RIVER WATER QUALITY MODELLING: GODAWARI RIVER

Bhoir Saurabh Hemant

Abstract— **Godavari River is the Largest River on Indian Plateau. It has its source in Sahyadris near Trimbakeshwar. The Pranhita, Indravati and Manjara join this river. The river passing through Kopargaon City is 80% polluted by domestic pollution and 20% by industries. River water quality models are used extensively in research as well as in the design and assessment of water quality management measures. The application of mathematical models for that purpose dates back to the initial studies of oxygen depletion due to organic waste pollution. Since then, models have been constantly refined and updated to meet new and emerging problems of surface water pollution, such as eutrophication, acute and chronic toxicity, etc. In order to handle the complex interactions caused by the increased influence of human activities in rivers. It is today mandatory to couple river water quality models with model describing emissions from the drainage and sewerage system. Special attention is given here to the modeling of convergence processes, but also the methods and tools to work with the models i.e. parameter estimation, and simulation software QUAL2E are discussed. QUAL2E is a framework for the simulation of water quality in streams and rivers. We have selected a stretch of 25km of Godavari River for determination of water quality parameters.**

Index Terms— **Water quality Model, Conventional pollutants, River stream, Software (QUAL 2E).**

I. INTRODUCTION

Water, forms a basic need of human and almost all living things. Most of such a basic need is satisfied by rivers mainly. Whereas the use of water leads to release of unwanted and harmful pollutants discharged into lakes and rivers. This makes the water of lake and river impure. For instance, water quality of river channels in India as whole has the most serious water pollution. Moreover, in recent years, many cities have begun to study the control measures for the river stream pollution.

In this work, based on the theoretical method of river water quality simulation and system optimization, the pollution caused by municipal drainage, industrial drainage and other inlets is studied for river in flood season and related pollution control planning. An attempt is made to develop an optimization model that provides means of finding the most feasible treatment option that if adopted can improve water quality of river. The model has been developed for Godavari River system that receives waste effluent from domestics as well as industries in its vicinity.

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***Saurabh Hemant Bhoir**, BE Civil, LLB-I Kopargaon, Ahmednagar, Maharashtra, India, +919527 677287*

A. *Necessity*

It is necessary to develop certain effective way to obtain good quality water flow in river. Water flow in the region is mainly dependent on the river water retained by the barrage which helps it to infiltrate and increase ground water level to be used for functioning of the rural life. Population and the small scale industries are insufficient in processing enough economic prospects to establish good quality water by direct treatment plant establishments. Water treatment plant establishment for given locality may have various conflicts in case of revenues related cases as the level of pollutants released by small industries is considerably high to meet with standards and may cost high against the company prospects although control of the point sources by the industries as per the law for release of pollutants is checked the problem continues with release of nonpoint sources of pollution by the town and agricultural activities. Use of water quality would be an effective tool in developing solution to problem in such case. With use of property of self cleansing of river, pollution level is reduced to a great extent and thus in turn achieving economy and also control on unpredicted unknown nonpoint sources of pollutants.

Analysis and determining data related to water flow conditions and long with it the waste polluting matter released at various intervals by various agencies is computed and its functionality in duration basis which is correlated with water present in river and self purifying agencies at various locations river stretch.

B. *Objective*

1. Know the level pollutants released by the town.
2. Know pollutants present into the river before river entering the locality.
3. Hydraulics water flow conditions in seasons and in average cases.
4. Aquatic life in the river body throughout the stretch.
5. Relation of release of pollutants by the industries into the river in relation with actual river pollution level.
6. Development of model to regulate rate of flow of pollution to water present in river.
7. Suggesting a proper technique for obtaining water quality of river.
8. Establishing water quality standards in place of fixed effluent discharge standards.

C. *Summary*

In India the environment pollution control is based on the factor of prevention at source and standards are established on fixed emissions standards. These are almost difficult to be practiced by the rural population with low prospects. The domestics from towns and various unknown nonpoint sources of pollutants also lead to great level of pollution.

The river gets reduced in its self purification capacity by great extent. When such things are well monitored and calibrated in length and water quality model is developed to obtain good quality water in the river.

II. Methodology

A. General

In our project we have conducted preliminary survey of Godavari River and finalized a particular stretch of 4.5 Km. the waste effluents from Kopargaon city, MIDC area and Sanvatsar village has been discharged to main stream under consideration. By considering the problem of Godavari River faced by surrounding locality and to take a sound decision over these problems, we are conducting following experiments on river water to determine the quality standards of water:

1. DO
2. BOD
3. COD
4. Total Solids
5. Phosphate
6. Nitrite
7. PH

B. What is River Water Modeling?

The dilution of waste water in natural stream and its self purification process is dependent on the discharge of pollutants into stream and the quantity of discharge of good water in the stream. Rivers have property of self cleansing the impurities and make available good quality water for use for settlements on the downstream of the River. The calibration of such values in form of a model to facilitate the country to adopt the water quality standards instead of fixed effluent discharge standards is known for river water modeling.

River water modeling is calibrating a river model at certain analyzed river length which the values of hydraulic and water quality data is calibrated and modeled with. River Water modeling studies has its type of approach with their application

Modeling Approach	Applications
Mass Balance	Assessment of compliance with derived Intermittent standards.
Simplified River Model	Assessment of compliance with fundamental intermittent standards.
Full 1 D model with default parameters	Assessment of solutions.
Fully calibrated 1 D model	Calibration of simplified models or development of site specific standards. Assessment of solutions to water quality standards. Develop understanding of river system, focus in on true problem.

Water Quality Models are very use full in describing the ecological state of river system and to predict the change in this state when certain boundary or initial conditions are altered. Such changes may be due to morphological notifications to the water body, such as straightening and discharge regulations using control structures,(weirs, dams etc.), changes in the type, amount and location of pollutant loading into the system, and changes in meteorological inputs due to changing trends in climate. The degree of complexity in describing the ecological state varies from model to model. The complexity of deterministic models, the type investigated in this study, varies by the number and type of variables describing the state of the ecological system and the parameters underlying the processes governing the kinetics of the system.

C. Objective:

1. To continuously monitor the water quality of Godavari River on monthly to annual basis. In the various stretches in order to assess water quality trend over a period of time.
2. To assess the impact of tributaries or other outfalls e.g. Drains.
3. To evaluate effectiveness of pollution control measures already in existence and to assess nature and extent of requirement of additional pollution control measures.
4. To assess the improvement in water quality as a result of implementation.

D. Godavari Action Plan

1. To assess pollution loads in terms of important pollutants, joining the river by regularly monitoring major drains on monthly basis.
2. To assess micro-pollutants load in the river water and sediment at critical stretch of Godavari River through monthly and seasonal monitoring.
3. To assess water quality of river in terms of important water quality parameters once a month in the river stretch identified under Godavari Action Plan.

E. Sampling Location

The sampling stations for river and major drains joining Godavari River were selected on basis of the need and potential of water quality impact or pollution load transported respectively. The sampling locations of Godavari River along with major outfalls of drains are depicted in fig. *(a)*

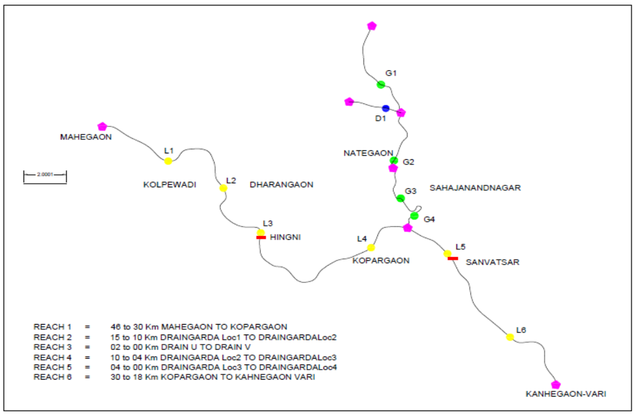

Fig. (a) Sampling locations Map

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a) Small Bridge:
The sampling site is situated just upstream of small bridge. This location is approximately 20m upstream from bridge of main stream of Godavari river. This reference station provides water quality of river near the source.

b) Major bridge:
Approximately 1km from Godavari Bridge, this location provides information about the impact of various tributaries that joins main stream at high reaches.

c) Khandak nala;
Approximately 300m from small Bridge at downstream.

d) Stream 1:
Approximately 1.5km from Godavari Bridge, This location provides water quality prior to the river and before receiving any significant pollutant from industrial centers.

e) Stream 2
Approximately 2 km downstream of small bridge, this location provides water quality after the domestic tributaries.

f) Sanvatsar Nala
Located upstream side of Mahanubhav Temple 1km east of Sharada-nagar at Sanvatsar Village, This location provides quality of Godavari water mainly contributed by ground water accrual and some river tributaries etc.

F. Monitoring Methodology

Grab river water samples were collected from the end stream (end of river width) or from the well mixed zone at all the river locations from a depth of about 0.3m. Additional samples were also collected at four impact locations towards out fall side. Grab samples were also collected from the drains location before their merger with river or canals. The collected samples were preserved by chemicals, depending upon the parameters and transported to the laboratories as early as possible for the analysis. Measurement of few parameters like temperature and dissolved oxygen at river locations and discharges at drain locations have been carried out at the monitoring site itself.

G. Parameters to be considered

August, September and October, parameters for river flow-

Table 1: For River Flow

PARAMETERS	R (Aug)	R (Sept)	R (Oct)
pH	7.3	7.26	7.24
DO	3.34	4.28	3.84
BOD	82.52	80.68	78.68
COD	9792	9337.4	10480
CONDUCTIVITY	398	376	388.4
TS	36.924	42.33	38.41
TDS	8.868	9.926	9.62
TSS	28.056	32.408	28.78
TVS	5.594	8.104	6.41
TFS	31.33	34.23	28.39
CHLORIDES	37	26.5	34
TOTAL HARDNESS	239.2	226.8	224
SULPHATES	29.5	36	31
PHOSPHATES	0.604	ABSENT	0.994
NITRATES	0.46	0.27	0.23
NITRITES	0.366	0.47	0.44
TEMPERATURE	27.6	27.2	25.2

River water flow for August, September, October stream water flow-

Table 2: For Streams.

PARAMETER S	S (Aug)	S (Sept)	S (Oct)
pH	6.967	6.9	6.96
DO	8.1	6.67	7.73
BOD	38.6	27.7	26.82
COD	25390	26796	25748
CONDUCTIVITY	480	480	480
TS	126.16	138.6	127.63
TDS	1.866	3.03	1.96
TSS	124.3	135.566	125.66
TVS	2.83	2.33	1.86
TFS	122.566	136.26	125.76
CHLORIDES	11	9.5	7
TOTAL HARDNESS	159.66	142.67	145
SULPHATES	17	5.16	0.47
PHOSPHATES	0.233	ABSEN T	0.29
NITRATES	1.12	2.89	1.67
NITRITES	2.55	3.1	2.78
TEMPERATURE	28	28	26

III. QUAL2E SOFTWARE REPRESENTATION-

As environmental control become more costly to implement and the penalties of judgment errors become more Sevier, environmental quality management requires more efficient management tools based on better knowledge of the environmental phenomena to be managed

The stream water quality model QUAL2E is widely used for waste load allocations, discharge permit determinations, and other conventional pollutant evaluation in this state. Since the introduction of QUAL2E in 1970, several different versions of models have been evolved.

The enhancement to QUAL2E incorporated improvements in eight areas- 1)algal, nitrogen, phosphorous and dissolved and dissolved oxygen interactions; 2) Algal growth rate; 3)Temperature; 4)Dissolved oxygen 5)Arbitrary non conservative constituents;6) Hydraulics; 7) Downstream boundary considerations; 8)Input or output modification.

A. History:

QUAL2 water quality model were developed by F. D. Masch and associates Texas water developmental board. In 1972 water resources engineers (W.R.E.) under contract to

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U.S. environmental agency, modified and extended first version of QUAL2 .in March 1976, The Southeast Michigan Council Of Government contracted with WRE to make further modifications and to combine the best features of the existing versions of QUAL2.

1. Option of English or metric units on input data.
2. Option of English or metric output choice is independent of input units.
3. Option to specify channel hydraulic properties in terms of trapezoidal channel or stage discharge and velocity discharge curve.
4. Improvement in output display routine.
5. Improvement in steady state temperature computation routine.

These enhancements are fully documented in this report and summarized as follows,

1. Algal, nitrogen, Phosphorus, dissolved oxygen interaction
2. Algal growth rate
3. Temperature
4. Dissolved oxygen
5. Arbitrary non conservative constituent
6. Hydraulics
7. Downstream boundary
8. Input/output modification

B. QUAL2E Computer model

Prototype Representation

QUAL2E permits simulation of any branching one dimensional stream. The first step in modeling a system is to subdivide the stream system into reaches, which are stretches of stream that have uniform hydraulic characteristics. Each reach is then divided into computational element of equal length. Thus all reaches must consist of an integer number of computational element.

There are seven different types of computational elements:

1. Headwater element
2. Standard element
3. Element just upstream from a junction
4. Junction element
5. Last element in system
6. Input element
7. Withdrawal element

1.2.2 Model Limitation

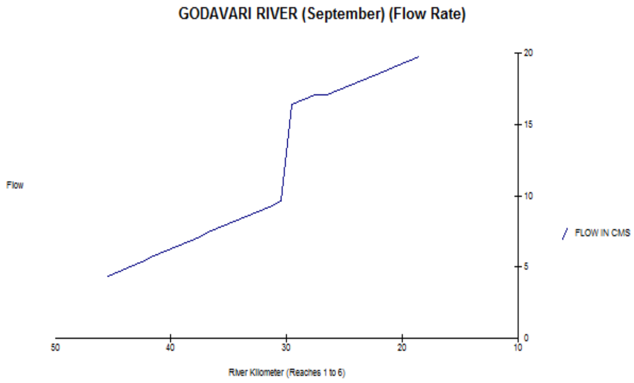
QUAL2E has been designed to be a relatively general program; however certain dimensional limitations have been imposed during program development. These limitations are:

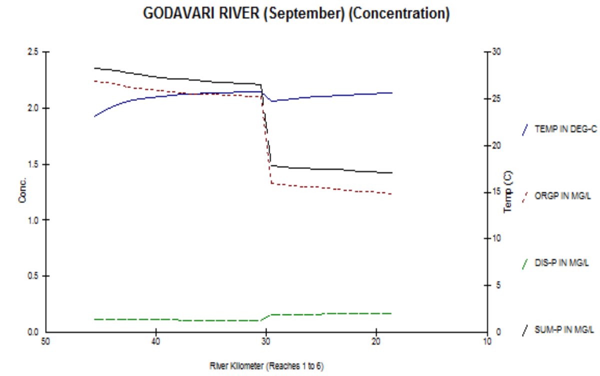
1. Reaches: a maximum of 25
2. Computational element: no more than 20 per reach or a total of 250
3. Headwater element: a maximum of 7
4. Junction elements: a maximum of 6
5. Input and withdrawal elements: a maximum of 25

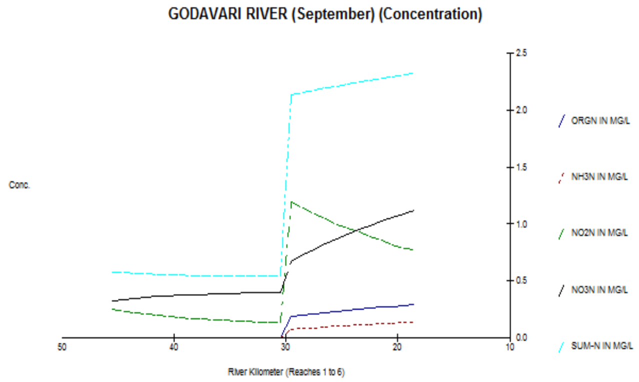
IV. RESULTS

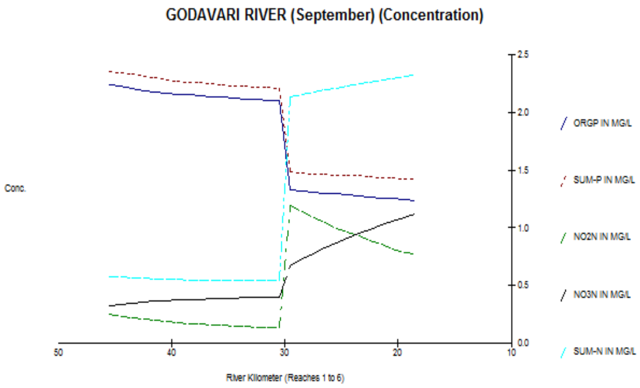
From the above process it has reached to the following results.

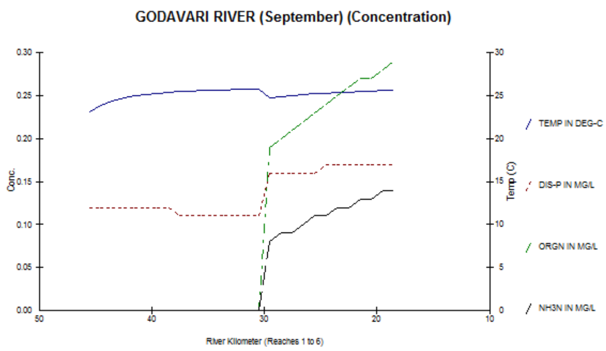
Following are the statistics resulting from parameters obtained from river flow for September Month, generated by QUAL2E.

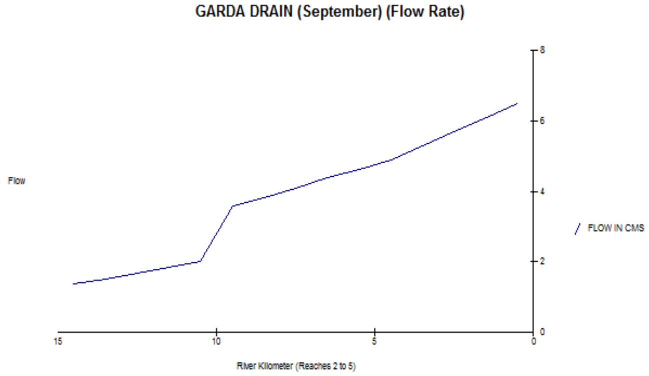


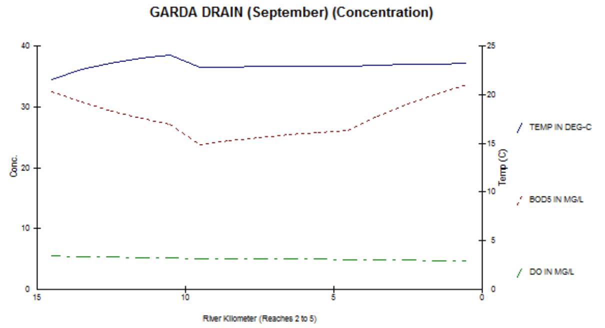


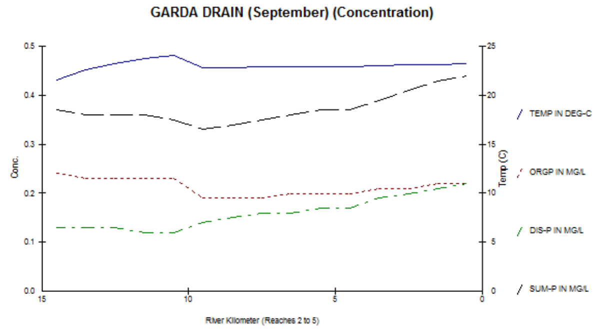


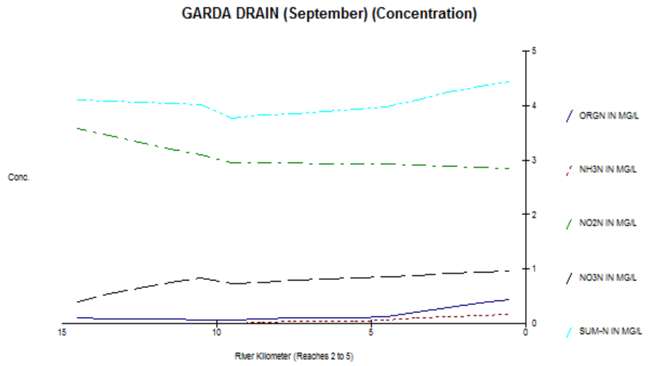


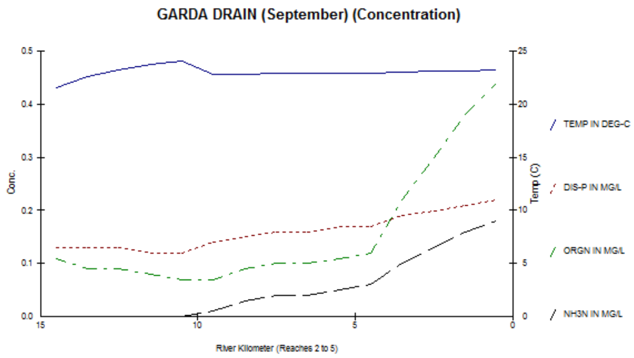


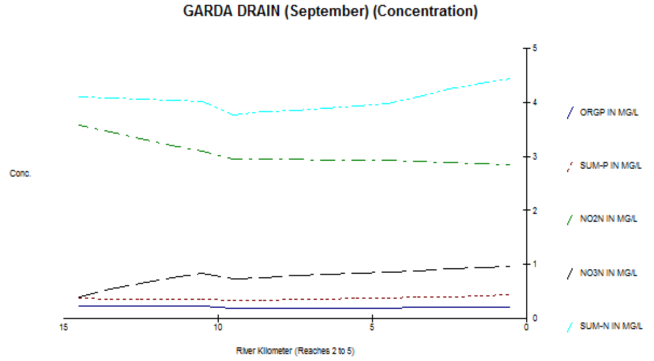


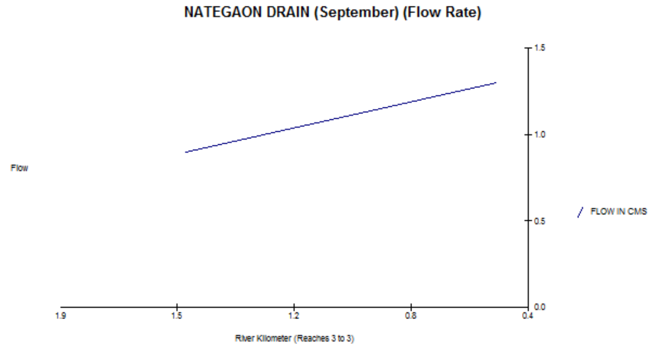


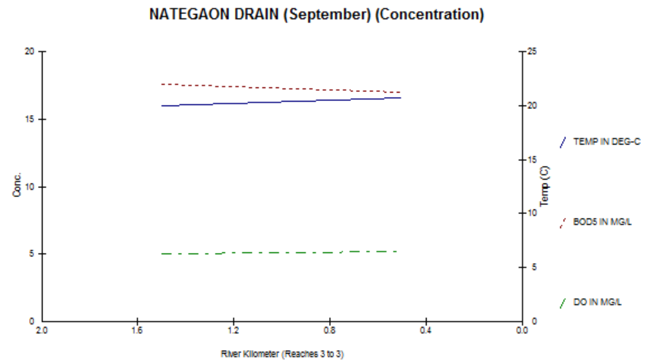


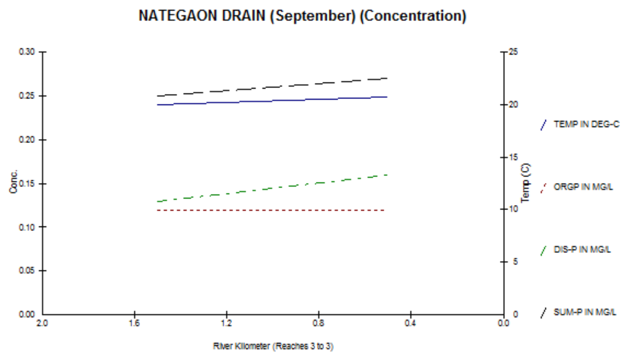


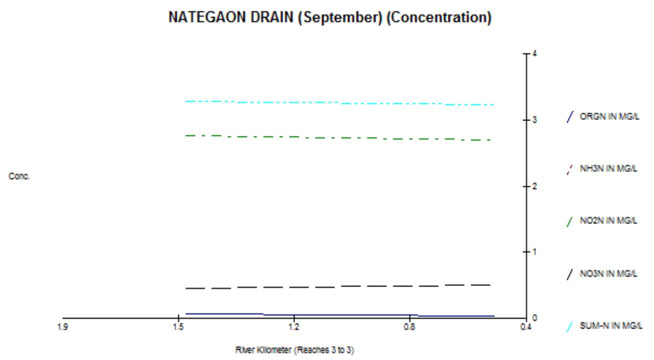












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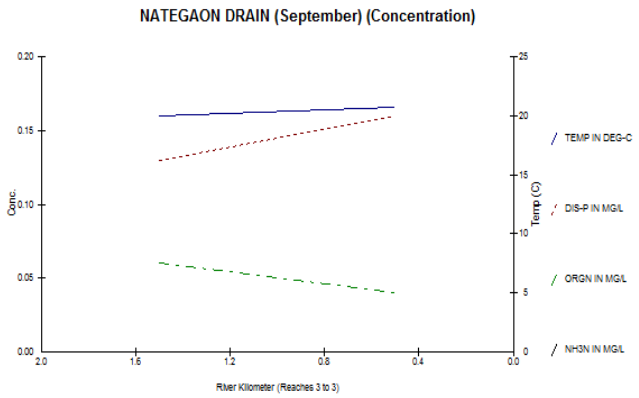

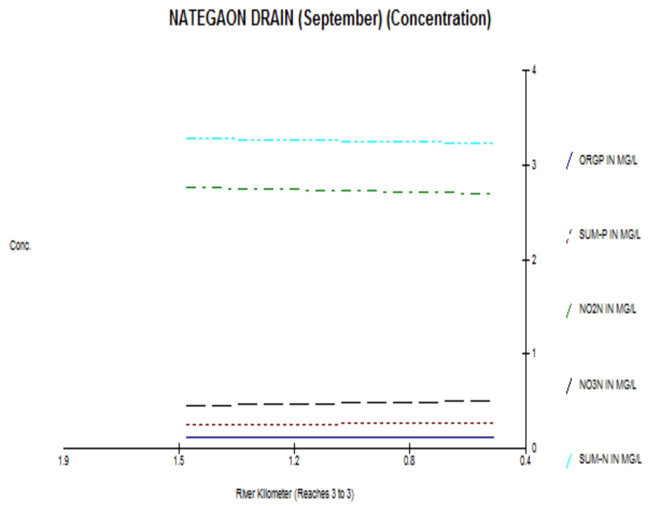

V. ABBREVIATIONS

DO -Dissolved Oxygen
COD -Chemical Oxygen Demand
BOD -Biochemical Oxygen Demand
TS -Total Solid
TSS -Total Suspended Solid
VSS -Volatile Suspended Solid
TDS - Total Dissolved Solids
TFS - Total Fixed Solids

VI. CONCLUSION

River water quality models are used extensively in research as well as in the design and assessment of water quality management measures. The water quality assessment consists of a 25 km stretch of Godavari River in polluted area includes industries like laundry, hotels, restaurants, etc., which are discharging into the river. In our project, we found out the parameters present in respective stretch and pollutant concentration. Further to assess the quality management of water we are going to formulate the models by using QUAL2E software. It is therefore suggested that in the light of present development in the study stretch, there is need to reassess the required facilities and to take effective steps to put them into full operation to achieve the targets.

VII. ACKNOWLEDGEMENTS

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VIII. REFERENCES

[1].A W. M. G, et al and B. J. C. PERERA, "Importance of genetic algorithm operators in river water quality model parameter optimization",pg .no.1943-1948
[2]. Erica J. Brown Gaddis, Helena Vladich, "Participatory modeling and the dilemna of diffuse nitrogen management in a residential watershed" ***Vladich*** 22 (2007) 619-626
[3]. Gregory J. Pelletier, Steven C. Chapra, Hua Ta, "Qual2E framework for simulation of model", 21 (2006) 419- 425
[4]. Himesh S, Rao C. V. C., Calibration and validation of water quality model
[5]. Macro J. Van De Wiel, Tom J. Coulthard, Mark G. Macklin, John Lewin, "Computation of model" 104 (2011) 167-185
[6] Richa Babar, Himanshu Joshi, "Mixed Integer Programming for Pollution Control Of Indian Tropical Rivers: A Case Study" The Journal of Transdisciplinary Environmental Studies vol. 9, no.2, 2010
[7]. W. Rauch, M. Henz, L. Koncso, P. Reichert, P. Shanaham, L. Somlyody and P. Vanrolleghem, "River water quality modeling: State of the Art", IAWQ Biennial International conference, Canada, 21-26 june 1998.
[8]. Seok S. Park, "Comprehensive water quality modeling of Rariten :***June*** River".1990, 35 (1) , 17-23
[9]. Ajay D. Chavan, M.P.Sharma and Renu Bhargava, "Water Quality Assessment of Godavari River", issue no. 5 Hydro Nepal, July 2009, Page no.31-35.

Bhoir Saurabh H. Graduated from University of Pune, licensed engineer, Pursuing Law at University of Pune, certified technical consultant and working on sustainable development technology along with environment factors.

