Water Quality Assessment of the Godavari River

Ajay D. Chavan, M.P.Sharma and Renu Bhargava

MP Sharma

Renu Bhargava

Abstract: The Godavari River is a second largest river in India originating from Trimbakeswar, Nasik, Maharashtra, India. It flows through the states of Madhya Pradesh, Karnataka, Orissa and Andhra Pradesh. The river, passing through Nasik City, is 82% polluted by domestic pollution and 18% by industries. The study covers about 65 km of the river starting from Kushawart Trimbakeswar to Saikheda Village, from where it enters the city. Ten locations were selected for collection of water samples from the river and the samples were analyzed for water quality parameters in the Environmental Laboratory of the Maharashtra Pollution Control Board (MPCB), Nasik. These data as well as data from the Central Pollution Control Board (CPCB) were used to compute the National Sanitation Foundation Water Quality Index (NSFWQI), mostly applicable in the USA and India. The results of NSFWQI of Godavari River indicates its water quality as 'bad' (26-50) or 'medium' (51-70) over the study stretch. The NSFWQI of December 2007 and February 2008 indicate an improvement in water quality at all locations over earlier data from 2002-07. Based upon the results, the existing conservation measures have been reviewed and additional measures are suggested. The study concludes that major stressor is sewage pollution.

Key words: Water quality parameters, water quality assessment, water quality management, conservation measures

Introduction

Fresh water is a scarce natural resource today, as 97% of the surface water is saline water of the oceans while 2% is locked up in ice-caps and glaciers and the remaining 1% is expensive to be exploited from the ground. Thus, effectively 0.2 million km^3 of water available in rivers, lakes, wetlands, soil moisture, shallow ground water and reservoirs can be used to meet the demands of plants, animals and human beings. Out of 4,000 billion m^3 annual rainfall of India, 1,869 billion m^3 is lost in natural run-off in streams and rivers, 432 billion m^3 goes for recharging the ground water and only 690 billion m^3 of the surface water is available for various use. Almost 200 million people in India do not have access to safe and clean drinking water and 90% of the country's water resources are polluted (Eaton et al 1995). As per an estimate, about 3,035 MLD of water supply during 2003-04, 80% (2,428 MLD) is available as waste water and only 3.67% (81 MLD) has been treated and 96.3% (2,239 MLD) as untreated waste water is being discharged to our rivers, streams and lakes, making them highly polluted.

The present study deals with the water quality assessment of 65 km stretch of Godavari River from Kushawart to Saikheda village in Nasik District in the Indian state of Maharashtra. Attempts were made to identify point and non-point sources of pollution, collect data from CPCB and the study stretch, compute NSFWQI (National Sanitation Foundation Water Quality Index), define the status of water quality, and review existing and suggest additional conservation measures. The study stretch is sacred and attracts pilgrims in large numbers. As a result, the river has become the dustbin for eventual disposal of all sorts of pollutants (waste water, debris, etc.) generated on account of pilgrimage activities, as well as due to rapid

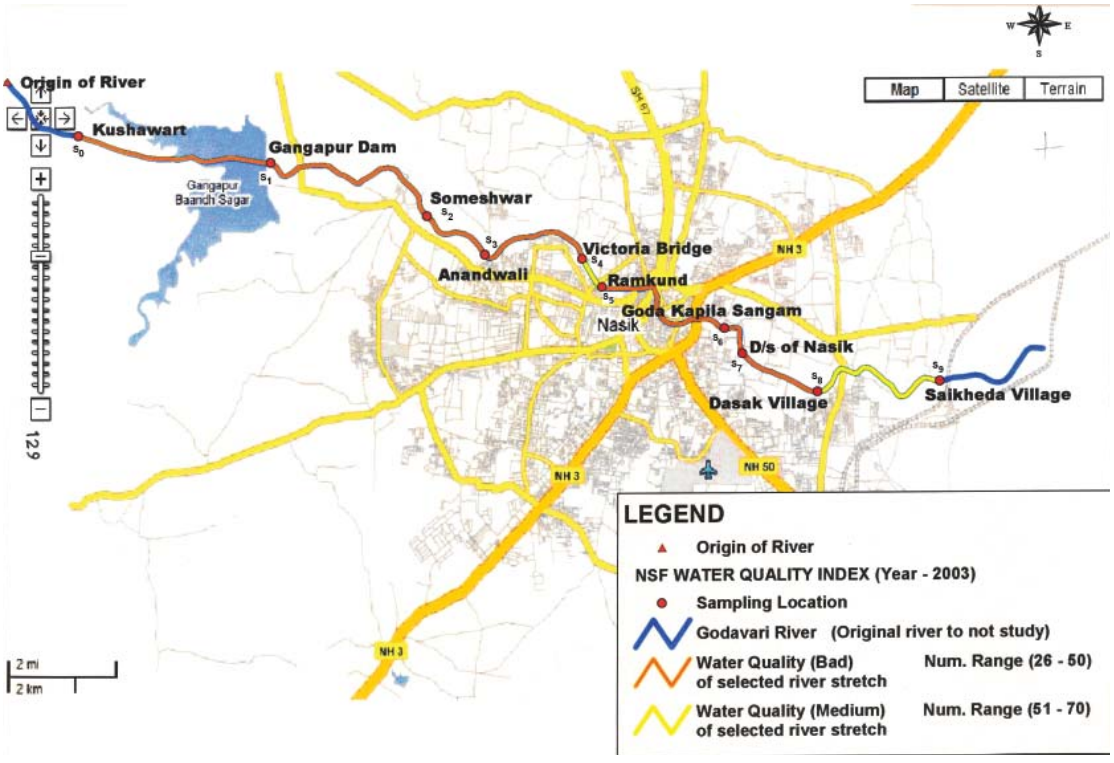

Fig 1. Godavari River Map Showing Sampling Location

and unplanned growth of human settlements along both sides of the river banks, inadequate sewage disposal and treatment facilitates, lack of bathing ghats, *dhobi*ghats (place for washing clothes), etc.

During religious riverside festival of Kumbh Mela of 2003-04, a 78 MLD Sewage Treatment Plant (STP) at Tapowan, Nasik, a 7.5 MLD STP at Dasak Village, and a 12 MLD STP at Takali Village, Solid Waste Treatment Plant and bio- medical waste treatment were commissioned as part of conservation measures for the conservation of Godavari River in the study stretch. As of now, the existing conservation facilities have proved to be inadequate resulting in further pollution of the river. This necessitates the assessment of water quality of the river in the study stretch and suggest management strategies for improving the health of river. Different types of large and medium scale industries apart from small scale units as well as city urban areas are discharging huge untreated industrial effluents and sewage into the river as the major organic pollution as one single reason for river pollution.

Literature Survey

A literature survey reveals that physico-chemical characteristics of various rivers have been studied by many authors: Chakraborty *et al* (1959), Rai, (1974), Charu *et al* 2006, Kallol and Mahapatra (2005) and Das (2005) have measured the physico chemical parameters and assessed the water quality status to the rivers. A comparative study of DO, BOD and COD of Godavari River at Nanded and Rajahmundry has been carried out by Khan, Srinivasarao, Murthy *et al* (2008) who found that the river was more polluted at Nanded than at Rajahmundry.

About River Godavari and the Study Area

The River Godavari is the second largest river in the Indian Union. Starting from a trickle from the lips of a cow at Triambak, the width of the river grows till it is nearly 6.5 km wide at Dowlaiswaram. It is always spoken of as the Southern Ganga and Vriddha Ganga. At Papikonda, it is narrow as 200-300 m for about 3 km. The Godavari rises in the Western Ghats at Triambak near Nasik, about 113 km northeast of Bombay and only 80 km from the Arabian Sea. After descending the Western Ghats, it takes a south easterly course across the southern part of Indian peninsula and flows through 1,230 km and falls into the Bay of Bengal about 80 km east of Rajahmundry. The total catchment area drained by the river is 312,812 km^2, or nearly one tenth of India. The catchment in Maharashtra is about 152,199 km^2 . The average annual flow (50% dependable flow) of the Godavari basin has been estimated as 110.5 km^3, whereas the utilizable flow (75% dependable flow) is about 76.3 km^3. The present utilization is only about 39 km^3, which is hardly 50% (Carg 1999). The annual rainfalls are moderate, from 700 mm at Nasik to 1,000 mm at Nizamabad.

The Godavari River passes through the industrially developed Maharashtran city of Nasik. Rapid industrial development is taking place due to the establishment of the industrial areas like Satpur and Ambad MIDC, with the establishment of mainly large and medium scale industries like Motor Industries Company Limited (MICO), Mahindra and Mahindra, VIP Industries, Ceat Limited, Carbon Corporation Limited, ABB Limited, BCL Forging Limited, Glaxo Limited, Siemens, Garware Polyester Ltd, Gabriel, and so on. In addition, 125 large and 350 medium scale units and about 2,500 small scale units are also presently working in the industrial estate and are located at upper part of the city and on the banks of the river. This industrial development has resulted in the massive growth of some other industries like laundry, hotels, restaurants, pathological laboratories, nursing homes, etc. The river water is presently being used for domestic purposes such as drinking, bathing, cleaning, cooling and other, and untreated sewage and industrial effluents together with solid wastes are finding way directly into the river.

Experimental

In the present study, 10 sampling locations were selected along the Godavari River as given in Table 1 and Figure 1. Only during two months (December 2007 and February 2008) primary data were collected, while the other data from 2002-07 was taken from the records of the Central Pollution Control Board (CPCB) and the Maharashtra Pollution Control Board (MPCB) websites.

Samples were analyzed for SS, TDS, BOD, COD, pH, total hardness, calcium hardness, total alkalinity, chlorides, sodium/potassium, sulphate, phosphate, nitrate, fecal coliform, and electrical conductivity, as per standard methods of analysis (Das 2005). The results of analysis of the samples for December 2007 and February 2008 are given on Tables 2 and 3, respectively.

All the data have been converted to NSFWQI scores, which gives an idea about the status of water quality at given location at the specified time and help the policy and decision makers at the government and public sector levels to plan for conservation of the river. The numerical scores with water quality descriptions are given on Table 4. A comparison of NSFWQI at the three locations for the years 2002-08 is given on Table 5, based on data from the CPCB and MPCB.

Results and Discussion

The results of Tables 2 and 3 as shown in Figure 2 indicate that in December 2007 and February 2008 the water quality

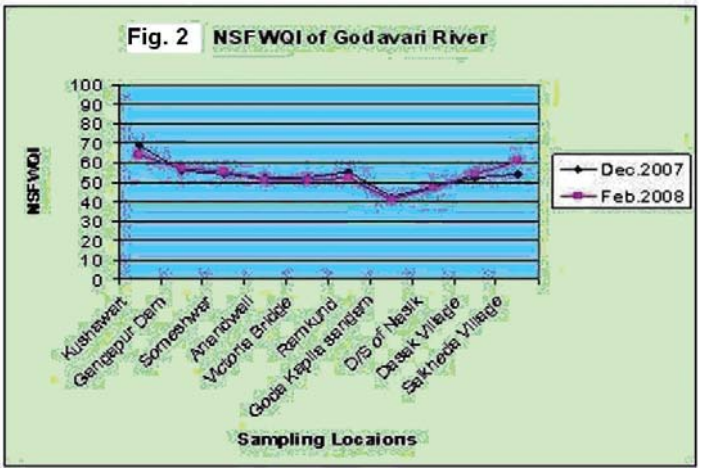

Fig. 2 NSFWQI of Godavari River

at location S_6 and S_7 was bad, while the water quality at other locations was medium, thereby indicating that there is not much change in the river water quality at all the locations during this period. As such, the water quality lies between medium to bad due to heavy pollutational load, as indicated above.

The results of Table 5 show that prior to December 2007, the water quality at locations S_1 and S_5 was bad, but it has improved to medium range in December 07 and remained so up to February 2008 due to the reasons that some conservation measures like installation of STPs, Effluent Treatment Plant (ETPs), solid waste management, biomedical waste management facilities started to function and treated water started to be discharged into the river. The observation of no further improvement in the quality beyond December 2007 and February 2008 can be attributed to the fact that the capacity of existing facilities have either became inadequate or these are not properly functioning and managed. The water quality at location S_7 has not recorded any improvement due to the discharge of untreated waste water in the downstream. As indicated above, the existing conservation facilities in the study area include STP of 78, 7.5 and 22 MLD capacity at

Table 1. Sampling Locations in the Study Stretch of the Godavari River

	Category	Sampling station	Location	Distance from the origin	Remarks
1	River Point	S_0	Kushawart	10 km	Origin of River with no anthropogenic impacts
2	River Point	S_1	Gangapur Dam, Nasik	28	• Monitored by CPCB. • Dam is source of drinking water
3	River Point	S_2	Someswar	34	Bathing, washing activities and puja material thrown
4	River Point	S_3	Anandwali	39	Sewage from restaurants, hotels etc. to the river.
5	River Point	S_4	Victoria Bridge	42	Sewage is discharged into the river.
6	River Point	S_5	Ramkund	43	Mass bathing activities
7	River Point	S_6	Goda Kapila Sangam	45	• Kapila river meets • Sewage/ other waste water added.
8	River Point	S_7	Tapowan, D/s Nasik	46	Treated waste water from 78 MLD STP meets the river
9	River Point	S_8	Dasak Village	52	Remains/ashes of human dead bodies, sewage/waste water from settlements/ oil and grease from vehicle washings added
10	River Point	S_9	Saikheda Village	75	• Remain/ashes of human dead bodies, sewage/waste water from settlements/ oil and grease from vehicle washings added • Hospital wastes and over flow from septic tanks is discharged to the river

	Parameters	Sampling Locations									
		S0	S1	S2	S3	S4	S5	S6	S7	S8	S9
1	P^H	7.11	8.10	7.78	7.86	8.27	7.50	7.60	7.75	7.6	7.86
2	DO	1.95	6.8	7.0	5.7	4.7	5.0	4.0	4.6	4.8	3.60
3	BOD	85	5.1	5.7	8.0	8.1	10.3	11.8	15	21	9
4	COD	152	21	24	29	30	40	37	40	36	44
5	electrical conductivity	379	200	279	154	170	160	160	594	523	270
6	TSS	16	22	25	35	34	49	46	49	30	52
7	TDS	210	180	490	335	535	299	155	487	212	215
8	chlorides	37	11	18	69	89	100	1	50	41	35
9	total hardness	100	78	118	114	135	190	196	198	230	236
10	calcium hardness	120	46	78	70.6	81	122	1	40	46	49
11	magnesium hardness	11.67	32	40	43.4	54	68	89	17.02	27	25.3
12	sodium	18	6.0	11	10	17	21	27	28	25	29
13	sulphates	29	5.16	17	29	24	14.6	14.5	38.2	59	0.48
14	phosphates	.450	0.011	0.06	0.05	0.07	0.04	0.07	2.94	0.54	0.50
15	nitrate	0.478	0.23	0.27	1.39	1.81	0.8	1.12	0.021	2.89	0.03
16	NSFWQI	69	56	54	52	52	55	42	48	52	54

Table 2: Parameters for Water Quality Assessment of Godavari River (December 2007)

	Parameters	Sampling locations									
		S0	S1	S2	S3	S4	S5	S6	S7	S8	S9
1	P^H	7.01	7.30	7.99	7.91	8.30	7.20	7.10	7.69	7.68	7.78
2	DO	1.9	7.5	7.4	5.8	4.7	4.8	3.1	1.6	4.17	3.40
3	BOD	24	4.8	5.9	7.3	7.60	9.8	10.3	36	24	12
4	COD	40	28	19	21	33	24	33	84	40	32
5	electrical conductivity	426.5	189	248	296	378	370	620	599.5	-	240
6	total suspended solids	27	45	51	36	26	41	51	40	35	52
7	total dissolved solids	340	165	149	139	221	156	597	212	166	215
8	chlorides	53	17	19	37	62	93	129	85	37.5	45
9	total hardness	140	126	126	127	191	96	214	-	260	256
10	calcium hardness	64	92	80	81.2	122	66	148	-	56	99
11	magnesium hardness	2.44	34	46	45.8	69	30	66	-	3.76	29.3
12	sodium	19	25	5.0	8.5	9.5	16.5	35	-	-	39
13	sulphates	18	3.28	27	23	25	15.4	16.6	-	75	68
14	phosphates	0.358	0.015	0.5	0.14	0.21	0.	0.04	-	0.52	0.90
15	nitrate	0.833	0.15	0.90	1.93	2.23	0.97	0.99	-	3.76	0.13
16	NSFWQI	64	57	55	51	51	52	41	47	54	61

Table 3. Parameters for Water Quality Assessment of Godavari River (February 2008)

	Water quality	NSFWQI score	Color
1	Very Bad	0-25	Red
2	Bad	26-50	Orange
3	Medium	51-70	Yellow
4	Good	71-90	Green
5	Excellent	91-100	Blue

Table 4. NSFWQI Scores and WQ descriptions

	NSFWQI						
	2002	2003	2004	2005	2006	2007	2008
Gangapur Dam, Nasik (S_1)	36 bad	38 bad	40 bad	42 bad	49 bad/ medium	56 medium	57 medium
Godavari River Ramkund, Nasik (S_5)	35 bad	34 bad	40 bad	40 bad	44 bad	55 medium	52 medium
Godavari River d/s of Nasik (S_7)	34 bad	35 bad	40 bad	41 bad	45 bad	48 bad	47 bad

Table 5. Comparison of NSFWQI in Different Years at Three Locations

Tapowan, Dasak and Takali respectively, as well as the solid waste treatment plant and bio-medical waste treatment plant, etc., that have become inadequate in view of the expansion of the industrial base and rapid growth of the population in the catchment of the study area. The presence of fecal coliform in the river is attributed to the discharge of sewage into the river near its banks.

In view of the above, it is proposed to review and add the additional STPs, ETPs, Municipal Solid Waste (MSW) management, hospital/biomedical facilities in the area along with low cost sanitation, electric crematoria, construction of bathing ghats/river front developments, afforestation and landscaping, rain water harvesting, organization of short term awareness/training programs for the local people, in order to revolutionize the concept and benefits of a clean environment.

Conclusions

The water quality assessment of a 65 km stretch of Godavari River in Nasik District from Kushawart to Saikheda village in Maharashtra State indicates that the river is heavily polluted due to 125 large and 350 medium scale units and about 2,500 small scale units, in addition to massive growth of some other industries like laundry, hotels, restaurants, pathological laboratories, nursing homes, etc., which are discharging into the river. The National Sanitation Foundation Water Quality Index (NSFWQI), computed from December 2007 and February 2008, as well as from 2002-07 (from CPCB and MPCB) indicate that the study stretch had bad water quality up to 2006, but that improved to medium due to conservation facilities implemented in 2005. The water quality has not improved beyond medium range up to February 2008, perhaps due either to the fact that current facilities have become inadequate or are not properly functioning. 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.

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Ajay D. Chavan*, is a civil engineer, admitted to the M. Tech program on 'Conservation of Rivers and Lakes, AHEC, Indian Institute of Technology (IIT), Roorkee, India as a sponsored candidate from Maharashtra Pollution Control Board, Nasik. He completed his dissertation on the topic 'Water quality management of Godavari River in Nasik city' in 2008-09.*

M.P. Sharma*, PhD, has been working as Associate Professor at AHEC, since the last 25 years. His area of research is renewable energy with special reference to modeling of IRES, hybrid energy systems, modeling of induction generators, environmental impact assessment of renewable energy projects, energy conservation, conservation of environment, conservation of water bodies, water quality assessment, and biodiesel production and utilization.*
Corresponding address:
mpshafah@iitr.ernet.in, mahendrapal_sharma@gmail.com.

Prof. Renu Bhargava *works at Civil Engineering Department, IIT, India in the area of waste water treatment technologies, solid waste management, vermi composting etc. Corresponding address: renbhfce@iitr.ernet.in*

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