

Limnological Studies and Statistical Analysis of River Narmada with Special Focus on 5 nearby Ghats of Jabalpur Region, M.P. (India)



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Abstract

Rivers are the most important source of water to the global population. The Narmada or Narbada is the fifth longest river in India and largest west flowing river of Indian peninsula. The present study was carried out for the period of two years i.e., October 2010 to September 2012. Water samples were collected from all the Ghats, banks as well as middle. Sample collection is done seasonally. Seasons are categorized as winter (Oct-Jan), summer (Feb -May) and Rainy (June – Sept.). Physico-chemical analysis of water is done as per standard methods of APHA and Trivedi. Physical and chemical parameters like water temperature, turbidity, conductivity, alkalinity, total hardness, chloride, nitrate, Dissolved Oxygen, phosphate and Sulphate were analyzed in the laboratory. The results indicate that the Narmada river water is unfit for drinking and other purposes too. Special attention is to be taken by the local people and Government along with NGO's in order to prevent further deterioration of this holy river.

Keywords: Narmada River, Physico-Chemical Parameters, Ghats.

Introduction

The rivers, which are the lifelines of our culture and economy, are dying because of severe pollution. In India, all the 14 major rivers and their tributaries have been polluted. Nearly 70% of water is polluted due to rapid industrialization and domestic sewage etc. The Narmada River is also contaminated with the discharge of industrial effluents and domestic sewage. The assessment of any water quality of any aquatic source is based on physico-chemical parameters. Water quality depends upon its source of history which is generally signified the terrain through which water is flowing its origin and most important the extent to which it is contaminated on its way by anthropogenic means (Gopal and Zutshi, 1998; Pandey et al., 1999, Singh and Singh, 2007).

The Narmada is the 5th largest river in India and largest west flowing river of Indian Peninsula which originated from the Mikal ranges at Amarkantak in Madhya- Pradesh at an elevation of 900 meters. It flows over a length of 1312 Km before draining into the Gulf of Cambay, 50 Km west of Bharuch. The river is also known as "Life line of Madhya-Pradesh". Jabalpur city is also known as Mahakoushal and is situated almost in the Centre of India (between the coordinates of 23°10' Latitude to 79°05' Longitude with a general elevation of about 393 meters above MSL. Literature survey showed that there were certain studies by workers like Soni and Salahuddin (2013), Ashraf, M.P and Mukundan (2007). Considerable investigations of physico-chemical properties of river water are carried out in India by Singh and Gupta, 2004. Barai and Kumar, 2012.

Aim of the Study

To observe the seasonal variations in Narmada River water by evaluating its physico-chemical parameters at five different stations on the basis of which the nature and quality of water can be analysed. On the basis of which water quality can be analysed and appropriate measures can be taken to prevent deterioration by human acts or others.

Review of Literature

Rivers are the most important source of water to global population. Narmada is a holy river and is the only river in India that flows in a right valley.

Similar studies are done by many researchers. The water of lower Lake of Bhopal is used for drinking, irrigation and power supply but varies from one station to other. The situation is not too worst but its alarming (Ghosh et.al). Deep research is being done by Kushram, Parvati (2013), Mujumdar and Dutta (2014). Varhasiya, A.R., Pamnai, A.N., Patel N.R. (2016) also studied the physico-chemical water quality of Narmada River Gujrat.

Material and Methods

Water samples were taken from five stations namely Lamhetaghat, Laxminarayanghat, Gogra hat, Saraswatighat and Bhedaghat. Site-1 (S-1) Lamhetaghat is situated around 16 Km from the city headquarters. Narmada at this point is 200 m wide and depth 5-10 feet inner the bank and 40-5- feet in the middle. Site-2 (S-2) is also called as Gopalpurghat and is situated 17.5 Km away from the city headquarters. Site-3(S-3) Gograghat is a third sampling site and is also called as 'Little bloom water fall' situated at a distance of 19 Km from the city headquarters. Narmada at this station is 150Km wide and 70-75 feet in the middle. Site -4(S-4) is located 20 Km from Jabalpur city. The depth of Narmada at this bank is 25 feet in the bank and around 70-75 feet in the middle. This is slightly U shaped. Site-5(S-5) Bhedaghat in Jabalpur is one of the famous tourist place.

Major physico-chemical parameters observed and evaluated in this research period are Water temp., turbidity, conductivity, alkalinity, total hardness, chloride, nitrate, dissolved oxygen and phosphate.

Temperature

Temperature is the measure of the hotness of any material. It is one of the most important parameter for aquatic environment because all physical and chemical parameters are governed by the use of mercury filled thermometer up to the desired accuracy.

Turbidity

Turbidity of water is responsible for the light to be scattered or observed rather than a straight transmission through the sample. Turbidity was recorded by direct reading on water analysis kit. Results are presented in the form of Nephlo Metric Turbidity Unit (NTU).

Conductivity

Conductivity denote the capacity of a substance or a solution to conduct the electric current. Conductivity was recorded using conductivity meter in water analysis kit.

Alkalinity

Alkalinity of water is the capacity to neutralize strong acid and is characterized by the presence of all hydroxyl ions(OH⁻ions) capable of combining with the hydroxyl ions.

Total Alkalinity = ml of titrant×1000/ML of water sample

Total Hardness

It is the hardness caused due to bivalent cations such as calcium (Ca⁺⁺) and magnesium present in water.

Value of total hardness were computed by using following formula:

Total hardness, (mg/l)=ml of EDTA×1000/ml. of water sample

Chloride

Chloride occurs naturally in all type of water. In natural water fresh water its concentration remains quite low.

The concentration of chloride in mg/l was computed as –

Chloride in mg/l= mg/l of titrant×N×35.5×1000/ml of sample

Where, N=Normality of AgNO₃ solution.

Nitrate

Nitrate represents the highest oxidized forms of oxygen. It was estimated by phenol disulphuric acid method (Trivedi, 1986).

Dissolved Oxygen

The D.O content shows the ability of the stream to purify itself through bio-chemical processes. The dissolved oxygen was calculated by using the following formula:

D.O IN mg/l=ml of titrant×N×8×1000/ml of sample titrated.

Phosphate

The phosphate comprises soluble reactive phosphate, polyphosphate and soluble and insoluble organic phosphorous. Phosphate was estimated by spectrophotometric method (Trivedi, 1986).

Results and Discussion

The result of the study has been reported in the table and graphs given below.

The temperature of the river water ranged between the lowest of 20.47⁰ C to the highest as 35.5⁰C. Similar trends in temperature ranges of 23.6⁰ C to 46.6⁰ C was reported by Trivedi (1989) in the polluted zone of Chambal river at Nagda.

The Turbidity mean value ranges from 13.52 NTU to 15.09 NTU in the first year and 13.9 NTU to 15.54 NTU in the second year.

The conductivity mean value ranges between 222.91 mhos to 253.91 mhos in the first year and 223 mhos to 254.3 mhos in the second year. The maximum value was observed in rainy season due to voluminous run off carrying diverse type of electrolytes (from the nearby as well as distant areas). Similar observations has been reported by Teheruzzaman and Kushari(1995).

The minimum to maximum range of alkalinity was recorded between 182.25 mg/l to 211.08 mg/l in the first year and 210.5 mg/l to 221.8 mg/l in the second year of investigation. Similar reports are showed by Pahwa and Mehrotra (1966) with a range of 72 mg/l to 207 mg/l in the River Ganga.

In the first year, maximum total hardness was recorded as 469.8 mg/l and minimum as 416.73 mg/l. whereas in the second year, the maximum range was observed to be 479.6 mg/l and minimum as 428.16 mg/l. similar ranges are reported Wagela (1982) and Rao (1979).

During the present study, Chloride ranged between 537 mg/l to 620 mg/l in the first year and 554 mg/l to 650 mg/l in the second year. Similar range has been reported by Laxminarayan (1965) and Dwivedi (1984).

The range of Nitrate for the first year was reported as, minimum of 12.9 mg/l to the maximum of 24.4 mg/l, whereas in the second year, maximum range was 24.55 mg/l and minimum was 13.5 mg/l. The high values of Nitrate at the few sampling stations was due to bathing, washing cattle's and clothes and other ritual activities.

The present study reported that Dissolved Oxygen of maximum range 5.52 mg/l and minimum of 4.05 mg/l in the first year, whereas in the second year, D.O value ranged between minimum of 3.87 mg/l to the maximum of 5.27 mg/l. It has been reported that in the summer season, D.O value of rivers lowers down due to the fact that waste volume entering into the water was more or less same but volume decreases and temperature of river increases, resulting in the reduction of D.O value of rivers in the rainy season. Similar results has also been reported by Hussain (1967) and Srinivasan (1964).

In the first year, Phosphate was observed with a maximum range of 3.37 mg/l to the minimum range of 1.6 mg/l, in the second year maximum range was observed to be 3.37 mg/l and minimum as 1.23 mg/l. Nandanet.al. In 1985 have also reported high quantities of phosphate in the studies in Vishwamitra River.

Conclusion

Narmada, often called as the life line of Madhya-Pradesh, is one of the holy rivers of India. But, while assessing the parameters it was concluded that the water quality level of river is not up to the mark and hence is unsatisfactory for drinking and other domestic purposes. So, it is highly suggested that the State Government along with some NGO'S and local people should take some appropriate steps like "Swachh Narmada Abhiyaan" in order to prevent further deterioration of this holy river.

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Shrinkhla Ek Shodhparak Vaicharik Patrika**Table: 1.1 Seasonal variation in temperature ($^{\circ}$ C) at five different sampling stations of river Narmada (Oct. 2010-Sept. 2011)**

Sampling Stations	Oct. 2010	Nov. 2010	Dec. 2010	Jan 2011	Winter Mean Value	Feb. 2011	Mar. 2011	Apr. 2011	May 2011	Summer Mean Value	Jun. 2011	July 2011	Aug. 2011	Sep. 2011	Rainy Mean Value	Annual Mean Value
Lamhetghat	24.3	21.6	18.5	18.3	20.6	23.2	31.4	41.4	42.2	34.5	39.1	28.7	26.4	29.2	30.85	28.65
Laxmi Narayan Ghat	24.1	22.7	18.1	18.3	20.8	23.2	33.9	41.6	42.2	35.2	38.8	27.9	28.1	30.3	31.27	29.09
Gograghat	23.9	23.6	18.5	18.1	21.0	22.7	34.1	41.2	42.2	35.05	39.2	27.6	27.1	30.3	31.05	29.03
Saraswati-ghat	24.9	24.8	18.2	18.7	21.6	23.3	34.5	40.9	41.7	35.1	39.4	27.9	27.2	31.0	31.37	29.35
Bhedaghat	25.4	23.9	18.1	18.6	21.5	22.9	34.0	41.6	42.2	35.1	39.0	28.4	26.9	30.4	31.17	29.25

Table: 1.2 Seasonal variation in temperature ($^{\circ}$ C) at five different sampling stations of river Narmada (Oct. 2011-Sept. 2012)

Sampling Stations	Oct. 2011	Nov. 2011	Dec. 2011	Jan 2012	Winter Mean Value	Feb. 2012	Mar. 2012	Apr. 2012	May 2012	Summer Mean Value	Jun. 2012	July 2012	Aug. 2012	Sep. 2012	Rainy Mean Value	Annual Mean Value
Lamhetghat	23.9	22.4	17.4	18.2	20.47	23.1	31.8	40.2	42.2	34.32	39.0	27.6	27.4	29.9	30.9	28.5
Laxmi Narayan Ghat	24.1	22.1	18.4	18.3	20.72	23.2	34.4	41.6	42.8	35.5	39.1	28.7	26.8	31.6	31.5	29.2
Gograghat	23.6	22.1	18.0	18.3	20.5	24.0	34.6	40.8	42.0	35.35	39.51	28.0	27.1	30.8	31.35	29.06
Saraswati-ghat	24.8	23.1	18.5	18.9	21.32	23.9	34.1	40.8	42.2	35.25	39.7	28.3	26.9	30.2	31.27	29.28
Bhedaghat	24.6	22.2	18.1	17.9	20.7	23.5	34.2	41.6	41.8	35.2	39.2	28.3	26.8	29.4	30.92	28.94

Table: 2.1 Seasonal Variation in Turbidity (NTU) at Five Different Sampling Stations Of River Narmada (Oct. 2010-Sept. 2011)

Sampling Stations	Oct. 2010	Nov. 2010	Dec. 2010	Jan 2011	Winter Mean Value	Feb. 2011	Mar. 2011	Apr. 2011	May 2011	Summer Mean Value	Jun. 2011	July 2011	Aug. 2011	Sep. 2011	Rainy Mean Value	Annual Mean Value
Lamhetghat	15.2	14.5	14.0	14.2	14.47	12.2	12.1	12.3	11.5	12.02	15.5	19.0	19.1	18.2	17.95	14.81
Laxmi Narayan Ghat	15.4	15.6	14.3	14.3	14.9	12.2	12.1	12.3	13.0	12.4	15.4	19.2	19.4	17.9	17.97	15.09
Gograghat	12.9	13.5	12.8	12.4	12.9	12.1	11.6	11.8	11.9	11.85	14.4	16.2	16.3	16.6	15.87	13.54
Saraswati-ghat	15.8	14.2	14.4	15.5	14.97	12.6	12.2	12.1	11.7	12.15	14.6	19.9	19.0	18.3	17.95	15.02
Bhedaghat	13.2	13.8	13.3	11.9	13.05	12.3	11.6	11.1	12.5	11.87	14.2	16.3	16.0	16.1	15.65	13.52

Table: 2.2 Seasonal Variation in Turbidity (NTU) at Five Different Sampling Stations of River Narmada (Oct. 2011-Sept. 2012)

Sampling Stations	Oct. 2011	Nov. 2011	Dec. 2011	Jan 2012	Winter Mean Value	Feb. 2012	Mar. 2012	Apr. 2012	May 2012	Summer Mean Value	Jun. 2012	July 2012	Aug. 2012	Sep. 2012	Rainy Mean Value	Annual Mean Value
Lamhetghat	13.9	13.5	13.5	13.1	13.5	15.5	15.2	15.0	14.8	15.12	16.1	17.3	17.6	17.2	17.05	15.22
Laxmi Narayan Ghat	14.0	13.6	13.5	13.4	13.62	15.9	15.2	15.6	15.2	15.47	16.1	18.3	17.9	17.9	17.55	15.54
Gograghat	13.5	13.1	12.9	12.6	13.02	12.9	12.6	13.1	13.3	12.97	14.91	16.1	17.0	17.0	16.25	14.08
Saraswati-ghat	14.3	13.9	13.3	13.1	13.65	15.0	15.5	15.2	15.3	15.25	15.1	18.0	18.0	17.6	17.17	15.35
Bhedaghat	13.2	13.3	12.7	12.4	12.9	13.3	13.2	12.4	12.6	12.87	15.6	16.0	16.1	16.1	15.95	13.90

Table: 3.1 Seasonal Variation In Conductivity (mhos) at Five Different Sampling Stations of River Narmada (Oct. 2010-Sept. 2011)

Sampling Stations	Oct. 2010	Nov. 2010	Dec. 2010	Jan 2011	Winter Mean Value	Feb. 2011	Mar. 2011	Apr. 2011	May 2011	Summer Mean Value	Jun. 2011	July 2011	Aug. 2011	Sep. 2011	Rainy Mean Value	Annual Mean Value
Lamhetghat	349	241	221	170	245.5	180	182	163	202	181.75	258	252	260	282	263	230
Laxmi Narayan Ghat	374	278	264	226	285.5	183	183	179	227	193	270	283	285	295	283.25	253.91
Gograghat	360	244	228	173	251.25	180	169	177	206	183	246	245	261	270	255.5	229.91

Saraswati-ghat	371	258	249	212	272.5	182	192	181	220	193.75	278	275	276	291	280	248.75
Bhedaghat	375	254	270	211	277.5	180	176	182	266	191	268	271	270	289	274.5	247.66

Table: 3.2 Seasonal variation in conductivity (mhos) at five different sampling stations of river Narmada (Oct. 2011-Sept. 2012)

Sampling Stations	Oct. 2011	Nov. 2011	Dec. 2011	Jan 2012	Winter Mean Value	Feb. 2012	Mar. 2012	Apr. 2012	May 2012	Summer Mean Value	Jun. 2012	July 2012	Aug. 2012	Sep. 2012	Rainy Mean Value	Annual Mean Value
Lamhetghat	335	211	200	186	233	170	191	192	200	188.25	201	246	250	294	247.75	223
Laxmi Narayan Ghat	380	268	259	200	276.75	190	208	210	230	209.5	249	260	276	306	272.75	253
Gograghat	336	204	204	189	233.25	180	192	192	204	192	203	240	248	290	245.25	223.5
Saraswati-ghat	380	241	237	192	262.5	193	212	218	238	215.25	242	261	282	310	273.75	250.5
Bhedaghat	384	265	267	191	276.75	192	215	215	223	213.75	248	260	273	311	273	254.3

Table: 4.1 Seasonal variation in Alkalinity (mg/l) at five different sampling stations of river Narmada (Oct. 2010-Sept. 2011)

Sampling Stations	Oct. 2010	Nov. 2010	Dec. 2010	Jan 2011	Winter Mean Value	Feb. 2011	Mar. 2011	Apr. 2011	May 2011	Summer Mean Value	Jun. 2011	July 2011	Aug. 2011	Sep. 2011	Rainy Mean Value	Annual Mean Value
Lamhetghat	162	164	172	169	166.75	261	266	277	280	271	170	177	176	180	175.75	204.5
Laxmi Narayan Ghat	169	172	174	174	172.25	261	274	285	274	273.5	175	196	193	186	187.5	211.08
Gograghat	165	169	171	175	170	260	265	282	274	270.25	170	186	184	182	180.5	206.9
Saraswati-ghat	161	168	168	173	167.5	261	264	280	271	269	169	187	184	180	180	205.5
Bhedaghat	164	162	164	169	164.75	261	264	269	266	206.25	172	183	172	176	175.75	182.25

Table: 4.2 Seasonal variation in Alkalinity (mg/l) at five different sampling stations of river Narmada (Oct. 2011-Sept. 2012)

Sampling Stations	Oct. 2011	Nov. 2011	Dec. 2011	Jan 2012	Winter Mean Value	Feb. 2012	Mar. 2012	Apr. 2012	May 2012	Summer Mean Value	Jun. 2012	July 2012	Aug. 2012	Sep. 2012	Rainy Mean Value	Annual Mean Value
Lamhetghat	160	172	171	181	171	269	279	280	274	275.5	195	189	186	180	187.5	211.3
Laxmi Narayan Ghat	157	173	177	168	168.75	269	282	274	273	274.51	192	191	186	184	188.25	210.5
Gograghat	182	179	193	184	184.5	271	279	281	288	279.75	210	201	200	194	201.25	221.8
Saraswati-ghat	166	168	173	172	169.75	269	271	273	281	273.5	200	195	196	188	194.75	212.6
Bhedaghat	181	169	174	182	176.5	275	282	286	280	280.75	206	200	194	192	198	218.25

Table:5.1 Seasonal variation in Total Hardness (mg/l) at five different sampling stations of river Narmada (Oct. 2010-Sept. 2011)

Sampling Stations	Oct. 2010	Nov. 2010	Dec. 2010	Jan 2011	Winter Mean Value	Feb. 2011	Mar. 2011	Apr. 2011	May 2011	Summer Mean Value	Jun. 2011	July 2011	Aug. 2011	Sep. 2011	Rainy Mean Value	Annual Mean Value
Lamhetghat	378	378	395	367	379.5	419	430	415	429	423.25	498	507	580	509	523.5	442.08
Laxmi Narayan Ghat	389	380	400	392	390.25	442	457	466	479	461	530	534	599	570	558.2	469.8
Gograghat	356	369	384	371	370	379	374	426	445	406	475	493	540	481	497.2	424.4
Saraswati-ghat	396	365	394	370	381.2	412	433	456	461	440.5	492	509	559	486	511	444.2
Bhedaghat	339	349	371	352	352.7	370	381	422	433	401	475	497	533	481	496.5	416.73

Table:5.2 Seasonal variation in Total Hardness (mg/l) at five different sampling stations of river Narmada (Oct. 2011-Sept. 2012)

Sampling Stations	Oct. 2011	Nov. 2011	Dec. 2011	Jan 2012	Winter Mean Value	Feb. 2012	Mar. 2012	Apr. 2012	May 2012	Summer Mean Value	Jun. 2012	July 2012	Aug. 2012	Sep. 2012	Rainy Mean Value	Annual Mean Value
Lamhetghat	379	394	413	396	395.5	450	432	454	466	450.5	530	541	560	499	532.5	459.5

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Laxmi Narayan Ghat	389	404	445	409	411.7	466	445	486	495	473	550	558	574	535	554.2	479.6
Gograghat	366	374	403	399	385.5	406	424	444	462	434	516	513	525	506	515	444.8
Saraswati-ghat	374	389	420	398	395.5	420	414	440	446	430	520	522	539	508	522.2	449.13
Bhedaghat	316	366	394	369	372.5	402	412	440	446	425	488	500	510	490	487	428.16

Table:6.1 Seasonal variation in Chloride (mg/l) at five different sampling stations of river Narmada (Oct. 2010-Sept. 2011)

Sampling Stations	Oct. 2010	Nov. 2010	Dec. 2010	Jan 2011	Winter Mean Value	Feb. 2011	Mar. 2011	Apr. 2011	May 2011	Summer Mean Value	Jun. 2011	July 2011	Aug. 2011	Sep. 2011	Rainy Mean Value	Annual Mean Value
Lamhetghat	536	540	552	550	544.5	557	572	585	571	571.25	566	572	591	579	577	564.25
Laxmi Narayan Ghat	583	574	583	593	583.25	572	584	595	604	588.75	602	608	628	642	620	597.33
Gograghat	556	540	558	562	554	575	564	580	601	580	590	596	595	603	601	578
Saraswati-ghat	532	539	548	546	541.25	560	574	588	576	577	570	576	595	583	581	566
Bhedaghat	526	532	551	539	537	555	571	590	568	571	564	570	589	577	575	561

Table:6.2 Seasonal variation in Chloride (mg/l) at five different sampling stations of river Narmada (Oct. 2011-Sept. 2012)

Sampling Stations	Oct. 2011	Nov. 2011	Dec. 2011	Jan 2012	Winter Mean Value	Feb. 2012	Mar. 2012	Apr. 2012	May 2012	Summer Mean Value	Jun. 2012	July 2012	Aug. 2012	Sep. 2012	Rainy Mean Value	Annual Mean Value
Lamhetghat	574	578	560	564	569	581	582	586	590	584	587	634	600	581	600	584
Laxmi Narayan Ghat	611	615	600	601	606.75	587	591	595	599	593	538	687	651	632	652	617
Gograghat	603	607	589	593	598	578	581	589	593	587	606	655	619	600	620	601
Saraswati-ghat	574	579	562	565	570	581	582	586	590	584	592	636	602	586	606	586
Bhedaghat	559	562	544	552	554.22	575	578	582	586	580	581	630	594	575	595	576

Table:7.1 Seasonal variation in Nitrate (mg/l) at five different sampling stations of river Narmada (Oct. 2010-Sept. 2011)

Sampling Stations	Oct. 2010	Nov. 2010	Dec. 2010	Jan 2011	Winter Mean Value	Feb. 2011	Mar. 2011	Apr. 2011	May 2011	Summer Mean Value	Jun. 2011	July 2011	Aug. 2011	Sep. 2011	Rainy Mean Value	Annual Mean Value
Lamhetghat	18.0	18.2	19.5	19.5	18.8	22.5	23.5	25.5	26.1	24.4	26.5	20.0	19.7	15.0	20.3	21.16
Laxmi Narayan Ghat	18.4	18.7	19.3	19.5	18.9	22.4	23.2	25.5	26.1	24.3	26.4	20.2	20.1	15.3	20.52	21.23
Gograghat	11.7	12.2	15.3	14.7	13.4	15.3	15.7	15.9	17.1	16	17.1	14.8	13.3	11.6	14.2	14.53
Saraswati-ghat	18.0	18.2	19.1	19.3	18.6	19.3	20.0	21.3	21.7	20.5	20.1	16.2	14.3	14.1	16.1	18.4
Bhedaghat	11.1	11.6	14.4	14.5	12.9	15.2	15.6	15.5	16.3	15.6	17.0	15.4	13.6	11.9	14.4	14.3

Table:7.2 Seasonal variation in Nitrate (mg/l) at five different sampling stations of river Narmada (Oct. 2011-Sept. 2012)

Sampling Stations	Oct. 2011	Nov. 2011	Dec. 2011	Jan 2012	Winter Mean Value	Feb. 2012	Mar. 2012	Apr. 2012	May 2012	Summer Mean Value	Jun. 2012	July 2012	Aug. 2012	Sep. 2012	Rainy Mean Value	Annual Mean Value
Lamhetghat	18.6	18.8	18.5	18.6	18.6	22	22.9	26.0	26.0	24.22	26.2	22.0	20.0	19.1	21.82	21.54
Laxmi Narayan Ghat	18.9	19.3	19.6	19.5	19.3	23	23.1	25.9	26.2	24.55	26.1	21.4	20.31	19.3	21.77	21.87
Gograghat	12.2	12.0	16.3	15.9	14.1	16.1	16.9	17.0	17.3	16.82	16.5	15.3	14.8	14.6	15.3	15.40
Saraswati-ghat	18.3	18.4	19.3	19.2	18.8	19.6	20.9	21.3	21.5	15.82	20.0	17.4	16.5	15.5	17.35	17.32
Bhedaghat	11.5	11.4	15.5	15.6	13.5	16.3	16.5	16.2	17.1	16.52	17.0	15.4	15.0	19.2	16.65	15.55

Table:8.1 Seasonal variation in Dissolved Oxygen (mg/l) at five different sampling stations of river Narmada (Oct. 2010-Sept. 2011)

Sampling Stations	Oct.	Nov.	Dec.	Jan	Winter Mean	Feb.	Mar.	Apr.	May	Summer	Jun.	July	Aug.	Sep.	Rainy Mean	Annual Mean
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	2010	2010	2010	2011	Value	2011	2011	2011	2011	Mean Value	2011	2011	2011	2011	Value	Value
Lamhetghat	4.7	5.7	4.8	4.6	4.95	4.5	4.7	4.1	4.2	4.37	3.8	4.9	5.2	5.5	4.85	4.60
Laxmi Narayan Ghat	4.4	3.9	4.4	4.3	4.25	4.2	4.5	4.3	4.2	4.3	3.6	4.9	4.4	5.2	4.52	4.35
Gograghat	4.0	4.6	4.2	4.1	4.22	4.1	4.0	4.2	4.1	4.1	4.0	4.6	5.1	5.3	4.75	4.35
Saraswati-ghat	4.3	3.9	4.2	4.4	4.2	3.8	3.9	4.2	4.3	4.05	3.6	5.4	5.4	6.0	5.1	4.45
Bhedaghat	4.9	4.6	5.2	4.9	4.9	5.3	4.9	5.1	4.8	5.02	3.9	5.8	5.9	6.5	5.52	5.14

Table:8.2 Seasonal variation in Dissolved Oxygen (mg/l) at five different sampling stations of river Narmada (Oct. 2011-Sept. 2012)

Sampling Stations	Oct. 2011	Nov. 2011	Dec. 2011	Jan 2012	Winter Mean Value	Feb. 2012	Mar. 2012	Apr. 2012	May 2012	Summer Mean Value	Jun. 2012	July 2012	Aug. 2012	Sep. 2012	Rainy Mean Value	Annual Mean Value
Lamhetghat	4.0	4.0	3.8	3.9	3.92	4.5	4.3	4.3	4.6	4.42	3.1	5.4	5.3	5.4	4.8	4.38
Laxmi Narayan Ghat	3.9	4.0	4.1	3.7	3.92	4.1	4.0	4.1	4.1	4.07	3.2	5.4	5.2	5.7	4.87	4.28
Gograghat	4.2	4.2	4.4	3.9	4.1	3.9	4.2	4.0	4.1	4.05	3.6	5.4	5.2	5.8	5.0	4.38
Saraswati-ghat	4.0	4.4	3.6	3.5	3.87	4.04	4.0	3.9	4.2	4.02	3.2	5.1	5.6	5.0	4.72	4.20
Bhedaghat	4.4	4.8	4.6	4.8	4.65	5.0	4.9	5.1	5.1	5.02	4.2	5.56	5.9	5.4	5.27	4.98

Table:9.1 Seasonal variation in Phosphate (mg/l) at five different sampling stations of river Narmada (Oct. 2010-Sept. 2011)

Sampling Stations	Oct. 2010	Nov. 2010	Dec. 2010	Jan 2011	Winter Mean Value	Feb. 2011	Mar. 2011	Apr. 2011	May 2011	Summer Mean Value	Jun. 2011	July 2011	Aug. 2011	Sep. 2011	Rainy Mean Value	Annual Mean Value
Lamhetghat	1.14	1.16	1.19	1.14	1.6	2.99	3.11	3.26	3.58	3.23	1.77	1.8	1.84	1.87	1.82	2.07
Laxmi Narayan Ghat	1.8	1.21	1.19	1.26	1.21	3.21	3.28	3.44	3.52	3.37	1.91	1.15	1.25	1.33	1.41	2.0
Gograghat	1.22	1.26	1.22	1.29	1.24	3.09	3.13	3.31	3.36	3.22	1.85	1.89	1.29	1.26	1.57	2.01
Saraswati-ghat	1.24	1.23	1.20	1.25	1.23	3.11	3.18	3.32	3.33	3.24	1.80	1.81	1.92	1.8	1.84	2.10
Bhedaghat	1.18	1.24	1.26	1.27	1.24	2.99	3.04	3.14	3.40	3.14	1.60	1.61	1.80	1.89	1.72	2.03

Table:9.2 Seasonal variation in Phosphate (mg/l) at five different sampling stations of river Narmada (Oct. 2011-Sept. 2012)

Sampling Stations	Oct. 2011	Nov. 2011	Dec. 2011	Jan 2012	Winter Mean Value	Feb. 2012	Mar. 2012	Apr. 2012	May 2012	Summer Mean Value	Jun. 2012	July 2012	Aug. 2012	Sep. 2012	Rainy Mean Value	Annual Mean Value
Lamhetghat	1.20	1.33	1.34	1.04	1.23	3.15	3.24	3.35	3.22	3.24	1.78	1.49	1.40	1.63	1.57	2.01
Laxmi Narayan Ghat	1.36	1.58	1.21	1.10	1.31	3.31	3.32	3.50	3.21	3.33	1.47	1.86	1.92	1.81	1.77	2.14
Gograghat	1.15	1.51	1.32	1.15	1.28	3.10	3.37	3.37	3.33	3.29	1.42	1.51	1.36	1.42	1.42	1.99
Saraswati-ghat	1.8	1.32	1.40	1.52	1.51	3.21	3.27	3.41	3.30	3.68	2.01	1.58	1.92	1.87	1.85	2.34
Bhedaghat	1.65	1.88	1.76	1.87	1.79	3.15	3.0	3.11	3.12	3.09	1.87	1.91	1.34	1.62	1.68	2.18