Study of variations in water quality status of Ganga and Ramganga rivers

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ABSTRACT

Water is a natural resource to basic human need and a precious national asset. India accounts for 2.2% of the global land and 4% of the world water resources, but must support 16% of the world population. Water bodies are continuously in natural dynamic state and are sometimes upset by human activities. More than half of India's water resources are either polluted or under pollution threat. Rapid growth in population, haphazard industrialization and sprawl of urban centers coupled with lack of adequate resources in rural areas, have created critical situations for water resources. Rivers play a significant role in providing water resources for human and ecosystem survival and health. Hence, river water quality is an important parameter that must be preserved and monitored regularly. The objectives of this study are to assess the water quality status for two rivers in Ganga basin i.e. Ganga and Ramganga and to establish the WQ trend. In order to promote pollutant monitoring and preservation of water resources, the trends in water quality conditions of Ganga and Ramganga rivers was evolved. Using monthly WQ data from June 1991 to May 2012, trend analysis was conducted at three water quality monitoring stations at each of Ganga and Ramganga rivers. Six water quality indicating parameters viz. dissolved oxygen (DO), electrical conductivity (EC), total hardness (TH), total alkalinity (TA), fluoride and pH were selected for trend analysis. At majority of sampling locations EC, TA, TH, and F show variations in trends over time. Many sampling locations show increasing DO concentrations. The mean values of pH in most of the sites are around 8. The sites in Moradabad and Kanpur regions show a slightly higher average values than other sites. The highest pH value is found at Kanpur in Ganga and Moradabad in Ramganga. The highest DO average value is found at Garhmukteshwar 7.5 mg/l. Most of the trends of DO showed decreasing value expect the at Moradabad region. The decreased trend of DO and increasing value of pH at Ganga river is mainly the result of domestic pollution from the urban area, sewage and agricultural runoff and lack of wastewater management. Significant decreasing trends were found in all the sites.

1. INTRODUCTION

Fresh water is a limited resource as important for industry and agriculture as for human existence Khalil & Ouarda , 2009, Bartram & Balance 1996. River water is essential for domestic use, irrigation, industrial production and numerous other activities Kido et al., 2009. Anthropogenic impacts directly affect watershed hydrology Claessens et al., 2006, Chang, 2007 the energy balance in water Oke, 1987 and biologeochemical cycling in streams Baker,2003 all of which influence water quality. Monitoring of river water quality is essential both for understanding the current condition of rivers and for maintaining water quality impairments under various stresses Deano et al.2008, Simeonov, 2002, Berjas, 2000, He et. al. 2011 . The analysis of monitoring data using trend analysis provides numerous insights into water quality conditions that will prove useful to both the private and public sectors.

River Ganga originates from its source at Gangotri in the middle Himalayas where it is known as Bhagirathi and after receiving Alaknanda at Deoprayag, it is called as Ganga. It leaves the boundaries of lower Himalayas and Shivalik ranges at Rishikesh to carve its journey across the extensive

Northern and Eastern plains to the bay of Bengal. The river during its course from Rishikesh downwards receives small rivulets namely Malini between Rishikesh and Garhmukteshwar, Mahawar and Sot between Garhmukteshwar and Fatehgarh on the left flanks. Between Fatehgarh and Kanpur, it receives one of its major tributaries namely Ramganga on the left bank while small streams like Kalindi and Issan also fall in to the River from the right bank.

The river Ramganga originates from southern part of Chamoli district in Uttarakhand state. It is a tributary of river Ganga. After meandering about 500 km, it meets river Ganga in the U/S of Kannauj site.

A large number of pilgrimage centers are situated on the river throughout its length which attract large population of the country & abroad. Some of the important religious centers (up to Bhitaura) like Rishikesh, Haridwar Garhmukteshwar, Kannauj have existed since time immemorial. Due to human activities pollution load has increased not only at these places but also at various Ghats. With the advent of modern era, a large number of industrial complexes also sprang up in the course of time, bringing with them the curse of technological age viz. the imbalance in ecology and the destructive pollutionary threats to the water resources of the basin.

Different kind of industries have developed along the course of river Ganga which discharge their effluents directly in to the river water. Though the major industrialized town (up to Bhitaura) is only Kanpur, however, several small industries have grown along the course of Ganga due to increased urbanization.

Starting from up-stream, there are six Water Quality monitoring stations at the Ganga river named Garhmukteshwar, Kachlabridge, Fatehgarh, Ankinghat, Kanpur and Bhitaura, three on river Ramganga named Moradabad, Bareilly and Dabri.

2. MATERIALS AND METHODS

2.1 DESCRIPTION OF STUDY SITE AND DATA COLLECTION

In this study two main rivers of U. P., India, Ganga and Ramganga were selected. Data for analysis monthly collected from 6 river water quality observation stations located at the various places of these two rivers. Starting from the beginning Garhmukteshwar, Kanpur and Bhitaura sites of Ganga river and Moradabad, Bareilly and Dabri of Ramganga river were selected. The period of the collected data is from May 1990 to April 2012 and they were published annually in the water quality year book by the Central water Commission, G O I.

2.2 WATER QUALITY PARAMETERS

Six water quality parameters, namely pH, EC, TA (Ca & Mg), TH (CO_3 & HCO_3), F and DO were considered for the evaluation of overall status of river waters.The pH of surface waters is specified for protection of fish life and to control undesirable chemical reactions. Electrical Conductivity (EC) is a measure of how well water can pass an electrical current. It is an indirect measure of the presence of inorganic dissolved solids such as Cl, NO_3, Ca, Fe, and Mg. The presence of these substances increases EC of a body of water. Total Alkalinity (TA) measures the amount of alkaline compounds in water such as carbonates, bicarbonates. These compounds are natural buffers that can remove excess hydrogen ions. Total Hardness (TH) is governed by the content of carbonates and bicarbonates and other anions. Fluoride in water derives mainly from dissolution of natural minerals fluorite, apatite and micas in the rocks and soils with which water interacts. Fluoride has been found to have a significant mitigating effect against dental caries and it is accepted that some fluoride presence in drinking water is beneficial. Optimal concentrations are around 1 mg/l Dissanayake, 1991.

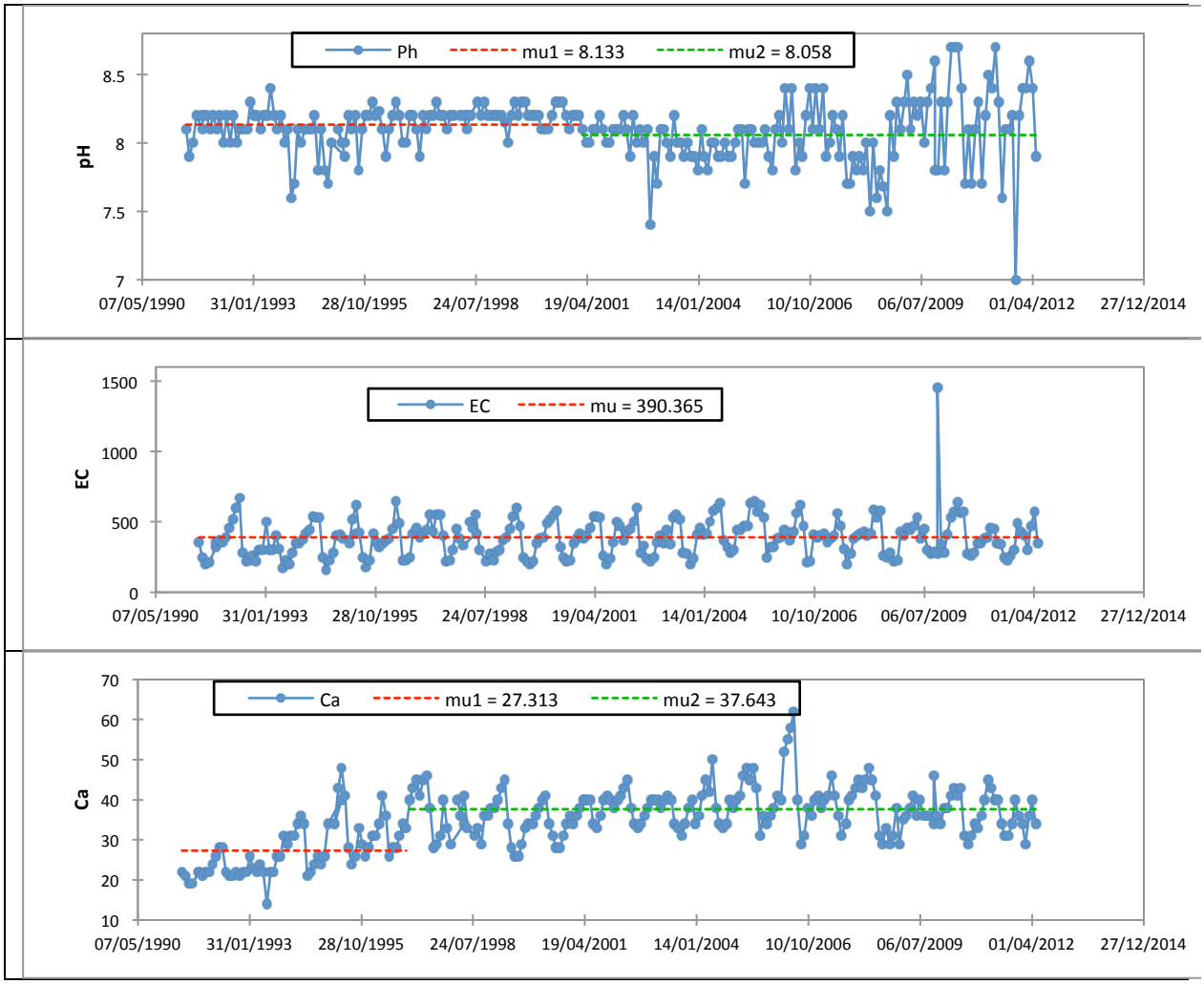
2.3 TREND ANALYSIS BY PETTIT'S TEST

XL STAT software for MS EXEL was used to prepare trend analysis. The Pettit's homogeneity Test Pettit,1979 was applied in this study in order to calculate the trend values for pH, EC, TA (Ca & Mg), TH (CO3 & HCO3), F and DO.

3. RESULTS AND DISCUSSION

In this section, the status of the river water quality is presented and trend analysis is explored. Monthly water quality data for six stations from May 1990 to April 2012 were considered. Time series plots of pH, EC, Ca, Mg, CO3, HCO3, F and DO were drawn for all the six sites selected for the study. But because of space limitations plots of only Kanpur (Ganga) and Bareilly (Ramganga) are given here.

Fig. 1: Time series plots of pH, EC, Ca, Mg, CO_3, HCO_3, F and DO at Kanpur (Ganga)



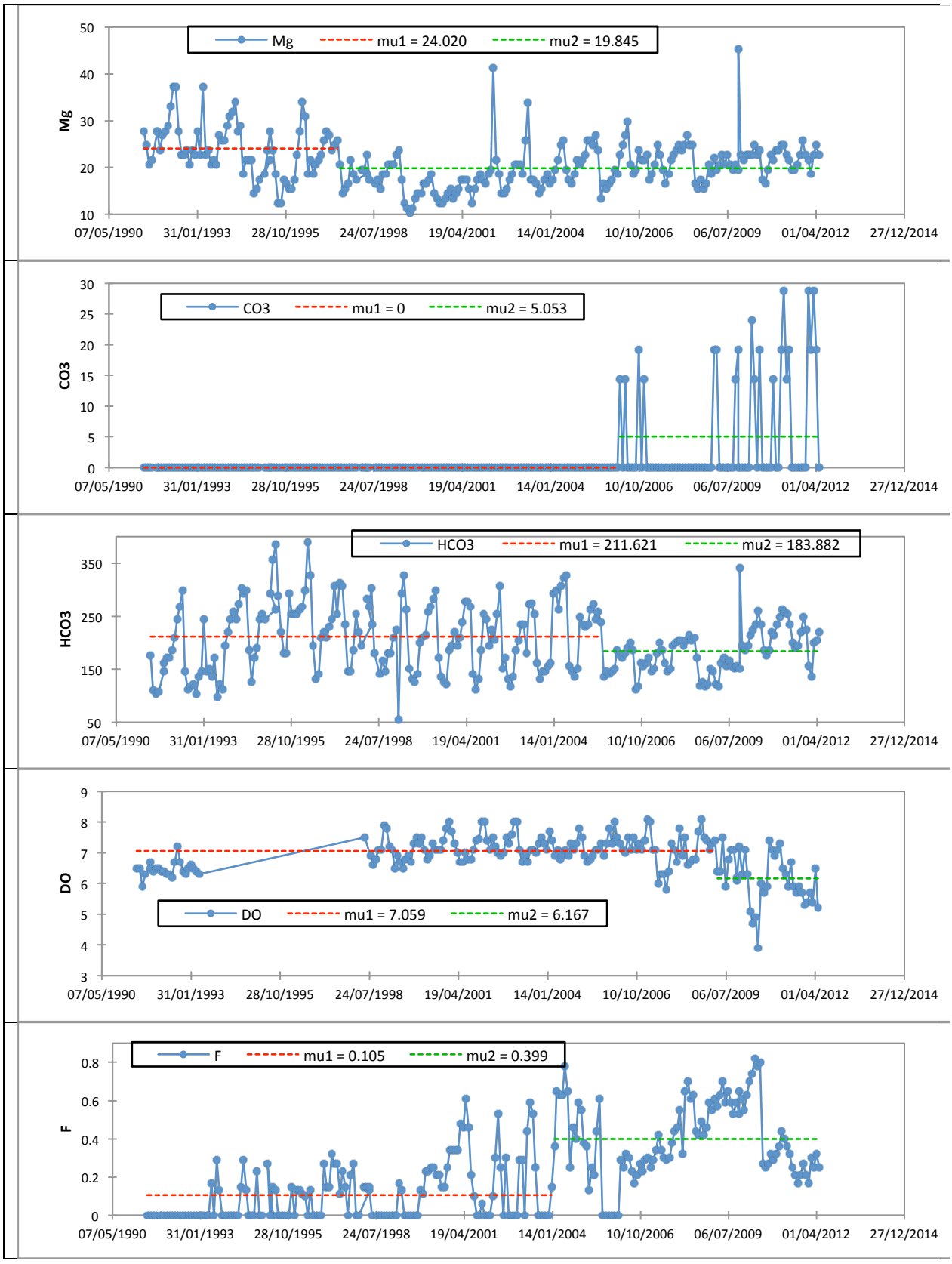
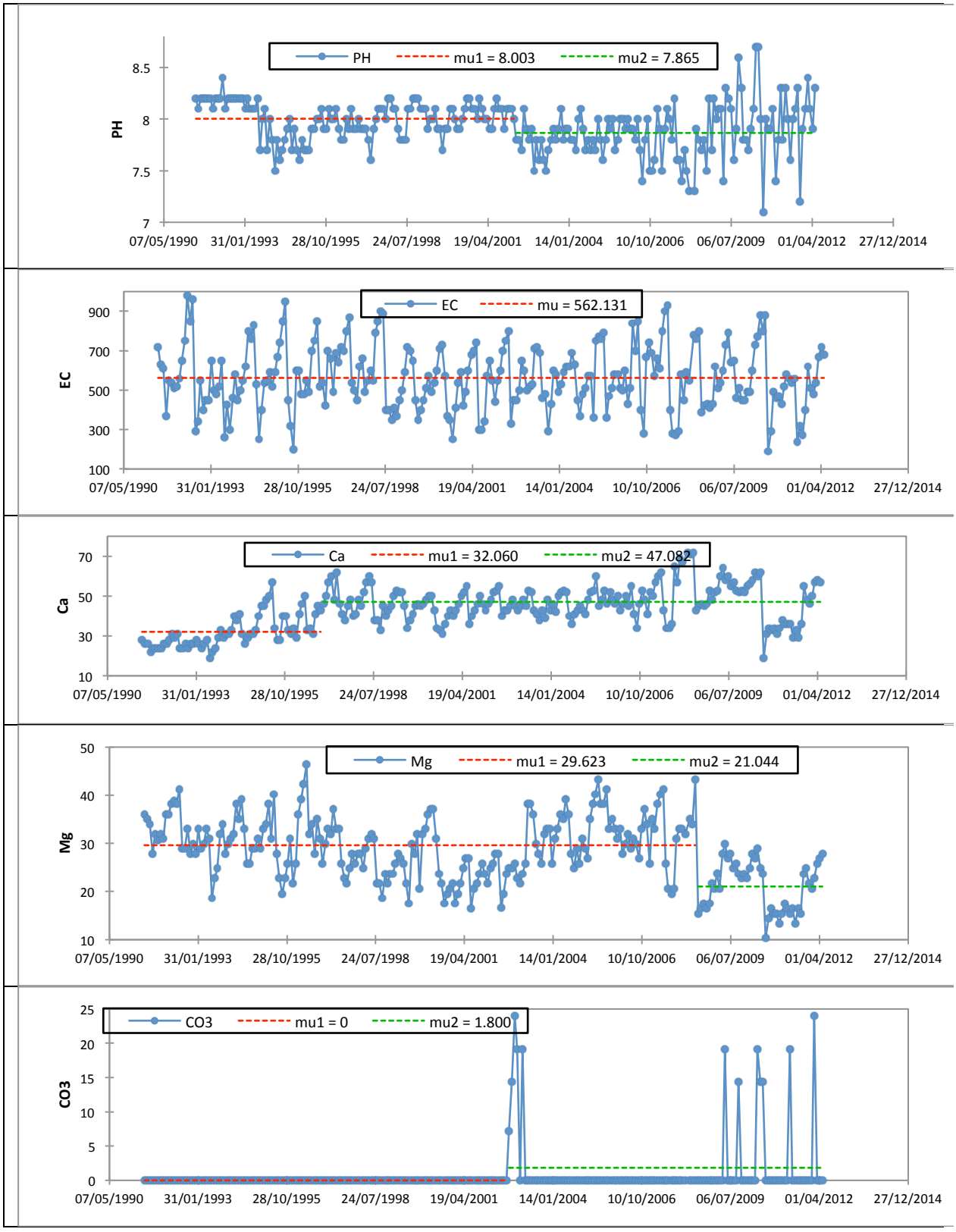
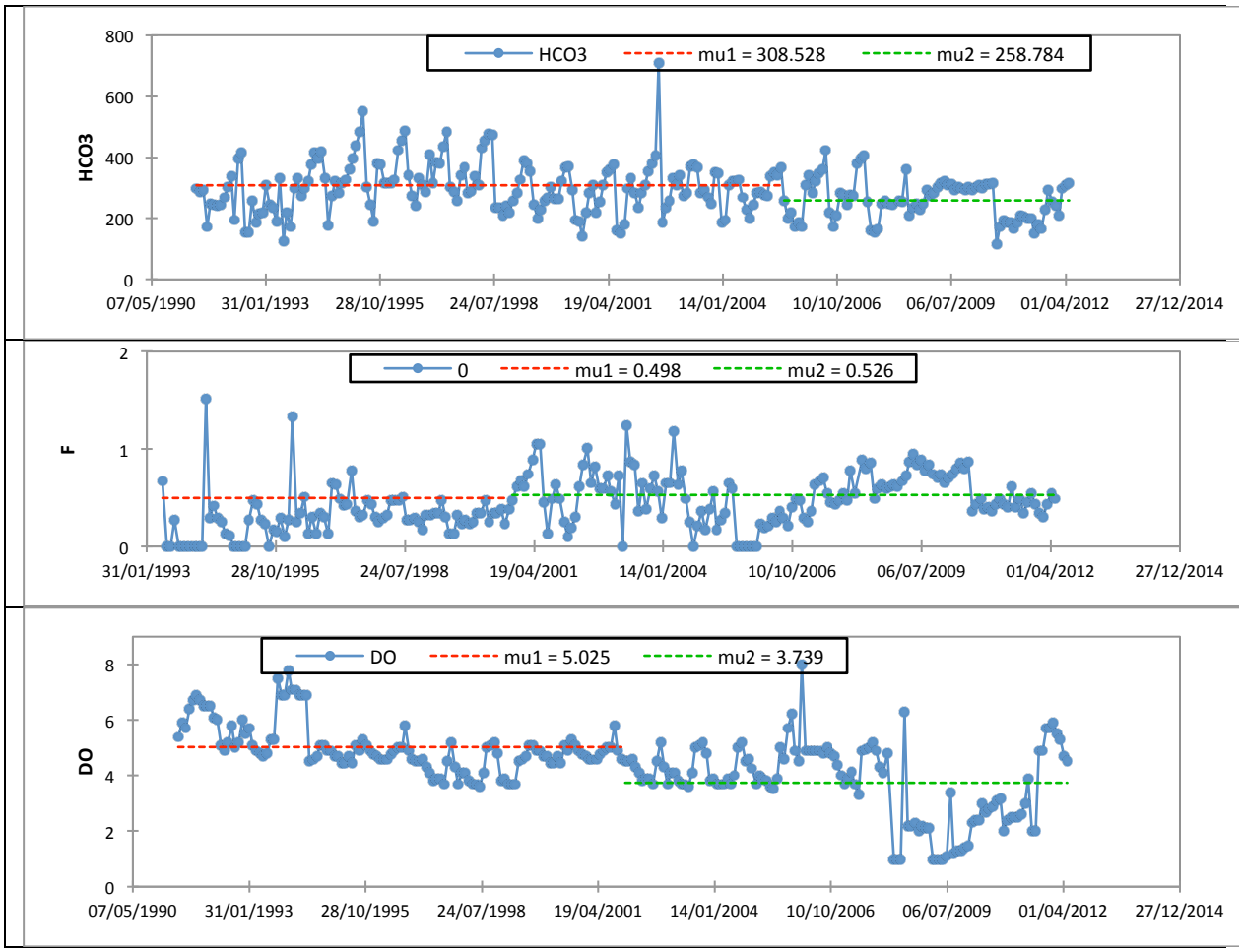

Mg
mu1 = 24.020
mu2 = 19.845
Mg
50
40
30
20
10
07/05/1990
31/01/1993
28/10/1995
24/07/1998
19/04/2001
14/01/2004
10/10/2006
06/07/2009
01/04/2012
27/12/2014
CO3
mu1 = 0
mu2 = 5.053
CO3
30
25
20
15
10
5
0
HCO3
mu1 = 211.621
mu2 = 183.882
HCO3
350
250
150
50
DO
mu1 = 7.059
mu2 = 6.167
DO
9
8
7
6
5
4
3
F
mu1 = 0.105
mu2 = 0.399
F
0.8
0.6
0.4
0.2
0

Fig. 2: Time series plots of pH, EC, Ca, Mg, CO_3, HCO_3, F and DO at Bareilly (Ramganga)





3.1 TREND OF pH, EC & DO

The mean values of pH in most of the sites are around 8. The sites in Moradabad and Kanpur regions show a slightly higher average values than other sites. The highest pH value is found at Kanpur in Ganga Fig 1. and Moradabad Table 4 in Ramganga because of industrialization in these two cities and lack of wastewater management. Significant decreasing trends were found in all the sites.

EC shows an increasing trend 216.77 to 237 5621µmhos/cm only at garhmukteshwar Fig. 1 but the value is low and at all other sites it shows no trend. Its highest values lie in the range 5621µmhos/cm at Bareilly fig. 4. As shown in Table 1, 2, 3 the sites with highest DO values are located at the river Ganga. The highest DO average value is found at Garhmukteshwar 7.537 mg/l table 1. Most of the trends of DO showed decreasing value but there are also some increasing trends at Moradabad region Table 5. The decreased trend of DO at Ganga river is mainly the result of domestic pollution from the urban area, sewage and agricultural runoff.

Table 1: Results of trend analysis for Garhmukteshwar at Ganga River

GARHMUKTESHWAR- Ganga river				
S No.	PARAMETER	Trend	Average shifted to	
1	Ph	F	8.165	7.835
2	EC	R	216.775	237.939
3	Ca	R	21.277	27.583
4	Mg	F	16.788	12.947
5	CO3	R	0	10.80
6	HCO3	F	139.508	117.045
7	F	R	0.025	.175
8	DO	-	7.537	-

Table 2: Results of trend analysis for Kanpur at Ganga river

KANPUR- Ganga				
S No.	PARAMETER	Trend	Average shifted to	
1	pH	F	8.133	8.058
2	EC	-	390.365	-
3	Ca	R	27.313	37.643
4	Mg	F	24.02	19.845
5	CO3	R	0	5.053
6	HCO3	F	211.621	183.882
7	F	R	.105	.399
8	DO	F	7.059	6.167

Table 3: Results of trend analysis for Bhitaura at Ganga river

BHITAURA- Ganga				
S No.	PARAMETER	Trend	Average shifted to	
1	pH	F	8.128	8.039
2	EC	-	410.569	-
3	Ca	R	26.797	38.593
4	Mg	F	27.098	20.450
5	CO3	R	.097	3.419
6	HCO3	F	228.711	202.647
7	F	R	.110	.420
8	DO	F	7.498	6.845

3.2 TREND OF TH, TA & F

Total hardness is sum of calcium and magnesium present in water as mgCaCO3/liter. Amount of calcium and magnesium present in river water is presented separately in trend analysis graphs. Calcium shows a rising trend at Garhmukteshwar Fig.1. It also shows rising trends at all other sites of Ganga and Ramganga Fig. 2-6. Its highest values of average shift are found at Bareilly from 32.06 to 47.082 mg/l Fig.5. Its lowest average value shift is from 21.27 to 27.58mg/l at Garhmukteshwar table 1.

Magnesium shows a falling trend at all sites of Ganga and Ramganga Fig. 1-6. Its highest values of decreasing average shift are found at Bareilly from 29.62 to 21.04 mg/l table 5. Its lowest average value shift is from 16.78 to 12.94 mg/l at Garhmukteshwar table 1.

Total Alkalinity is sum of carbonate and bicarbonate present in river water as mgCaCO3/liter. Amount of carbonate and bicarbonate present in river water is presented separately in trend analysis graphs. Carbonate shows a rising trend at all sites except Moradabad Fig 1-6. Table 6 clearly indicates no shift in average value of carbonate at Moradabad.

Bicarbonate shows a falling trend at all sites of Ganga and Ramganga Fig. 1-6. Highest shift in average is observed in table 4 of Moradabad from 320.92 to 250.06 mg/l. Lowest shift in average was observed in table 1 of Garhmukteshwar from 139.5 to 117.04 mg/l.

Fluoride shows a rising trend table 5at all sites of Ganga and Ramganga rivers Fig. 1-6. Maximum fluoride levels are reported in Bareilly table 5, where average 0.498 shifted to 0.526mg/l. Minimum fluoride levels are observed at Garhmukteshwar table 1, where average 0.025 shifted to 0.175 mg/l.

Table 4: Results of trend analysis for Moradabad at Ramganga river

MORADABAD- Ramganga				
S No.	PARAMETER	Trend	Average shifted to	
1	Ph	F	7.949	7.681
2	EC	-	548.214	-
3	Ca	R	31.31	41.871
4	Mg	F	30.086	23.224
5	CO3	-	.648	-
6	HCO3	F	320.923	250.067
7	F	R	.381	.535
8	DO	R	2.681	4.889

Table 5: Results of trend analysis for Bareilly at Ramganga river

BAREILLY- Ramganga				
S No.	PARAMETER	Trend	Average shifted to	
1	pH	F	8.003	7.865
2	EC	-	5621.131	-
3	Ca	R	32.06	47.082
4	Mg	F	29.623	21.044
5	CO3	R	0	1.8
6	HCO3	F	308.528	258.784
7	F	R	.498	.526
8	DO	F	5.025	3.739

Table 6: Results of trend analysis for Dabri at Ramganga river

DABRI- Ramganga				
S No.	PARAMETER	Trend	Average shifted to	
1	pH	F	8.07	7.992
2	EC	-	493.163	-
3	Ca	R	32.472	43.315
4	Mg	F	28.597	22.428
5	CO3	R	.337	5.908
6	HCO3	F	262.003	223
7	F	R	.2476	.547
8	DO	F	6.823	5.056

3.3 WATER QUALITY CRITERIA

The sources of usable water on the earth are limited, any kind of pollution in them will further reduce its availability. Polluted water cannot be utilized for drinking because of its inherent health risk. Water with high salt contents is not suitable for agriculture and most industries. However, the water, which is not suitable for irrigation, may be quite suitable for industrial cooling. Every use of water requires a certain minimum quality standards with regards to the presence of dissolved and suspended materials of both chemical and biological nature. To maintain the minimum quality standard for diverse user has led to the formulation of water quality criteria, and water quality standards. Water quality criteria can be considered as specific requirements on which a decision or judgment to support a particular use will be based. The criteria for the various uses are developed based on the experimental data, and our

current knowledge of the health, ecology and other issues and assessing its overall economical effect these are not a set of fixed values, but subject to modification as the scientific data get updated and more and more knowledge is gathered. The term standard applies to any definite principle or measure established by an authority by limiting concentration of different constituents in water to ensure the safe use of water and safeguard the environment.

Drinking Water Standards: In view of the direct consumption of water by human beings, the domestic water supply is considered to be most important use of water and drinking use has been given first priority on utilization of water resource in the National Water Policy. In India, agencies like the Bureau of Indian Standards (BIS) and Indian Council of Medical Research (ICMR) have formulated drinking water standards. The World Health Organization (WHO) has also laid down drinking water standards, which are considered international standards. Values of the trace and toxic metals covered in this research paper and given in table 7 are according to BIS 10500, 2012 as given below.

Table 7: Drinking Water Standards for Trace & Toxic metals (BIS:10500;2012)

S. No	Parameter	Unit	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternative Source
1	**pH**	mg/l	6.5-8.5	No relaxation
2	**Calcium as CaCO3, Max**		75	200
3	**Magnesium as Mg, Max**		30	100
4	**Total Hardness as CaCO3, Max**		300	600
5	**Alkalinity, Max**		200	600
6	**Fluoride, Max**		1.0	1.5

3.4 ENVIRONMENT MANAGEMENT FOR IMPROVING WATER QUALITY

The trend analysis presented in this study provides river water quality data at a glance of Ganga and Ramganga and offers a better understanding of current conditions of rivers. Stations with increasing trends and high average concentrations of deleterious river water quality parameters are easy to identify using the data presented here. Findings in this study show that improvements are highly dependent on improved wastewater management and other water quality improvements efforts promoted under government initiative. Environment management must focus on reducing key pollution sources and emissions from point sources.

4. CONCLUSIONS

This study presents the result of trend analysis using the Pettit's Homogeneity test to generate useful water quality information of Ganga and Ramganga rivers. Overall, trends show some improvements in river water quality over last 22 years (1990-2012). Decreasing water quality in the Ramganga was identified at Bareilly. The result of analysis indicates that the water quality is not safe in river Ganga at Kanpur for drinking, bathing and other purposes. Water quality in river Ramganga at Moradabad, Bareilly and Dabri is also not safe for drinking, bathing and other purposes.The unusual water quality conditions are linked with the events or disasters but further study is necessary to clearly indentify causes of poor water quality. Education on environmental awareness and campaigns should be intensified to ensure active participation from all sections of society.

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