Water Quality Status and Trend of important parameters of the river Gomti with special reference to Lucknow city

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ABSTRACT

Clean, safe and adequate freshwater is vital to the survival of all living organisms and smooth functioning of ecosystem, communities and economies. Declining water quality has become a global issue of concern as human population grow, industrial and agricultural activities expand, and climate change threaten to cause major alterations to the hydrological cycle. Water quality issues are complex and diverse, and are deserving of urgent global attention and action.

Central Water Commission is involved in the water quality monitoring of Indian Rivers since 1945. Gomti is one of the important tributaries of the holy river Ganga. Water Quality data of the last 30 years pertaining to the river Gomti have been taken for the present study. Current water quality status and trend of selected parameters like pH, Electrical Conductivity, Dissolved Oxygen etc. have been evolved. Among the eleven parameters selected for the study of trend analysis 7 parameters (pH, Mg, Na, K, SO4, HCO3 and DO) found falling, 3 parameters (Ca, Cl and F) found rising trend at the Lucknow WQ station. Electrical conductivity is the one and only parameter found no trend at all during the twenty years.

1. INTRODUCTION

Rivers and streams are an important component of the natural environment, and need to be protected from all sources of pollution because man's own survival depends on their sustainable use. Rivers, however, are increasingly under threat from different pollutants, which include conventional pollutants (organic matter and inorganic nutrients) and hazardous substances (organic contaminants and heavy metals). Despite the fact that the river water quality can be influenced by natural phenomena such as climate and geology (Boorman 2003 and DWAF 1995). Water Quality Management Series. Crocodile River Catchment Eastern Transvaal. Water Quality), the main sources of pollution are related to anthropogenic activities: mining, agriculture, forestry, cattle farming and urbanization. As a result, river water quality is affected by both point and diffuse sources of pollution. Point sources of pollution include domestic or industrial discharges via pipe connections to the river system, whereas diffuse sources of pollution include runoff from the agricultural land and mining sites. Currently, both point and diffuse sources of pollution have resulted in two important water quality problems in surface waters: eutrophication (nutrient enrichment) and contamination by hazardous organic compounds.

To tackle these typical water quality problems, and for the sake of both ecological and human welfare, rivers (all water resources in general) must be protected, restored and sustained. This needs appropriate nationwide environmental regulations and assessment tools. The most widely applied environmental regulations are the Environmental Quality Objectives/Standards (EQO/EQS) and the Uniform Emission Standard (UES) (Tyson 1993). The former is based on the pursuit of a certain emission level, i.e. the receiving water quality, whereas the latter is based on the selection of an allowed emission level, e.g. effluent water quality. In the most recent developments, the combined approach of EQO and UES- a holistic approach– is the best approach towards the protection of all waters from all types of pollutants, including both conventional pollutants and hazardous substances (Bloch 2001).

2. METHODOLOGY

2.1. Sampling Station

Water Quality monitoring is one of the important objectives of Central Water Commission under the Ministry of Water Resources. It has a wide network of Water Quality monitoring stations on thirteen river basins of India. There are 22 water quality monitoring stations located on the river Ganga and its tributaries under Upper Ganga Basin Organisation, Lucknow, where on monthly basis water quality analysis work on all the 22 stations are carried out. Water quality data of last twenty years from the water year 1992-93 to 2011-2012 of one water quality stations are the river Gomti at Lucknow is taken for the present study.

2.2. Sampling

Following the standard norms as set by the Water Quality Assessment Authority (WQAA 2005), the water samples are collected every month during 08.00 AM to 11.00 AM on first working day of the month. These water samples were collected at 0.6 times the depth from surface without disturbing the bottom sediments, from the point across the river section having maximum depth or maximum flow along the cross section of the river, so that sample must be representative of the source (i.e. water stream) that is to be evaluated. The samples were collected in clean and pre-rinsed polythene bottles of one litre capacity, filled up to their full capacity without air bubbles. One more sample for bacteriological analysis was collected in BOD bottles of 300 ml capacity. Within 24 hours of collection, the collected water samples are transported to Ganga River Water Quality Laboratory, Central Water Commission, Lucknow for chemical analysis.

2.3. Analysis of the samples

The water sample preserved in laboratory were analysed for 24 water quality parameters using standard analytical and/or instrumental methods (APHA 1998). The quantitative estimation for the parameters is determined by titrimetric methods, electrical methods, optical methods etc.

2.4. Trend Analysis and its applications

Trend Analysis is the practice of collecting information and attempting to spot a pattern, or trend, in the information. Trend analysis is one of the most often used methods in forecasting. It aims to observe and register the past performance of a certain factor and project it into the future. It involves analysis (of two groups of trends: quantitative, mainly based on statistical data, and qualitative, these are at large concerned with social, institutional, organizational, environmental and political patterns (Sharma et al 2011 and Gupta et al 2007).

2.5. Parameters taken for trend analysis

Basic and very important water quality parameters like Electrical Conductivity (EC), pH, DO (Dissolved Oxygen), Calcium (Ca^{++}), Magnesium (Mg^{++}), Sodium (Na^{+}), Potassium (K^{+}), Chloride (Cl^{-}), Carbonate (CO_3^{--}), Bicarbonate (HCO_3^{-}) and Fluoride (F^{-}) were selected for assessing the trend of water quality. Homogeneity test was applied to the data and obtained graph have shown the trend of the concerned parameters.

3. RESULTS

From the data collected during the last twenty years minimum-maximum of the Water Quality parameters of the river Gomti for the period 1992-2012 at Lucknow Water Quality monitoring stations under Upper Ganga Basin Organisation, Lucknow were withdrawn from the SWDES Software meant for the data storage and statistical analysis purposes, and presented in Tables 1-2.

From the tables 1-2, it is evident that out of the eleven parameters taken for the study almost all the parameters are within their respective tolerance limits as set by the Bureau of Indian Standards. In the Tables 1-2, maximum Electrical Conductivity for the river Gomti is reported to be 700 µmho/cm and maximum pH to be 8.8 during the last twenty years. The minimum and maximum of other parameters like Ca, Mg, Na, K, HCO_3^{-}, Cl^{-}, $SO_4^{--}$and F^{-} are within the prescribed limits except pH to be maximum 8.8.

Table-1: Minimum-Maximum of the Water Quality parameters of the river Gomti for the period 1992-2012 at Lucknow Water Quality monitoring stations under Upper Ganga Basin Organisation, Lucknow.

Year	EC (µmho/cm)		pH		Ca (mg/L)		Cl (mg/L)		F (mg/L)		HCO3 (mg/L)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1992-1993	320	650	8.0	8.3	22	28	12.1	24.1	0.00	0.00	156	303
1993-1994	250	650	7.6	8.3	17	38	12.1	32.0	0.00	0.32	122	376
1994-1995	250	650	7.6	8.1	24	52	19.9	38.0	0.17	0.42	220	1457
1995-1996	250	640	7.9	8.1	26	52	19.9	40.1	0.11	0.42	210	390
1996-1997	300	650	7.8	8.2	26	46	25.9	35.9	0.13	0.47	190	356
1997-1998	300	600	7.8	8.2	28	41	24.1	41.9	0.15	0.32	181	327
1998-1999	270	650	7.9	8.2	29	45	25.9	46.2	0.25	0.47	151	351
1999-2000	310	620	7.9	8.2	31	43	13.8	38.0	0.11	0.47	185	342
2000-2001	260	550	8.0	8.3	31	43	16.0	30.2	0.06	0.74	142	283
2001-2002	260	580	7.8	8.1	34	46	9.2	34.1	0.00	0.53	142	298
2002-2003	320	560	7.7	8.0	34	45	24.1	36.2	0.15	0.70	171	268
2003-2004	230	600	7.8	8.1	27	55	22.0	41.9	0.11	1.16	146	278
2004-2005	280	630	7.3	8.1	34	55	24.1	46.2	0.00	0.78	151	283
2005-2006	350	640	7.8	8.3	31	55	9.9	25.9	0.00	0.53	146	268
2006-2007	280	610	7.5	8.3	31	52	2.2	28.0	0.19	0.47	139	264
2007-2008	230	700	7.3	8.3	31	58	9.9	32.0	0.27	0.86	112	259
2008-2009	150	720	7.2	8.2	21	58	9.9	32.0	0.38	0.78	112	210
2009-2010	250	640	7.3	8.8	21	33	24.1	46.2	0.47	0.74	146	205
2010-2011	210	630	7.5	8.6	21	45	24.1	44.0	0.11	0.72	112	238
2011-2012	200	580	7.1	8.7	28	43	9.9	32.0	0.23	0.49	142	234

Table-2: Minimum-Maximum of the Water Quality parameters of the river Gomti for the period 1992-2012 at Lucknow Water Quality monitoring stations under Upper Ganga Basin Organisation, Lucknow.

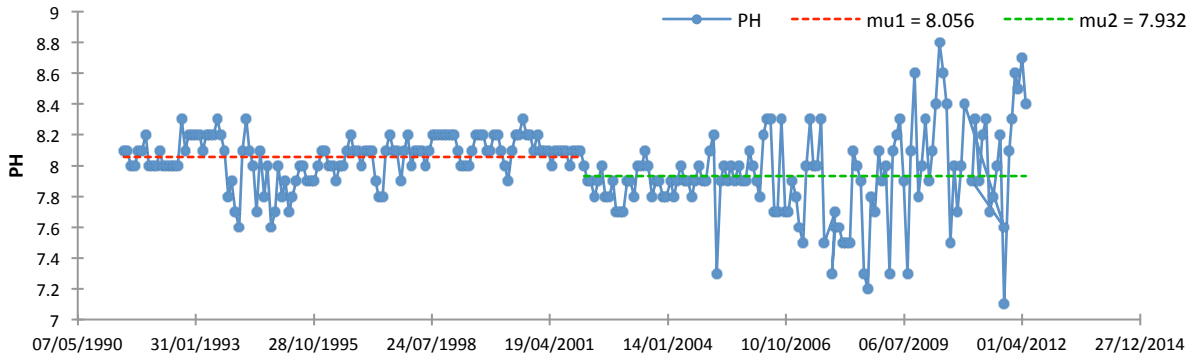
Year	K (mg/L)		Mg (mg/L)		Na (mg/L)		SO4 (mg/L)		DO (mg/L)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1992-1993	2.3	312.8	23.7	42.3	8.1	32.0	8.2	49.9	2.1	7.2
1993-1994	2.0	12.5	21.6	32.0	5.1	32.4	14.9	41.8	5.4	6.7
1994-1995	4.3	12.9	15.6	37.2	14.5	32.9	2.9	43.2	1.4	7.3
1995-1996	5.1	14.1	18.6	36.1	10.4	34.5	0.0	13.4	1.0	5.3
1996-1997	3.1	14.9	20.7	28.9	12.4	25.8	0.0	0.0	0.8	7.1
1997-1998	4.7	9.4	19.6	27.8	12.0	22.3	0.0	0.0	2.1	7.2
1998-1999	6.3	14.5	15.4	28.9	7.6	18.4	0.0	3.8	5.1	7.9
1999-2000	5.9	11.7	15.4	22.7	7.6	14.5	0.3	2.9	5.6	6.6
2000-2001	4.3	7.8	14.5	19.6	6.4	11.3	0.0	1.9	5.6	6.6
2001-2002	5.1	7.0	15.4	23.7	6.2	10.4	0.0	0.6	5.4	6.7
2002-2003	5.9	9.4	16.5	31.0	8.1	14.5	0.0	1.4	5.2	6.7
2003-2004	5.1	9.0	21.6	36.2	0.3	22.1	0.0	0.0	5.1	7.9
2004-2005	3.9	10.6	23.7	39.2	4.8	22.5	0.0	12.0	2.5	7.8
2005-2006	4.7	12.5	20.7	41.2	10.6	28.8	8.6	33.6	1.4	7.3
2006-2007	5.1	9.0	16.5	29.9	14.5	30.4	15.4	32.2	1.0	5.3
2007-2008	0.8	12.5	20.7	35.1	14.5	29.4	17.3	30.2	0.8	7.1
2008-2009	9.8	14.9	11.3	33.0	11.5	27.6	12.0	26.9	1.0	7.4
2009-2010	9.0	14.5	15.4	22.7	16.8	29.9	11.0	20.2	1.2	3.5
2010-2011	5.9	12.1	9.2	20.7	15.2	29.4	0.5	19.2	1.0	6.2
2011-2012	2.7	8.2	15.4	22.7	7.6	19.8	1.9	10.1	1.6	8.7

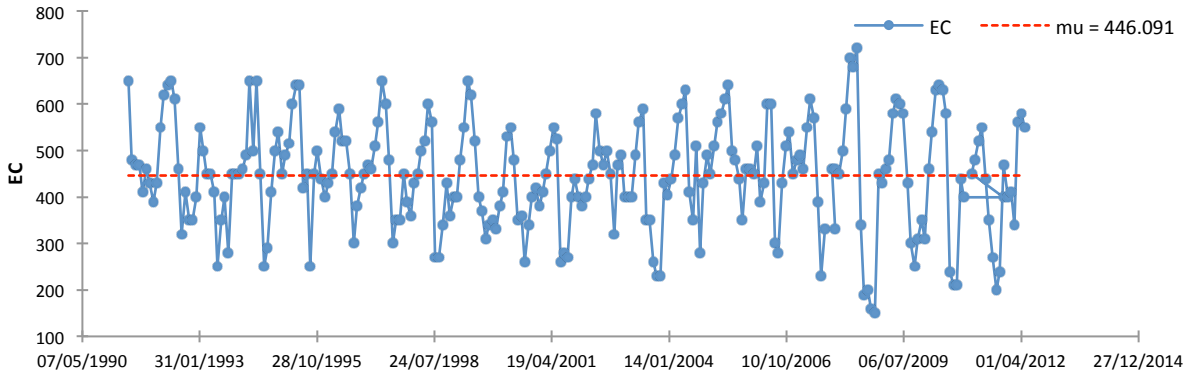
4. Discussion

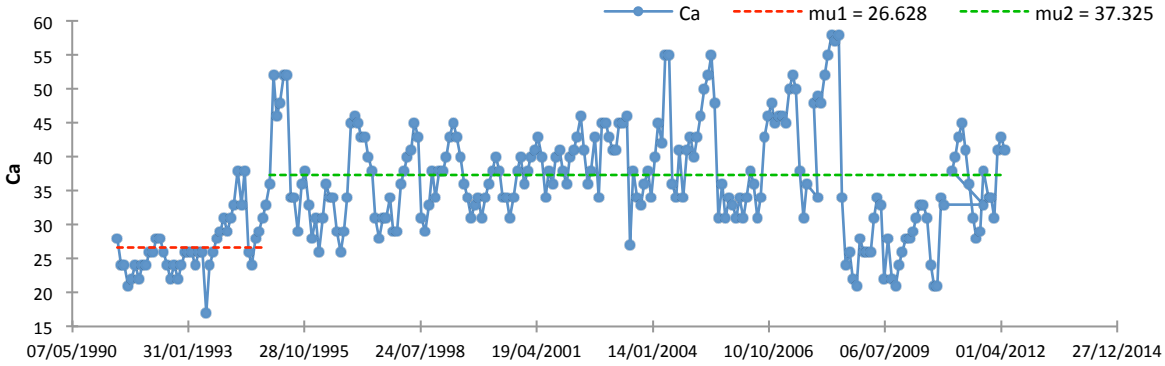
Among the eleven parameters selected for the study of trend analysis 7 parameters (pH, Mg, Na, K, SO4, HCO3 and DO) found falling, 3 parameters (Ca, Cl and F) found rising trend at the Lucknow WQ station. Electrical conductivity is the one and only parameter found no trend at all during the twenty years, which is further a good indicator.

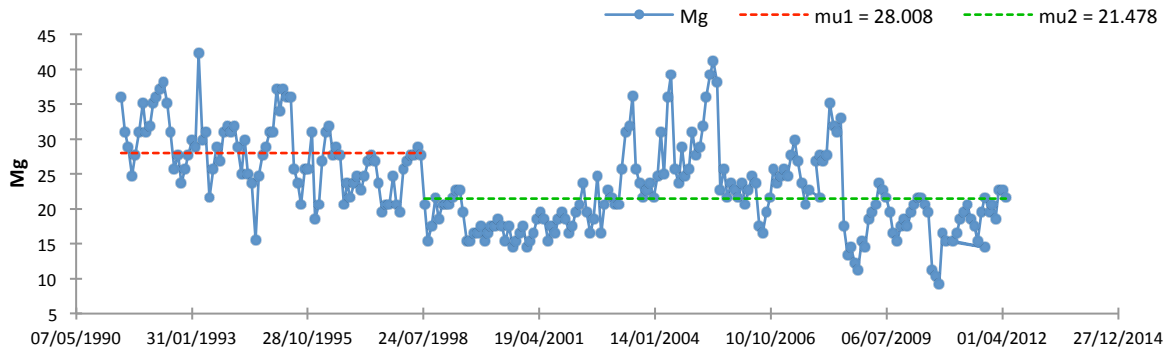
From the graphs plotted, the trends of the WQ parameters is very clear, Like pH of the river at Lucknow found falling from an average of 8.05 to 7.93. Mg, Na and K have significant falling trend from 28 to 21 mg/l, 19 to14 mg/l and 13 to 7 mg/l respectively.

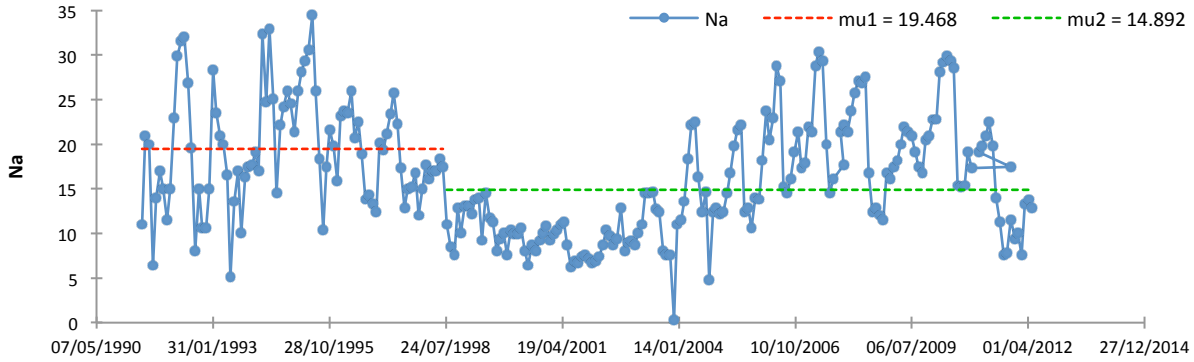
Table-3: Graphs drawn from the Homogeneity Tests on the Water Quality parameters of the river Gomti at Lucknow.

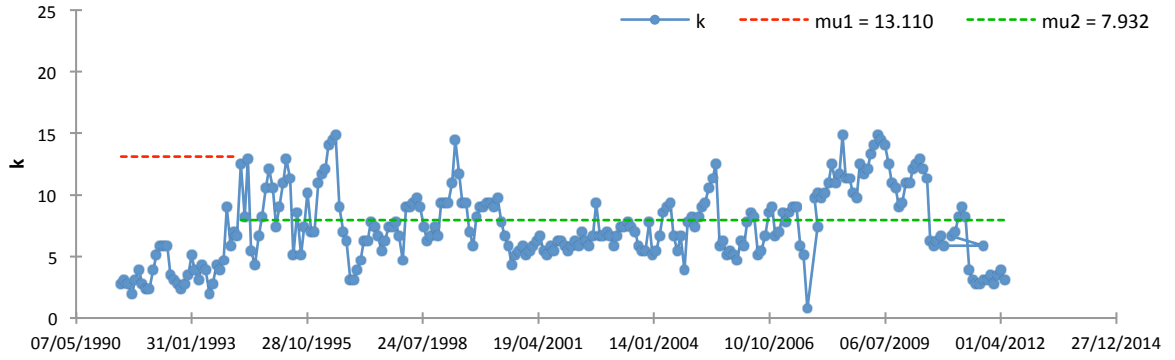


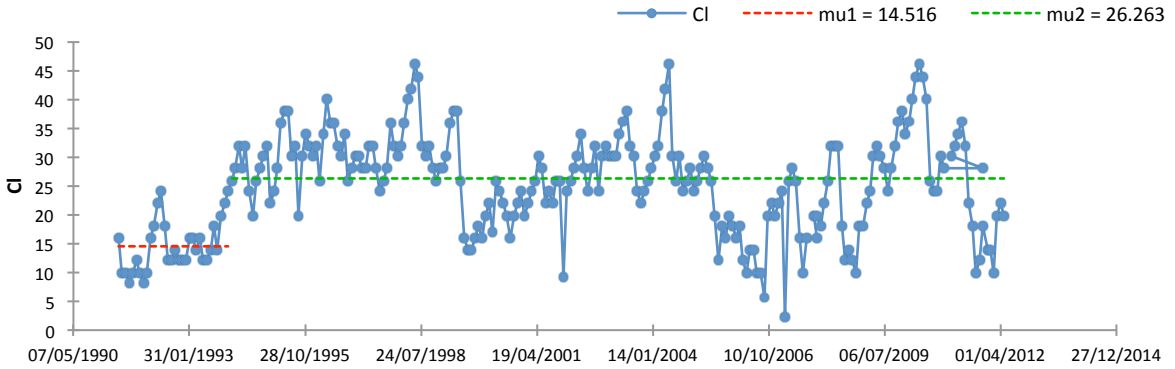


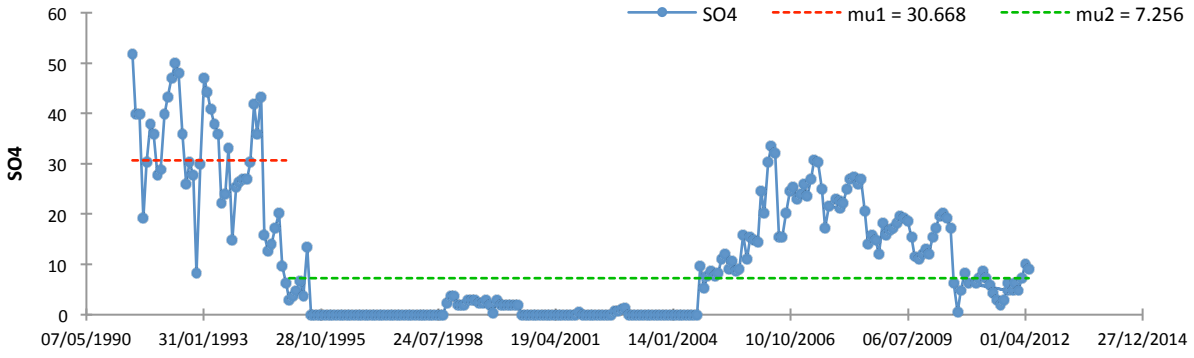


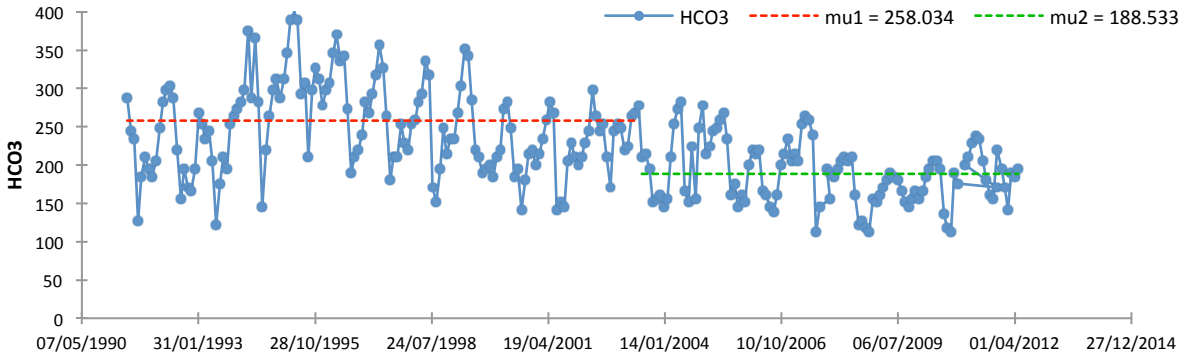


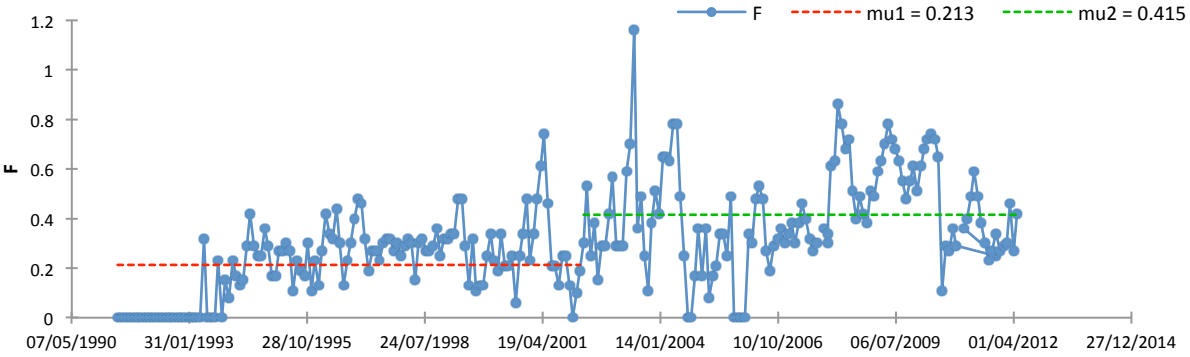

Na
mu1 = 19.468
mu2 = 14.892
35
30
25
20
15
10
5
0
07/05/1990
31/01/1993
28/10/1995
24/07/1998
19/04/2001
14/01/2004
10/10/2006
06/07/2009
01/04/2012
27/12/2014

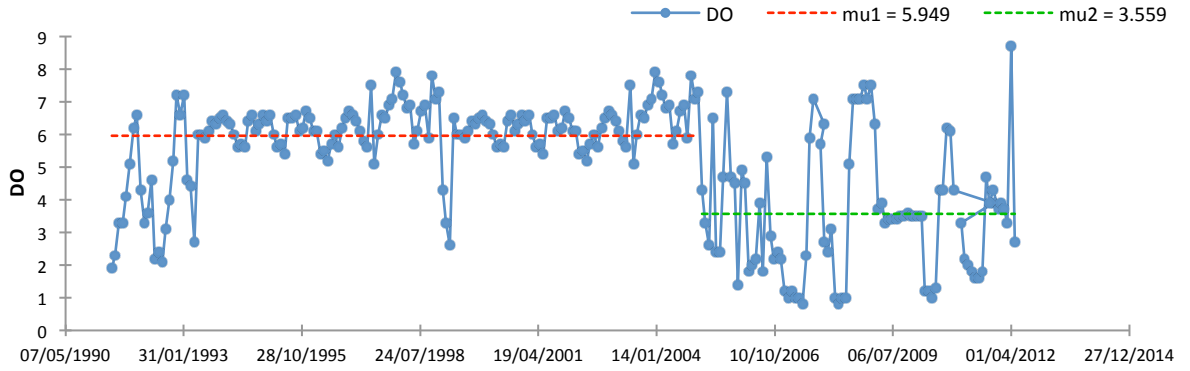

k
mu1 = 13.110
mu2 = 7.932
25
20
15
10
5
0
07/05/1990
31/01/1993
28/10/1995
24/07/1998
19/04/2001
14/01/2004
10/10/2006
06/07/2009
01/04/2012
27/12/2014


Cl
mu1 = 14.516
mu2 = 26.263
50
45
40
35
30
25
20
15
10
5
0
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


SO4
mu1 = 30.668
mu2 = 7.256
60
50
40
30
20
10
0
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


HCO3
mu1 = 258.034
mu2 = 188.533
HCO3
400
350
300
250
200
150
100
50
0
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


F
mu1 = 0.213
mu2 = 0.415
F
1.2
1
0.8
0.6
0.4
0.2
0
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


DO
mu1 = 5.949
mu2 = 3.559
DO
9
8
7
6
5
4
3
2
1
0
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

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