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VARIATION OF KRISHNA RIVER WATER QUALITY IN JAMKHANDI TALUKA OF BAGALAKOT DISTRICT, KARNATAKA, INDIA

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ABSTRACT

The study investigates the spatial and temporal variation in water quality parameters at seven different locations along river Krishna for twelve consecutive months. The present investigation deals with the analysis of important water quality parameters like Temperature, pH, EC, DO, COD, Chlorine, Carbonate, Bicarbonate, Total hardness, Lead, Cadmium, Cobalt, Iron, Manganese and Nickel of Krishna river of Jamakhandi taluka of Bagalkot Karnataka India have been analyzed for a period of year, i.e. from April 2014 to February 2015. Results shows that despite of all efforts pollution load is still increasing making water unfit for consumption. The paper presents pollution aspects of river Krishna.

KEYWORDS: spatial and temporal variation in water quality parameters.

INTRODUCTION

River water finds multiple uses in every sector of development like agriculture, industry, transportation, aquaculture, public water supply etc. In addition, since old times, river waters have also been used for cleaning and other domestic purposes. The growing problem of degradation of our river ecosystem has necessitated the monitoring of water quality of various rivers all over the country to evaluate their production capacity, utility potential and to plan restorative measures,[1,2] Rivers and their catchments are highly important parts of the natural heritage. Rivers have been utilized by mankind for thousands of years to the extent that few of them are now in their natural condition.[3] Aquatic systems worldwide are reported to be much polluted due to untreated sewage disposal and industrial effluents being disposed directly into the rivers. Wastes usually contain a wide variety of organic and inorganic pollutants including solvents, oils, grease, plastics, plasticizers, phenols, heavy metals, pesticides and suspended solids. Pollutants entering a river system normally result from many transport pathways including storm water runoff, discharge from ditches and creeks, vadose zone leaching, groundwater seepage and atmospheric deposition. These pathways are also seasonal-dependent. Therefore, seasonal changes in surface water quality must be considered when establishing a water quality management program.[4] Because of the anthropogenic activities fresh water resources are becoming deteriorate day-by-day at the very faster rate. So what, the water quality is becoming a global problem.[5]

River water represents a readily available source of water for human activities and historically many civilizations have relied on the ample supplies of fresh water found in major river catchment. High concentrations of all kinds of pollutants have an influence on the river water quality and determine the use of water and also can lead to diverse problems such as algal blooms, loss of oxygen, and loss of biodiversity.[6] In the last few decades, there has been a tremendous increase in the demand for fresh water due to rapid growth of population and the accelerated pace of industrialization. Human health is threatened by most of the agricultural development activities particularly in relation to excessive application of fertilizers and unsanitary conditions. Rapid urbanization, especially in developing countries like India, has affected the availability and quality of groundwater due to its overexploitation and improper waste disposal, especially in urban areas. According to WHO organization, about 80% of all the diseases in human beings are caused by water. The development of growing regions in developing countries is allied several social, economical, environmental and technical aspect of concern area along with the study of available, sustainable resources for civilization. Among all; Ground water is the one of the vital resources confined everlasting. In the context of quality and quantity; ground water fluctuates in variably in its own which reflects the time to time status of ground water as a whole for the region. The quality and quantity of river water is influenced by both natural processes and anthropogenic interferences; the latter constitutes one of the major causes of environmental problems that alter the hydrochemistry in our river systems. Rivers are highly heterogeneous at spatial as well as temporal scales. Variation in the quality and quantity of River water is widely studied across the globe. Riedel et al..[7] examined the spatio-temporal variation in trace elements in Patuxent River, Maryland, while Gupta and Chakrapani.[8] studied temporal and spatial variations in water flow and sediment load in Narmada River Basin, India. The hydrologic cycle is a very important and practical concept for maintaining a healthy and fundamental aspects life on the Earth. Water makes up a substantial part of living organisms, and those organisms need water for life. Therefore, managing water resources by thoroughly understanding the hydrologic cycle at scales ranging from the entire Earth to the smallest of watersheds is one of the greatest responsibilities of humans. Because fresh surface water and fresh groundwater are the only parts of the hydrologic cycle that can be used by humans, most interest in the hydrologic cycle by water managers is focused on these resources. Indeed, most researches in the hydrological sciences is devoted to understanding movement of water, and the movement of chemicals and sediment transported by water in watersheds. To assure adequate water resources for human use, water managers need to be able to measure the amounts of water that enter, pass through, and leave watersheds. This is a challenge because the relative magnitudes of the individual transfers in the hydrological cycle can vary substantially.

MATERIAL AND METHODS

The Krishna River is the fourth longest river in India, after the Ganges, Godavari and Narmada; which flows entirely in India. The river is almost 1,300 kilometers (810 km) long.[9] The river is also called Krishna. It is a major source of irrigation for Maharashtra, Karnataka, Telangana.[10] and Andhra Pradesh. The Krishna river rises in the Western Ghats, at an elevation of about 1337 m just north of Mahabaleshwar, about 64 km from the Arabian Sea. It flows for about 1400 km and outfalls into the Bay of Bengal. The principal tributaries joining Krishna are the Ghataprabha, the Malaprabha, the Bhima, the Tungabhadra and the Musi.

Most of this basin comprises rolling and undulating country, except for the western border, which is formed by an unbroken line of the Western Ghats. The important soil types found in the basin are black soils, red soils, laterite and lateritic soils, alluvium, mixed soils, red and black soils and saline and alkaline soils.An average annual surface water potential of 78.1 km^3 has been assessed in this basin. Out of this, 58.0 km^3 is utilizable water. Cultivable area in the basin is about 203,000 km^2, which is 10.4% of the total cultivable area of the country. The river Krishna receives discharges from the different streams and effluents from sugar industries.

Samples for the characterization of different physico-chemical parameters were collected at monthly intervals from seven (7) experimental sites during April, 2014 to March, 2015.

Water samples from different sites were collected by means of shallow water sampler in a polystyrene bottle. Some physico-chemical parameters like water temperature, pH, conductivity, total dissolved solid, BOD, COD, dissolved oxygen, Chlorine, Carbonate, Bicarbonate, Total hardness, lead, cadmium, cobalt, iron and manganese were analyzed and recorded on the spots immediately after collection of the water samples. Analysis for the remaining physico-chemical parameters were carried out in the laboratory. The methods used for the estimation of the variables were standard methods of APHA,[11] (1989) and Trivedy and Goel,[12] (1984).

RESULTS AND DISCUSSION

The results of the physico-chemical analysis for eight sites of Krishna river is depicted in table1-20. Values are mean for eight different sites Krishna River during April, 2014 to March, 2015.

Water Temperature

Temperature of water of Krishna river (Table.3& 4) ranges from 26.7 °C (Jan) to 33.6 °C (May). Seasonally, the average maximum mean value was recorded as 28.02 ±0.75°C in Krishna River.

pH

Unlike lakes and ponds, rivers are open systems, where frequent water exchange occurs. Despite this fact, the organisms that depend on rivers require some equilibrium. Various indicators give a measure of the quality of a river. These measurements include dissolved oxygen, temperature, and pH, which is a measure of hydrogen ion concentration. The pH value of Krishna river water shows a mark fluctuation for the different sites. The range of pH value shows a variation from 6. 6 (during October) and 8.2 (during May). However, the highest average mean value was recorded as 7.01 ±0.26. Similar trend was reported by Ekeh and Sikoki,[13] in the New Calabar River and also by Ansa,[14] in Andoni flats of the Niger Delta area.

Selection spots along and bank of the Krishna River

Table.1 The sample spots along the Krishna River

Sl No	Spots/Village	Up stream	Down stream	Distance from Effluent Point
A1	Sanal	Up Steam	----	300 mtrs before effluent discharge
A2	Effluent Point	----	----	250 fts to wards River
A3	Nagnoor	----	1.0 km	1.0 km
A4	Nagnoor	----	0.5 km	1.5 km
A5	Padasalagi Barrage	----	0.1 km	5 km
A6	Padasalagi Barrage	----	3 km	8 km
A7	Towards Galgali		3 km	10 km

Table.2 The sample spots along the bank of Krishna River Village

Sl No	Spots/Village	Up stream	Down stream	Distance from River to Village	Distance from Effluent Point
B1	Sanal public bore wells 1	Up Steam	----	1.4	700 mtrs
B2	Sanal public bore well 2	Up Steam	----	1.4	800 mtrs
B3	Nagnoor public bore well 1	----	Down stream	1.5 km	1.5 km
B4	Nagnoor public bore well 2	----	Down stream	1.5 km	1.7 km
B5	Padasalagi public bore well 1	----	Down stream	1.2 km	5.0 km
B6	Padasalagi public bore well 2	----	Down stream	1.2 km	5.1 km
B7	Galgali public bore well 1		Down stream	1.3 km	10 km
B8	Galgali public bore well 2		Down stream	1.3 km	1.2 km

Table.3 Temperature variation of Krishna River water

Spots → Month↓	A1	A2	A3	A4	A5	A6	A7
April	32.5	32.7	32.5	32.4	32.1	32.0	32.0
May	33.3	33.6	33.4	33.3	33.3	33.2	33.2
June	32.2	32.5	32.4	32.3	32.3	32.2	32.2
July	31.1	31.4	31.3	31.3	31.3	31.2	31.2
August	31.4	31.6	31.5	31.4	31.4	31.3	31.3
Sept	31.6	31.8	31.7	31.6	31.5	31.5	31.4
Oct	30.8	32.1	31.9	31.7	31.6	31.5	31.3
Nov	30.4	32.6	31.5	30.9	30.6	30.4	30.4
Des	28.6	30.7	29.7	28.9	28.6	28.6	28.5
Jan	26.8	28.9	27.8	27.1	26.8	26.7	26.7
Feb	28.9	30.1	29.0	29.0	28.9	28.9	29.0
Mar	31.3	32.5	31.4	31.3	31.3	31.3	31.3

Table.4 Temperature variation along the bank of Krishna River Village

Spots → Month↓	B1	B2	B3	B4	B5	B6	B7
April	34.3	34.4	34.4	34.3	34.3	34.2	34.2
May	34.6	34.6	34.5	34.5	34.6	34.7	34.7
June	34.2	34.2	34.3	34.4	34.3	34.2	34.3
July	32.3	32.4	32.3	32.3	32.2	32.2	32.3
August	31.8	32.0	32.0	31.9	31.9	31.8	31.7
Sept	31.1	31.2	31.2	31.1	31.2	31.1	31.2
Oct	31.0	31.0	31.1	30.8	30.6	30.5	30.4
Nov	30.6	30.7	30.7	30.6	30.5	30.7	30.6
Des	30.1	30.2	30.1	30.2	30.1	30.3	30.3
Jan	29.8	29.9	29.8	29.8	30.0	30.1	29.9
Feb	29.9	30.1	29.9	29.9	30.1	30.0	29.9
Mar	31.1	31.2	31.3	31.3	31.2	31.1	31.2

Table.5 pH variation of Krishna.

Spots → Month↓	A1	A2	A3	A4	A5	A6	A7
April	8.1	7.0	7.1	7.3	7.4	7.5	7.5
May	8.2	7.3	7.4	7.5	7.5	7.6	7.8
June	8.1	7.1	7.4	7.5	7.6	7.6	7.7
July	7.9	7.0	7.1	7.3	7.4	7.5	7.6
August	7.7	6.9	7.0	7.1	7.3	7.4	7.5
Sept	7.6	6.8	6.9	7.0	7.2	7.4	7.5
Oct	7.5	6.6	6.7	6.8	6.9	7.1	7.1
Nov	7.7	6.9	7.0	7.2	7.4	7.5	7.5
Des	7.8	7.0	7.3	7.4	7.5	7.6	7.7
Jan	7.8	7.1	7.3	7.4	7.4	7.5	7.6
Feb	7.9	6.8	7.0	7.2	7.3	7.4	7.6
Mar	8.0	6.9	7.2	7.3	7.4	7.5	7.5

Table.6 Variation of Electrical Conductivity of Krishna River water in micro ohms/cm.

Spots → Month↓	A1	A2	A3	A4	A5	A6	A7
April	255	2995	1200	706	547	428	315
May	266	2642	1095	701	535	412	304
June	251	2013	1006	698	515	397	289
July	235	1898	986	605	465	324	248
August	231	1508	908	597	453	310	241
Sept	228	1105	792	585	426	302	231
Oct	225	1505	879	598	456	352	243
Nov	247	2325	1126	599	453	352	259
Des	268	2552	1206	634	485	375	285
Jan	258	2356	1203	625	473	382	292
Feb	260	2602	1216	642	485	389	279
Mar	266	2709	1203	678	482	371	295

Table.7 Variation of Total Dissolved Solids (TDS) of Krishna River water in ppm

Spots → Month↓	A1	A2	A3	A4	A5	A6	A7
April	372	1612	1136	814	653	541	398
May	385	1403	1101	801	605	452	388
June	365	1300	1056	791	585	427	375
July	345	1002	954	754	564	437	364
August	351	985	857	692	562	445	371
Sept	368	785	602	586	545	487	368
Oct	368	1186	902	785	585	498	378
Nov	369	1425	912	759	595	489	375
Des	365	1502	956	769	610	495	378
Jan	382	1656	1083	785	654	501	402
Feb	385	1712	1062	774	639	509	415
Mar	375	1809	1053	795	652	521	405

Table.8 Variation of BOD of Krishna River water in ppm

Spots → Month↓	A1	A2	A3	A4	A5	A6	A7
April	6.0	89	72	52	39	29	16
May	6.8	78	65	49	36	27	15
June	6.9	70	69	50	33	24	13
July	6.2	65	48	39	28	19	10
August	5.9	61	45	35	30	18	11
Sept	6.3	69	48	39	28	20	09
Oct	6.3	75	47	40	27	19	09
Nov	6.2	80	45	38	25	18	10
Des	5.9	89	41	35	21	15	08
Jan	6.1	95	50	37	26	17	12

Feb	6.3	98	48	38	29	19	13
Mar	6.5	98	51	42	33	26	17

Table.9 Variation of COD of Krishna River water in ppm

Spots → Month↓	A1	A2	A3	A4	A5	A6	A7
April	11	112	84	65	41	21	14
May	10	88	71	58	36	18	12
June	13	55	39	28	20	16	12
July	15	51	35	26	19	16	13
August	18	45	28	21	20	18	15
Sept	17	43	26	20	19	18	16
Oct	17	98	75	61	43	22	17
Nov	18	120	91	70	48	24	18
Des	19	126	95	72	48	25	17
Jan	18	130	98	73	49	26	19
Feb	15	128	98	71	43	23	18
Mar	12	120	93	68	42	21	15

Table.10 Dissolved Oxygen of Krishna River Water in mg/l

Spots → Month↓	A1	A2	A3	A4	A5	A6	A7
April	2.5	1.1	1.6	1.9	2.1	2.2	2.3
May	2.4	2.1	2.2	2.3	2.4	2.4	2.4
June	2.5	2.2	2.3	2.4	2.5	2.5	2.5
July	2.6	2.2	2.3	2.4	2.5	2.6	2.6
August	2.6	2.3	2.4	2.4	2.5	2.6	2.6
Sept	2.7	2.2	2.3	2.4	2.5	2.6	2.7
Oct	2.7	2.1	2.2	2.3	2.4	2.5	2.6
Nov	2.8	1.2	1.4	1.5	1.7	1.9	2.1
Des	2.9	0.9	1.2	1.3	1.6	1.9	2.0
Jan	2.8	0.9	1.2	1.3	1.7	1.9	2.1
Feb	2.6	1.0	1.3	1.4	1.7	2.0	2.2
Mar	2.5	1.0	1.3	1.4	1.7	1.9	2.1

Note : 40% saturation or 3mg /Liter according to WHO

Table.11 Chlorine Demand of Krishna River Water in mg/l

Spots → Month↓	A1	A2	A3	A4	A5	A6	A7
April	302	715	657	602	562	506	432
May	298	603	512	487	421	396	321
June	321	584	503	459	406	378	305
July	350	561	515	467	405	372	301
August	356	536	497	461	403	365	296

Sept	380	565	506	469	398	352	284
Oct	382	654	589	489	419	385	302
Nov	390	856	714	667	601	523	456
Des	412	863	739	658	589	513	425
Jan	405	879	731	649	587	519	414
Feb	386	885	729	638	588	509	401
Mar	358	895	724	625	562	489	397

Note : Max Chloride 600 mg/l According WHO

Table.12 Carbonate of Krishna River Water in mg/l

Spots → Month↓	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**
April	0.06	0.6	0.4	0.3	0.1	0.09	0.08
May	0.05	0.7	0.5	0.4	0.2	0.1	0.08
June	0.03	0.6	0.5	0.4	0.2	0.1	0.09
July	0.07	0.8	0.6	0.4	0.3	0.2	0.09
August	0.06	0.7	0.6	0.5	0.3	0.1	0.09
Sept	0.06	0.8	0.7	0.6	0.4	0.2	0.1
Oct	0.05	0.6	0.5	0.4	0.3	0.1	0.09
Nov	0.03	0.5	0.4	0.3	0.1	0.09	0.07
Des	0.02	0.4	0.3	0.2	0.1	0.08	0.06
Jan	0.03	0.4	0.2	0.1	0.09	0.08	0.06
Feb	0.03	0.3	0.2	0.1	0.09	0.07	0.05
Mar	0.04	0.4	0.3	0.2	0.1	0.08	0.06

Table.13 Bicarbonate of Krishna River Water in mg/l

Spots → Month↓	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**
April	1.9	11.5	9.6	6.8	4.7	3.5	2.4
May	1.6	10.7	8.7	6.9	4.5	3.6	2.3
June	2.5	12.6	10.3	9.2	6.9	4.8	2.8
July	2.8	12.8	10.5	8.4	6.4	4.6	3.1
August	2.5	12.3	10.1	8.7	6.8	4.9	3.5
Sept	2.3	12.1	9.5	7.6	5.5	4.2	3.2
Oct	2.1	11.6	9.8	8.1	6.3	4.6	3.5
Nov	2.3	12.3	10.1	8.4	6.3	4.2	3.8
Des	2.0	11.1	9.8	7.8	5.9	4.1	3.0
Jan	2.0	11.2	9.9	7.6	6.2	4.3	3.1
Feb	1.9	11.3	9.8	7.5	5.9	4.1	3.3
Mar	1.8	11.3	9.6	7.	5.8	4.2	3.1

Table.14 Total Hardness of Krishna river water in ppm

Spots → Month↓	A1	A2	A3	A4	A5	A6	A7
April	375	455	436	418	395	381	378
May	384	412	396	390	387	386	386
June	350	409	387	376	369	362	360
July	336	403	389	371	358	342	339
August	327	395	388	373	361	346	340
Sept	329	402	382	369	353	340	336
Oct	330	489	452	431	415	402	365
Nov	341	503	462	430	409	395	354
Des	348	512	471	433	408	393	365
Jan	353	506	463	426	403	389	369
Feb	368	503	458	439	415	382	375
Mar	371	510	453	436	409	387	380

Table.15 Lead of Krishna river water in ppm

Spots → Month↓	A1	A2	A3	A4	A5	A6	A7
April	0.016	0.022	0.020	0.018	0.016	0.015	0.015
May	0.017	0.025	0.022	0.019	0.018	0.017	0.016
June	0.010	0.021	0.018	0.014	0.013	0.012	0.010
July	0.009	0.018	0.014	0.013	0.011	0.010	0.010
August	0.009	0.019	0.014	0.012	0.011	0.010	0.010
Sept	0.010	0.023	0.016	0.013	0.012	0.011	0.010
Oct	0.013	0.031	0.020	0.017	0.016	0.015	0.014
Nov	0.014	0.032	0.021	0.018	0.016	0.015	0.014
Des	0.014	0.031	0.020	0.017	0.016	0.015	0.015
Jan	0.015	0.032	0.021	0.018	0.017	0.016	0.016
Feb	0.014	0.033	0.022	0.017	0.015	0.015	0.014
Mar	0.015	0.031	0.023	0.018	0.017	0.016	0.016

Table.16 Cadmium level of Krishna river water in ppm (mg/lit)

Spots → Month↓	A1	A2	A3	A4	A5	A6	A7
April	0.0035	0.0092	0.0086	0.0078	0.0057	0.0049	0.0038
May	0.0025	0.0089	0.0079	0.0065	0.0052	0.0041	0.0036
June	0.0028	0.0086	0.0073	0.0068	0.0056	0.0045	0.0038
July	0.0024	0.0089	0.0075	0.0065	0.0052	0.0043	0.0037
August	0.0030	0.0087	0.0078	0.0067	0.0051	0.0042	0.0039
Sept	0.0029	0.0090	0.0074	0.0064	0.0050	0.0041	0.0040
Oct	0.0025	0.0098	0.0079	0.0066	0.0053	0.0046	0.0042
Nov	0.0029	0.0185	0.0171	0.0106	0.0101	0.0083	0.0074
Des	0.0027	0.0189	0.0178	0.0103	0.0087	0.0067	0.0052

Jan	0.0029	0.0178	0.0155	0.0100	0.0075	0.0058	0.0051
Feb	0.0026	0.0185	0.0098	0.0097	0.0071	0.0063	0.0054
Mar	0.0027	0.0181	0.011	0.0089	0.0077	0.0066	0.0052

Table.17 Cobalt level of Krishna river water in ppm (mg/lit)

Spots → Month↓	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**
April	0.85	1.2	1.11	1.11	1.0	0.93	0.90
May	0.83	1.3	1.20	1.14	1.03	0.92	0.90
June	0.84	1.2	1.12	1.08	1.01	0.94	0.89
July	0.88	1.3	1.13	1.06	1.00	0.91	0.89
August	0.85	1.2	1.12	1.03	0.95	0.91	0.88
Sept	0.90	1.3	1.21	1.11	1.0	0.96	0.93
Oct	0.86	1.2	1.12	1.05	0.98	0.95	0.91
Nov	0.89	1.05	1.01	0.98	0.95	0.92	0.90
Des	0.91	1.11	1.03	0.98	0.95	0.93	0.92
Jan	0.85	1.12	1.02	0.98	0.94	0.91	0.89
Feb	0.87	1.13	1.03	0.99	0.95	0.92	0.89
Mar	0.87	1.15	1.02	0.98	0.95	0.91	0.89

Table.18 Iron level of Krishna river water in ppm (mg/lit)

Spots → Month↓	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**
April	1.5	2.5	2.3	2.1	2.0	1.9	1.6
May	1.6	2.6	2.5	2.2	2.0	1.8	1.7
June	1.8	2.8	2.6	2.4	2.1	2.0	1.9
July	2.1	3.2	3.0	2.8	2.5	2.3	2.2
August	2.0	3.2	3.1	3.0	2.7	2.4	2.3
Sept	1.9	3.2	3.0	2.8	2.6	2.4	2.3
Oct	1.7	3.1	2.9	2.7	2.5	2.3	2.1
Nov	1.8	2.8	2.7	2.5	2.3	2.1	2.0
Des	1.6	2.7	2.5	2.4	2.3	2.0	1.8
Jan	1.6	2.6	2.5	2.3	2.1	1.9	1.7
Feb	1.5	2.5	2.4	2.1	2.0	1.8	1.7
Mar	1.4	2.4	2.2	2.0	1.9	1.7	1.6

Table.19 Manganese level of Krishna river water in ppm (mg/lit)

Spots → Month↓	A1	A2	A3	A4	A5	A6	A7
April	1.0	2.0	1.8	1.6	1.4	1.3	1.2
May	1.1	2.2	2.0	1.8	1.6	1.5	1.3
June	1.0	2.1	2.0	1.8	1.7	1.5	1.3
July	1.1	2.2	2.0	1.8	1.6	1.4	1.2
August	1.0	2.2	2.1	1.9	1.7	1.5	1.3
Sept	1.1	2.2	2.0	1.8	1.6	1.5	1.2
Oct	1.1	2.1	2.0	1.8	1.7	1.5	1.4
Nov	1.2	2.4	2.2	2.0	1.8	1.5	1.3
Des	1.1	2.6	2.4	2.3	2.1	1.8	1.4
Jan	1.2	2.8	2.6	2.3	2.2	1.9	1.5
Feb	1.1	2.5	2.3	2.1	1.9	1.7	1.5
Mar	1.1	2.5	2.2	2.0	1.8	1.6	1.4

Table.20 Nickel level of Krishna river water in ppm (mg/lit)

Spots → Month↓	A1	A2	A3	A4	A5	A6	A7
April	0.06	0.18	0.16	0.14	0.13	0.11	0.08
May	0.05	0.19	0.18	0.15	0.13	0.12	0.10
June	0.06	0.19	0.17	0.15	0.14	0.13	0.11
July	0.07	0.20	0.18	0.16	0.15	0.13	0.11
August	0.08	0.21	0.19	0.17	0.15	0.14	0.12
Sept	0.08	0.20	0.18	0.16	0.14	0.13	0.11
Oct	0.07	0.18	0.16	0.14	0.13	0.11	0.09
Nov	0.06	0.16	0.14	0.12	0.11	0.09	0.08
Des	0.05	0.14	0.12	0.11	0.09	0.08	0.07
Jan	0.04	0.12	0.10	0.09	0.08	0.06	0.05
Feb	0.04	0.12	0.11	0.09	0.07	0.06	0.05
Mar	0.06	0.16	0.15	0.13	0.12	0.10	0.08

CONDUCTIVITY

Average mean conductivity from all the sites of Krishna river (Table.4) was found maximum during summer. Maximum value is 2900 ±32. micromho/cm^2 and minimum value is during winter i.e. 250 micromhos/cm^2. Ranges of conductivity values from across the sites were 225-268 A1,1105-2995 A2,792-1216 A3,585-706 A4,426-547A5,302-428A6 and 231-315 A7 micromhos/cm^2 respectively. This indicates electrical conductivity values of most of the samples lies above in the range of medium salinity zone (250-750 micromhos/cm^2).

Total Dissolved Solid

TDS indicates the general nature of salinity of water. Water with high TDS produces scales on cooking vessels and boilers. Water containing more than 500mg/l of TDS is not considered suitable for drinking water supplies. In Krishna river water sample TDS was(Table.7) 351-385 A1,785-1809 A2,857-1136 A3, 586-814 A4, 545-654 A5, 427-541 A6 and 364-415ppm respectively. Except A1, A6 and A7 samples all the samples exceed the permissible limit i.e., TDS value of the sample lie above the range of low salinity zone (200 mg/l). Total dissolved solids influence the qualities of drinking water and is most important parameter in irrigation water because, it has the capacity to control the availability of water to plants through osmotic pressure – regulating mechanism Settle able matter is able to inhibit the growth of flora and biota. Extraordinarily high values of TDS in pre monsoon speak about a very high degree of eutrophication,[15] in Municipal wastewater.

Biochemical Oxygen Demand (BOD)

The BOD is an indication of the organic load of municipal wastewater. BOD values (Table.8) fluctuated from 5.9-6.8 A1,61-98 A2, 41-72 A3, 35-52 A4,21-39A5, 17-29 A6 and 8-17 A7 respectively. Comparatively lower BOD was observed during monsoon due to dilution of the effluent. The high value of BOD may be due to extensive use of organic nutrients. The BOD level in Krishna River at the studied location found exceeding the permissible limit of 2 mg/l. BOD 5-days value increased along the downstream at all the study sites of the river ecosystem.[16]

Chemical Oxygen Demand

The Chemical Oxygen Demand is used as a measure of the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant (*APHA, 1995*). This gives valuable information about the pollution potential of industrial effluents and domestic sewage.[17] In present study the values (Table.9) vary from 10-19 A1,43-130 A2, 26-98 A3, 20-73 A4,19-49 A5,16-26 A6 and 12-19 ppm A7 respectively. The highest values of COD indicates that most of the pollution in study zone in caused by industrial effluents discharged by industrial units like pulp and paper mill, sugar factory etc. upstream.[18] Similar results were also reported by Pande and Sharma.[19]

Dissolved Oxygen (DO)

Dissolved oxygen is a useful parameter (DO) to assess the quality of water. Temperature plays an important role in determining the dissolved oxygen in an aquatic system. Dissolved oxygen concentration(Table.10) was found to be fluctuated in each site from 2.5-2.9 A1,0.9-2.3 A2, 1.2-2.4 A3, 1.3-2.4 A4, 1.6-2.5 A5, 1.9-2.6A6 and 2.0-2.9 mg/l respectively. The DO values obtained from this study are similar to those reported else whereas,[20] The value of dissolve oxygen was found low, mostly at the bottom layer on account of low production of oxygen and higher consumption of dissolve oxygen by microbial activities.[21]

Chloride

Chlorides are the inorganic compound resulting from the combination of the chlorine gas with metal. Some common chlorides include sodium chloride (NaCl) and magnesium chloride ($MgCl_2$). Chlorine alone as (Cl_2) highly toxic, and it is often used a disinfectant. In combination with a metal such as sodium, it becomes essential for life. Small amounts of chlorides are required for normal cell functions in plant and animal life. Environmental impact of chlorides are not usually harmful to human health; however, the sodium part of the table salt has been linked to heart and kidney diseases. Sodium chloride may impact a salty taste at 250 mg/l; however, calcium or magnesium chloride is usually detected by taste until levels of 1000 mg/l are reached. Public drinking water standards require chloride level not to exceed 250 mg/l. Chlorides may get into surface water from several sources including: rocks contain chlorides, agricultural run-off, waste water from industries, oil well wastes, and effluent waste water from waste water treatment plants. Chlorides can corrode metals and affect the taste of food products. Chlorides can contaminate fresh water streams and lakes. Fish and aquatic communities cannot survive in high level of chlorides. Therefore, water that is used in industry or proceeds for any use has a recommended maximum chloride level. In the present study chloride concentration (Table.11) varied from 298-412 A1, 536-895 A2,497-739 A3,459-658A4, 403-601 A5,352-523A6 and 284-456mg/l respectively. About 21% sites show above permissible limits of WHO.

Carbonates

Bicarbonate is the major constituent of natural water. It comes from the action of water containing carbon dioxide on limestone, marble, chalk, calcite, dolomite, and other minerals containing calcium and magnesium carbonate. The carbonate-bicarbonate system in natural waters controls the pH and the natural buffer system. The typical concentration of bicarbonate in surface waters is less than 200 mg/l as HCO_3. In groundwater, the bicarbonate concentration is significantly higher. The carbonate precipitates generally occur as individual slabs, thinly lithified pavements, vertical pillars, mushroom-like structures, microbial mats, dispersed crystals and as micro-concretions. The bicarbonate pool produced as a result of bacterial anoxic methane oxidation is significantly enriched in ^{12}C.Carbonate concentration ranged from (Table.12& 13) 0.02-0.07 A1,0.3-0.8 A2, 0.2-0.7 A3, 0.1-0.6 A4, 0.09-0.4 A5,0.07-0.2 and 0.05-0.1 mg/l similarly Bicarbonate concentration varied from1.8-2.8A1, 10.7-12.8A2, 8.7-10.5A3, 6.8-8.7A4,4.5-6.7A5,3.5-4.8A6 and 2.3-3.8A7 respectively.

Hardness

It is defined as the sum of calcium and magnesium concentrations and is a measure of the capacity of water to precipitate soap. Total hardness (TH) is characteristics by contents of calcium and magnesium salts. Ca-H and Mg-H combine to form total hardness. Total hardness (TH) varied(Table.14) from 327-384 A1, 305-512 A2, 386-471 A3, 371-439 A4,353-415 A5, 305-402 A6 and 330-386 A7 respectively and these values are bellow the permissible limits of WHO. WHO recommended (100-500 mg/L) as safe permissible limit for hardness. In ground water, hardness is mainly due to carbonates, bicarbonates, sulphates and chlorides of Ca and Mg. The main natural sources of hardness in water are dissolved polyvalent metallic ions from sedimentary rocks,[22] seepage and run off from soil. Calcium and magnesium, the two main ions are present in many sedimentary rocks, the most common being limestone and chalk.

Lead

From a drinking water perspective, the almost universal use of lead compounds in plumbing fittings and as solder in water distribution systems is important.[23] Lead is present in tap water to some extent as a result of its dissolution from natural sources but primarily from household plumbing systems in which the pipes solder, fittings, or service connections to homes contain lead. PVC pipes also contain lead compounds that can be leached from them and result in high lead concentration in drinking water. According to India standard drinking water specification 1991, highest desirable limit of lead in drinking water is 0.05 ppm and no relaxation for maximum permissible limit. In the present study concentration of lead (Table.15) ranged from 0.009-0.033 A, 0.033A3, 0.012-0.019A4, 0.011-0.018A5, 0.010-0.017 and 0.010-0.016 respectively. Reported values are bellow the permissible limits of WHO.

Cadmium

Cadmium occurs in the earth's crust at a concentration of 0.1–0.5 ppm and is commonly associated with zinc, lead, and copper ores. Cadmium is a relatively rare soft metal that occurs in the natural environment typically in association with zinc ores and, to a lesser extent, with lead and copper ores. Some inorganic cadmium compounds are soluble in water, while cadmium oxide and cadmium sulfide are almost insoluble. In the air, cadmium vapor is rapidly oxidized. Wet and dry deposition transfers cadmium from the ambient air to soil, where it is absorbed by plants and enters the food chain. This process may be influenced by acidification that increases the availability of cadmium in soil. Atmospheric levels of cadmium range up to 5 nanograms per cubic meter (ng/m3) in rural areas, from 0.005 to 0.015 micrograms per cubic meter (μ/m3) in urban areas, and up to 0.06 μg/m3 in industrial areas (WHO 1992). Cadmium concentration (Table.16) was found to be fluctuated in each site from0.0025-0.0035 A1, 0.0086-0.0189 A2, 0.0073-0.015 A3, 0.0064-0.0097 A4, 0.0050-0.0101 A5, 0.0041-0.0083 and 0.0036-0.0074mg/l respectively. The present values are within the permissible limits of WHO guidelines.

Cobalt

The occurrence of cobalt in the earth's surface varies greatly. This element does not exist in its native form and is encountered only in meteorites. Cobalt is most often found in the form of arsenides and sulphides. The most important cobalt minerals are cobaltite CoAsS, linnaet $C0_3S_4$, smalty $CoAs_2$ and karrolit $CuCo2S_4$. The source of cobalt pollution (apart from industrial waste) is the burning of cobalt. Cobalt may occur at oxidation levels of from -1 to +4, but in nature it occurs usually as a double-valence cation Co^{2+} (cobalt compounds). In erosive environments it easily undergoes oxidation from Co^{2+} to Co^{3+} and creates the complex anion $Co(OH)_3^{-3}$. It relatively easily becomes mobile in acidic oxidizing environments, but does not undergo extensive aqueous migration, since it combines with the hydroxides of iron and manganese as well as salty minerals. The concentration of cobalt varied (Table.17) from 0.83-0.90 A1, 1.05-1.3 A2, 1.01-1.20 A3, 0.98-1.14 A4, 0.94-1.03A5, 0.91-0.96A6 and 0.88-0.93A7 respectively.

Iron

The concentration of iron fluctuated (Table.18) from 1.4-2.1 A1,2.4-3.2 A2, 2.2-3.1 A3, 2.0-3.0 A4,1.9-2.4 A5, 1.7-2.4 A6 and 1.6-2.3 A7 respectively. Concentration of iron in water get increased by corrosion of pipes and by of iron present in soil by acidic water. Kidney stone related problem may develop if calcium and iron contents are high. The level of Krishna water was below the detectable limit and it was well within the WHO and BIS permissible limits.

Manganese

Manganese is a mineral that naturally occurs in rocks and soil and is a normal constituent of the human diet. It exists in well water in CT as a naturally occurring groundwater mineral, but may also be present due to underground pollution sources. Manganese may become noticeable in tap water at concentrations greater than 0.05 milligrams per liter of water (mg/l) by imparting a color, odor, or taste to the water. However, health effects from manganese are not a concern until concentrations are approximately 10 times higher. The concentration of manganese (Table.19) ranged from 1.0-1.2 A1, 2.0-2.8 A2, 1.8-2.6 A3, 1.6-2.3 A4, 1.4-2.2 A5,1.3-1.9 A6 and 1.2-1.5 respectively. At concentrations as low as 0.02 mg/L, manganese can form coatings on water pipes that may later slough off as a black precipitate.[24]

Nickel

Nickel occurs predominantly as the ion $Ni(H2O)_6^{2+}$ in natural waters at pH 5–9 (IPCS, 1991). Complexes with ligands, such as OH^-, SO_4^{2-} , HCO^{3-}, Cl^-, and NH_3, are formed to a minor degree in this pH range. Nickel present as a consequence of leaching from nickel-plated fittings would be expected to be in a similar form. In assessing the hazard and potential risk from nickel in drinking-water, it is therefore appropriate to consider only data relating to water-soluble nickel salts, which will reflect the toxicity of the nickel ion. In the present study concentration of nickel varied from (Table.20) 0.04-0.08A1, 0.12-0.20 A2, 0.11-0.19 A3, 0.09-0.17 A4, 0.07-0.15 A5, 0.06-0.14 A6 and 0.05-0.12 respectively. In Europe, reported nickel concentrations in drinking-water were generally below 10 µg/liter.[25]

CONCLUSION

The present study leads to following conclusions:

1. Data indicate that in Krishna River the values of parameters such as pH, alkalinity, Iron and chloride were found to be within WHO and BIS permissible limits. Therefore water of this river can be used for irrigation and drinking purpose.
2. The hardness and TDS of some sites of Krishna River above the permissible limit of WHO

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