NWP, (2002). National Water Policy, Ministry of Water Resources, Government of India, 9pp.
6. The Math Works Inc. (2015), "Simulink User Guide".
7. Sarah Khan and Singh S.K. (2013), "Assessment of the impacts of point load on river Yamuna at Delhi

8. stretch, by DO-BOD Modelling of river, using MATLAB Programming”, International Journal of
9. Innovative Research in Science, Engineering and Technology 2(10), 282-289.
10. Jinal Y. Patel , Minakshi V. Vaghani (2015), “Correlation Study for Assessment of Water Quality and Its
11. Parameters of Par River Valsad, Gujarat, India”, International Journal of Innovative and Emerging
12. Research in Engineering, 150-156.