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Research Article

PHYSICO-CHEMICAL CHARACTERISTICS OF CANAL IN BHIMAVARAM TOWN ANDHRAPRADESH INDIA

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ABSTRACT: A Physico-chemical study of canal water samples collected from Upstream(CW1) midstream(CW2) and downstream(CW3) of Gostanadi Velpur canal in Bhimavaram, has been carried out for the suitability of surface water for drinking purposes, surface water was monitored for three different seasons namely, summer, rainy and winter during 2012-'13 was analyzed for pH, Turbidity, EC, TDS, Cl^-, SO_4^{2-}, NO_3^-, PO_4^{3-}, D.O, TH, Ca^{2+}, Mg^{2+}, F^-, Na^+, K^+ and BOD. The analytical results show that Turbidity values of canal exceed the recommended WHO limits in all the points (Upstream midstream and downstream) with three seasons while BOD values of midstream and downstream in rainy season exceed the recommended WHO limits. This study reveals that water of Canal is polluted with Turbidity and BOD. The sampling locations of CW3 (46.00 NTU) showed higher values of turbidity during rainy season. The results also indicated that the concentrations of nitrate, phosphate, K^+ and sulphate of the canal waters were low in the summer season but exhibited an increasing trend in rainy season, phosphate values were nil at the beginning of the monsoon season but whereas winter season showed a maximum value of 0.47mg/L. during the monsoon did not meet the WHO standards. The correlation analysis has proved that anthropogenic activities and percolation of domestic sewage into the canal water of the study area. The levels of parameters downstream were significantly elevated than the corresponding levels upstream. It is recommended that constant monitoring are needed to maintain water quality of the canal, which is a major source of potable water for Bhimavaram town.

Keywords: canal water, World Health Organization drinking water quality standards and Karl-Pearson Correlation

INTRODUCTION

Realizing the importance of water as elixir of life, the National Water Policy (2002) has rightly recognized it as a primary natural resource, basic human need and a precious national asset. Such a resource has remained the same in the last 2000 years whereas our population has increased fifty fold. This is the reason for water becoming scarce. This study aims to investigate the current status of a physico-chemical properties of Gostanadi Velpur canal water in Bhimavaram. A recent study is required to analyse the current status of surface water quality along the canal and hence this study was carried out with the aim of analyzing the quality of surface water along the Gostanadi Velpur canal.

MATERIALS AND METHODS

Study area

Bhimavaram is located between 16º32¹00 northern latitude and 81º32¹00 eastern longitude, with an average rainfall of 116.025mm per year and temperature variations between 21 and 48, The main canal, which takes off from the Godavari river on the right side from Vizzeswaram lock and head sluice, serves for both irrigation and navigation needs through various canals and tributaries. Irrigation in West Godavari is carried on through a network of canals, namely main canal, the Eluru canal, the Kakaraparru canal, the Narasapuram canal, the Bank canal, the Attili canal, the Junction canal and the Gostanadi Velpur canal, is the main source of surface water for Bhimavaram people. The total length of these canals is about 369 Kms. cultivating about 5, 19, 782 acres of land in the district (Henry Mantgomery, 1852). The study area, the town Bhimavaram with respect to state of Andhra Pradesh, India is shown in Fig. 1. Rain is the major made of precipitation of the area. The maximum temperature of the area was 48 and minimum was 21.

Sample analysis

The water samples were collected in pre-cleaned polyethylene bottles of 1L, about 1m away from the canal bank and at a depth of 1m, in the morning between 9 to 10 am at temperature 48, 28, 21 in the summer, rainy and winter respectively. The water samples were collected from three different locations (Table 1) like upstream, midstream and downstream during the year 2012-'13. The sampling sites are given in the table 1 and fig.1. The samples are transported to the laboratory of department of environmental science, Andhra University within 12 hrs. The physico-chemical parameters were determined by standard methods (APHA. 1998).

Table 1: Sampling locations with number, name, geographical coordinates and description of their surroundings.

S.No.	Sample Number	Sample name	Geographical Coordinates	Description of the sample location's surroundings
1	CW1	Gostanadi Velpuru Canal Upstream	N $16^0$32'50 E $81^0$33'08	Situated beside paddy fields
2	CW2	Gostanadi Velpuru Canal Midstream	N$16^0$32'39 E $81^0$32'53	Situated near by an aquaculture tank
3	CW3	Gostanadi Velpuru Canal Downstream	N$16^0$50'56 E $81^0$31'30	Situated adjacent to dumping yard

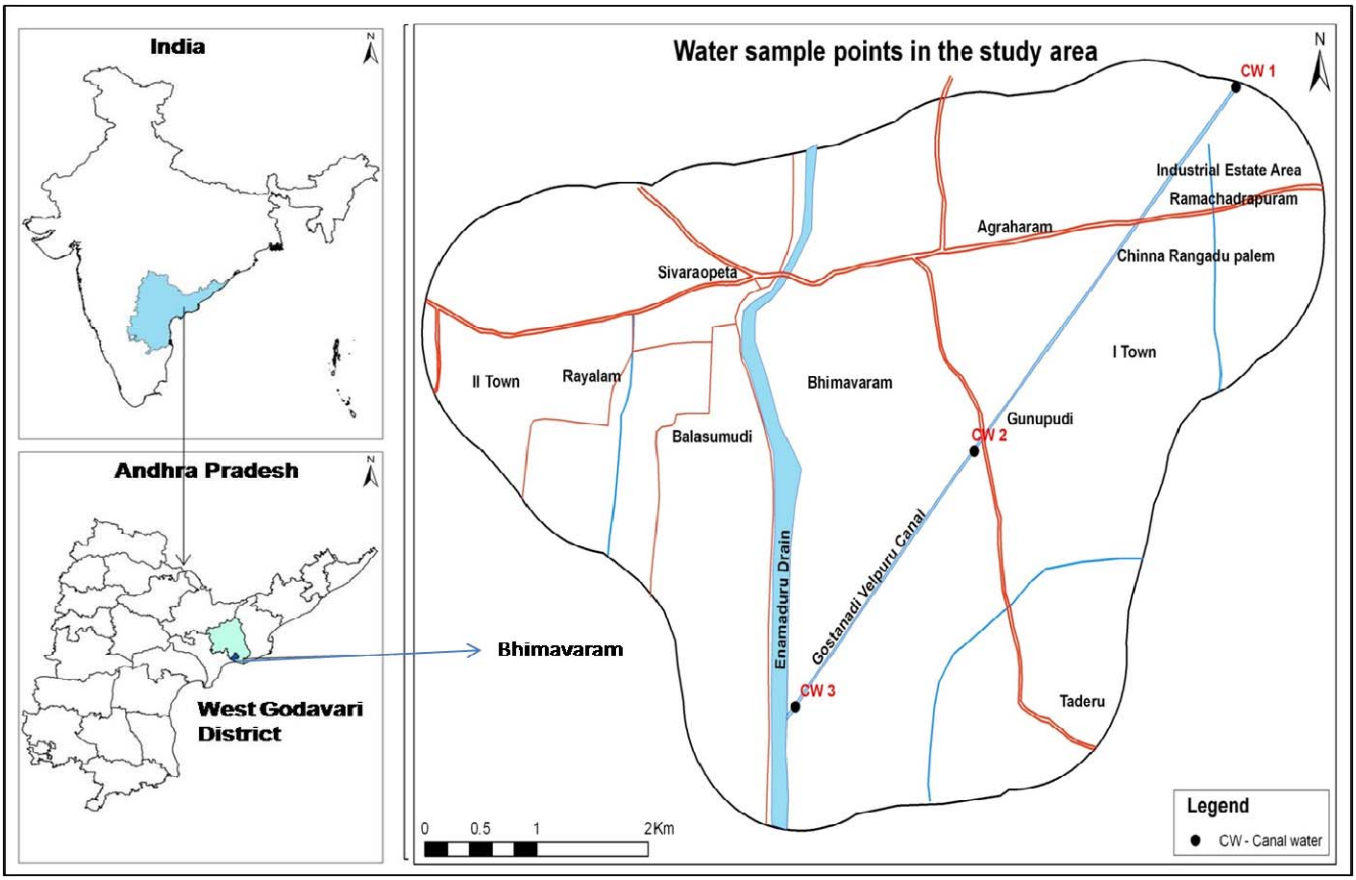


Fig.1 Locations of the sampling stations on Gostanadi Velpur canal in Bhimavaram study area

Statistical analysis

The samples were analyzed in triplicate, Graph pad prism version 6.0. To identify the correlation coefficients among the different parameters were computed as well.

RESULT AND DISCUSSION

Water quality analysis of Gostanadi Velpuru canal water at three different locations (upstream, midstream and downstream) at Bhimavaram

Water quality analysis of canal water at three different locations was performed and different chemical parameters were estimated and the results were shown in Table 2 and Fig. 2. The sampling points covered the length of 25 km at three different places, upstream (CW1), midstream (CW2) and downstream (CW3). It was observed that the concentration of different parameters is within the range excepting turbidity and BOD. Among the three different locations on the canal, during rainy season as per the table.2, the sampling locations of CW3 (46.00 NTU) showed higher values of turbidity. However, turbidity of all water samples from the canal water exceeded the WHO recommended limit of 5 mg/L throughout the study period. This can be attributed to the presence of clay and other suspended impurities. The appearance of water with a turbidity of less than 5 NTU is usually acceptable to consumers, although turbidity has no health effect but it can interfere with disinfection and provide a medium for microbial growth (WHO, 2004). The increase in turbidity could be attributed due to heavy soil erosion in nearby catchments and massive contribution of suspended solid from sewage canals. Another reason for this increase may also be due to surface runoff and domestic wastes. Similar results were reported by Khanna *et al.*, (2001) in their study on water quality of the Ganga canal at Haridwar, Bhuvaneshwari and Devika (2008) on Coovam River water, Jail 2009 on Hindone river water at Saharanpur and Tayyaba Aftab *et al.*, (2011) low turbidity values within the desirable limits of Lahore Branch canal water in Pakistan Verma, (2012) in his study of surface water of Allahabad region.

Results revealed that phosphate values were nil at the beginning of the monsoon season but whereas winter season showed a maximum value of 0.47mg/L (Table 2). During the monsoon, the increased levels of phosphate were due to precipitation which eroded the land containing fertilizer, the regeneration and release of total phosphorus from the bottom mud in the water column by turbulence, and also aquacultural backwaters which have come into the canal and mixture of soluble alkali metal phosphates in the upstream carried into the estuaries (Govindaswamy *et al.*, 2000).

The concentrations of nitrate, phosphate and sulphate of the canal waters were low in the summer season but exhibited an increasing trend in rainy season (Table 2). This might be due to discharge of several wastes into the canal including human excreta. However, these values did not exceed prescribed permissible limits of WHO. Similar results were reported by Kotaiah and Reddy (2004) in their study on canals located in Kurnool district. In the present study, the concentration of K^+ in the rainy season was found to be maximum value when compared to other seasons (Table 2). The reason for the increase in potassium content in the rainy season was due to the contributions from agriculture run-off filled with potassium fertilizers and waste effluents (Zafer and Sultanaeta, 2008). Higher values of BOD parameters were observed especially during rainy seasons (Table 2, Fig. 2). Higher value of BOD (15 mg/L) was observed in the CW3 sample during the rainy season of the year 2012-'13. It was higher than the BIS recommended limit of 5 mg/L. This may be due to the organic matter discharge, sewage, domestic waste and anthropogenic activities like bathing and washing. A similar observation was reported by Mishra *et al.*, (2003) in their study.

Table 2: Physico-chemical analysis of canal water samples in the study area during 2012-'13

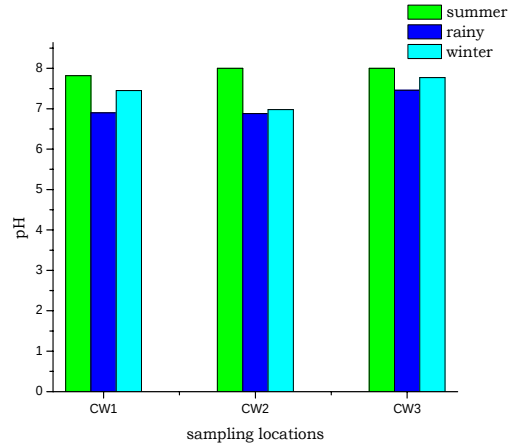
Name of the sample	pH	Turbidity	EC	TDS	Cl^-	SO_4^{2-}	NO^{3-}	PO_4^{3-}	D.O	TH	Ca^{2+}	Mg^{2+}	F^-	Na^+	K^+	BOD
during summer season																
CW1	7.82	29.00	210.00	116.00	20.00	29.12	2.30	3.20	6.20	92.00	15.74	15.78	0.34	17.20	1.60	2.10
CW2	8.00	35.00	220.00	123.00	23.00	30.90	3.50	4.50	5.20	104.00	16.00	18.56	0.40	17.80	2.00	3.21
CW3	8.00	39.00	234.00	133.00	30.24	30.98	4.60	5.90	4.00	118.00	17.00	21.52	0.34	18.00	3.00	6.80
During rainy season																
CW1	6.90	32.00	220.00	121.00	19.09	20.00	4.30	3.60	6.70	119.00	24.00	18.96	0.30	17.40	1.90	3.00
CW2	6.88	38.00	232.00	128.00	22.00	29.00	6.70	4.90	6.50	125.00	27.00	19.20	0.30	17.89	2.00	6.79
CW3	7.46	46.00	298.00	170.00	30.00	29.09	6.80	6.00	6.40	132.00	34.00	18.08	0.60	18.00	2.90	15.00
During winter season																
CW1	7.45	29.00	219.00	120.00	20.08	20.00	2.65	3.20	6.90	111.00	28.00	15.44	0.31	17.00	1.20	2.01
CW2	6.98	32.00	225.00	124.00	22.40	22.00	2.90	4.00	6.60	110.00	27.00	15.60	0.90	17.90	1.99	3.60
CW3	7.77	34.00	250.00	140.00	32.00	21.00	4.80	5.20	6.40	123.00	36.00	15.12	1.00	19.00	2.20	6.60

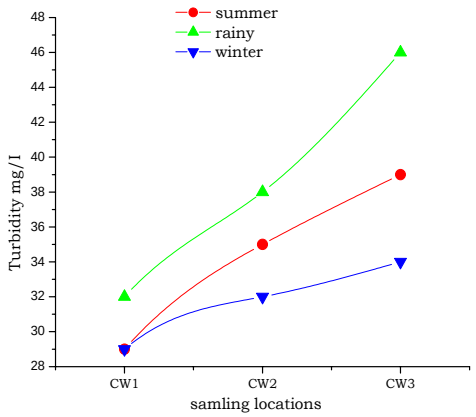
Concentration of all parameters are expressed in mg/L except pH, Turbidity (NTU) and EC (µS/ho).

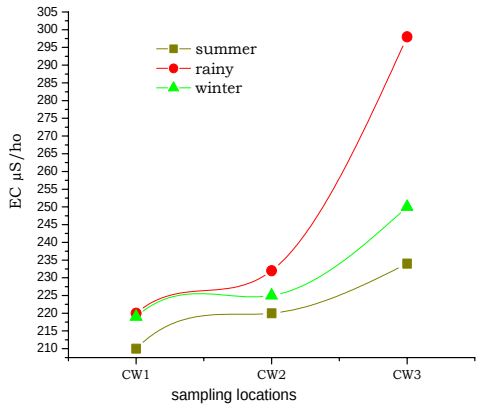
Earlier, the discharge of wastes (solid or liquid) into canals in the study area was very less due to low population, low agricultural and aquaculture activity. Further there was only paddy crop without any use of chemical fertilizers and pesticides. But now the agricultural activity and aquaculture activity has increased throughout the study area. People were using huge quantities of chemical fertilizers and pesticides. Owing to lack of awareness majority of the farmers were using huge quantities of fertilizers and pesticides than advised by the concerned agricultural authorities. Higher concentrations of several ions were finally reaching into the canal because of agricultural and aqua cultural back waters.

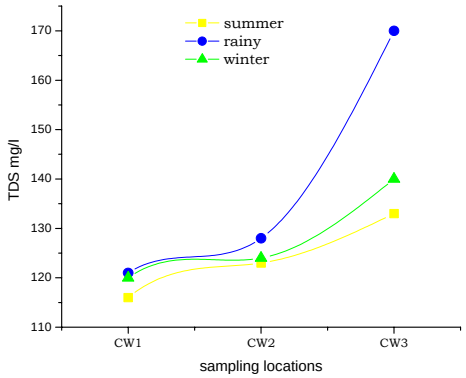
Table 3: Correlation matrix for physico-chemical parameters of canal water at three places during the study period 2012-'13 at Bhimavaram.

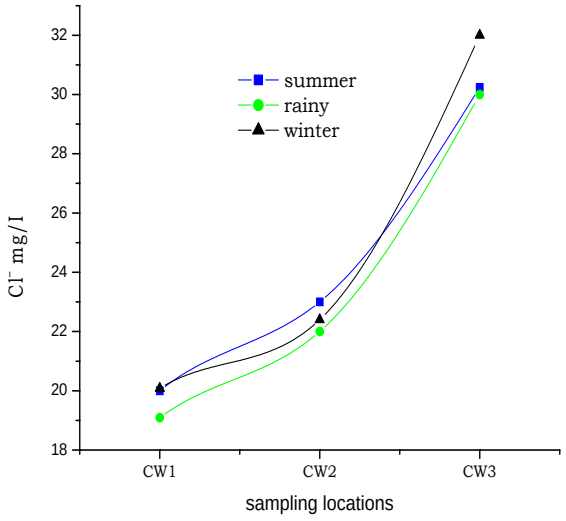
	pH	Turbidity	EC	TDS	Cl^-	SO_4^{2-}	NO^{3-}	PO_4^{3-}	D.O	TH	Ca^{2+}	Mg^{2+}	F^-	Na^+	K^+	BOD
pH	1.000															
Turbidity	0.026	1.000														
EC	0.168	0.812	1.000													
TDS	0.158	0.783	0.986	1.000												
Cl^-	0.525	0.550	0.714	0.703	1.000											
$SO4^{2-}$	0.350	0.200	0.148	0.171	0.141	1.000										
NO^{3-}	-0.219	0.856	0.709	0.684	0.444	0.219	1.000									
PO_4^{3-}	0.348	0.798	0.782	0.764	0.787	0.467	0.754	1.000								
D.O	-0.587	-0.327	-0.109	-0.120	-0.540	-0.479	-0.170	-0.589	1.000							
TH	-0.196	0.799	0.764	0.730	0.492	0.080	0.847	0.728	-0.043	1.000						
Ca^{2+}	-0.226	0.416	0.654	0.614	0.370	-0.276	0.428	0.302	0.461	0.723	1.000					
Mg^{2+}	0.033	0.532	0.168	0.176	0.177	0.475	0.582	0.587	-0.670	0.398	-0.347	1.000				
F^-	0.310	0.160	0.463	0.431	0.521	0.067	0.068	0.438	0.023	0.337	0.528	-0.244	1.000			
Na^+	0.473	0.382	0.538	0.497	0.794	0.266	0.390	0.725	-0.383	0.480	0.361	0.172	0.771	1.000		
K^+	0.307	0.225	0.476	0.523	0.465	0.504	0.198	0.553	-0.311	0.311	0.220	0.131	0.401	0.461	1.000	
BOD	0.064	0.846	0.910	0.913	0.589	0.421	0.805	0.839	-0.193	0.815	0.521	0.413	0.367	0.473	0.476	1.000

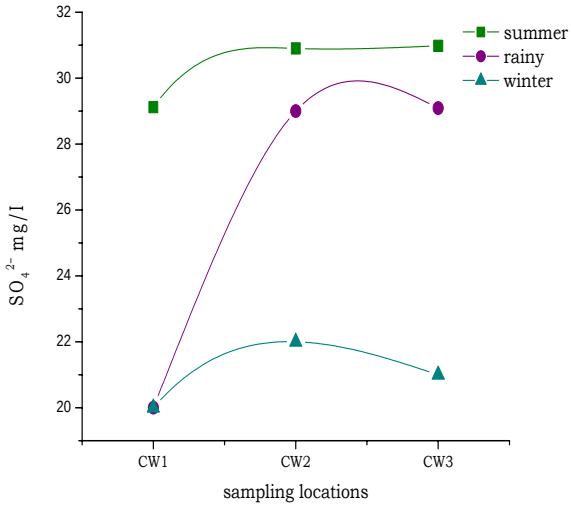


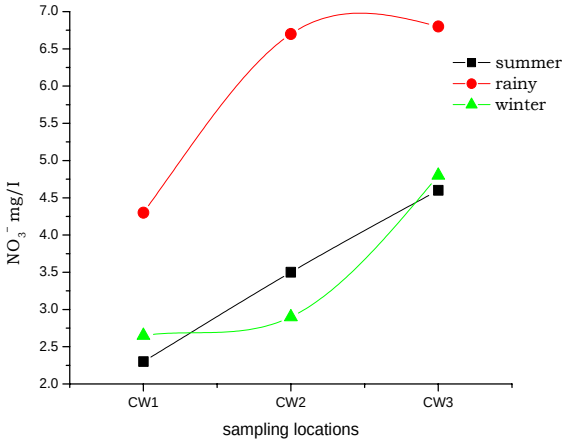


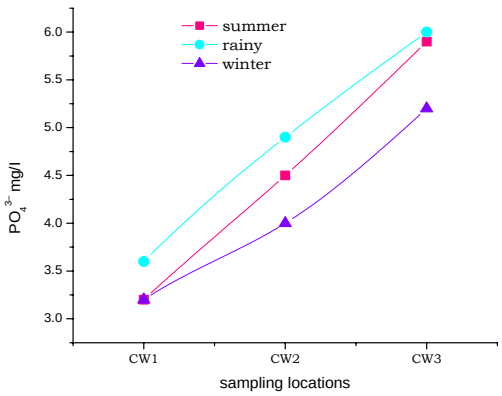


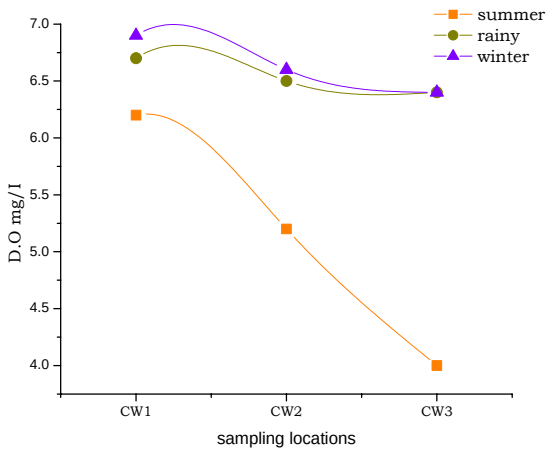


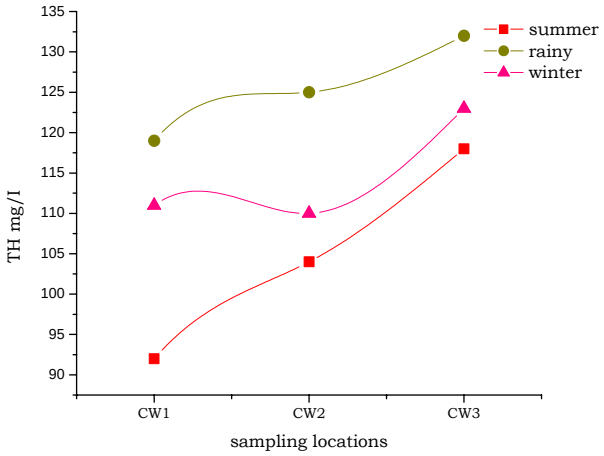

summer
rainy
winter
Cl⁻ mg/l
CW1
CW2
CW3
sampling locations


summer
rainy
winter
SO4 2- mg/l
CW1
CW2
CW3
sampling locations


summer
rainy
winter
NO3⁻ mg/l
CW1
CW2
CW3
sampling locations


summer
rainy
winter
PO4 3- mg/l
CW1
CW2
CW3
sampling locations


summer
rainy
winter
D.O mg/l
CW1
CW2
CW3
sampling locations


summer
rainy
winter
TH mg/l
CW1
CW2
CW3
sampling locations

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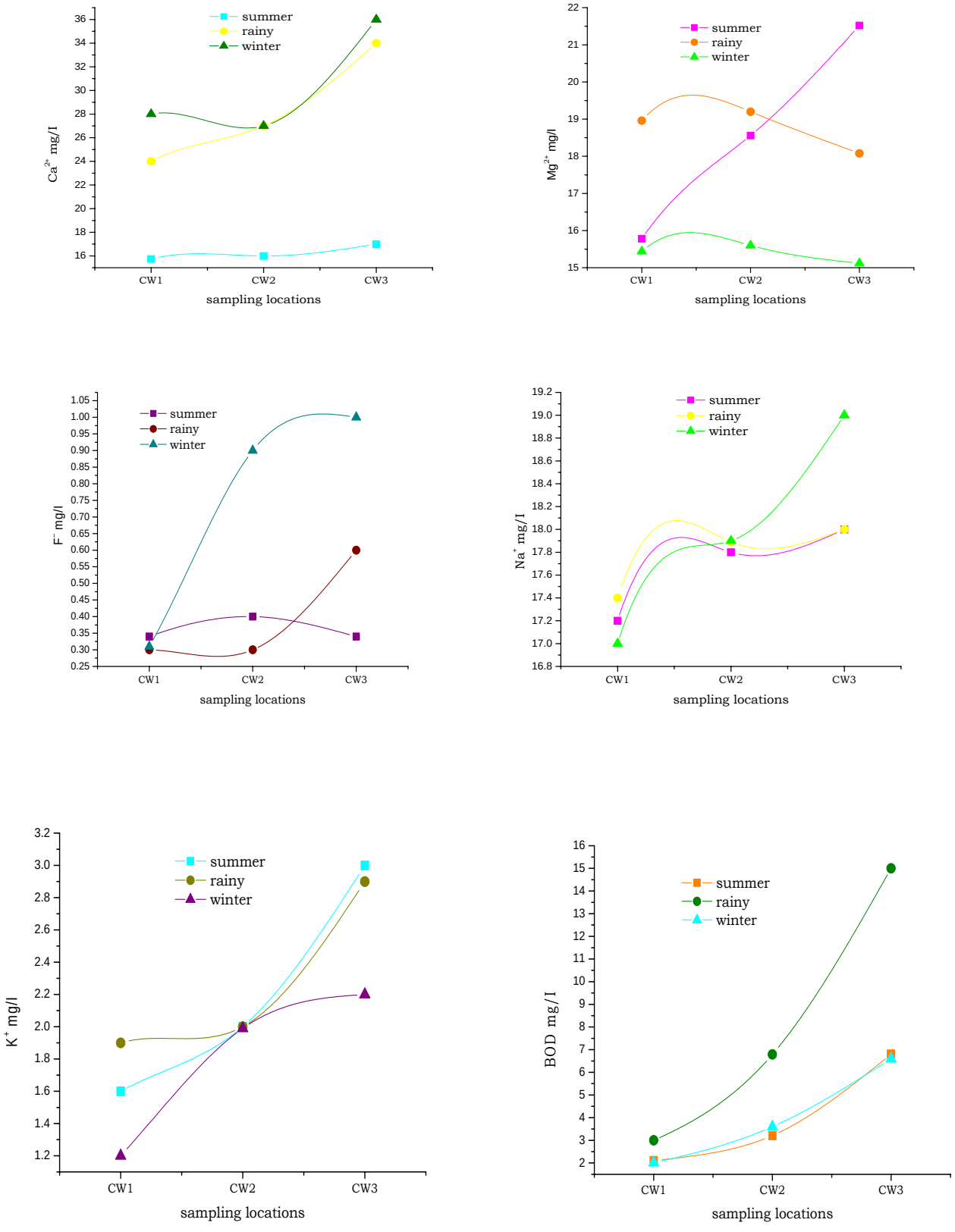

Fig-2: Seasonal (summer rainy and winter) disparity in physicochemical parameters at sampling locations

pH values of water samples vary in a narrow range within the BIS permissible limit of 6.5-8.5 thereby indicating the suitability of canal water for various uses. The samples from all the surface water sources (CW1, CW2 and CW3) were found well with respect to DO throughout the study period. It is attributed to direct diffusion of air across the air-water–interface. In addition to that, it may be due to penetration of direct sunlight across the wide surface canal which is capable of supporting photosynthetic activities of phytoplankton and helps in maintaining the DO level (Raja *et al.,* 2002). Maximum DO was recorded in the winter season but the minimum value in the monsoon season (Table 2). A similar pattern was also observed by Kataria and Jain,(1995) on the river Ajnar. A similar observation was made by Pandey *et al.,* (2003) on the Ganga canal at Haridwar, Khanna *et al.,* (2005) on river Panvdhoi at Saharanpur and Singh *et al.,* (2006) on river Ganga at Bulandshahar.

Correlation coefficient of physico-chemical parameters in Gostanadi Velpuru canal water at Bhimavaram

Correlation coefficients were one of the indices to assess the strength of the relationship between different variables (Kim *et al.,* 2007). The strong correlations between the elements generally indicate that these elements had the same input sources and similar geochemical behavior (Moore *et al.,* 2011). Pearson correlation analysis was used to describe the data to assess the suitability of the water for human consumption and domestication purposes (Okoro *et al.,* 2012). The correlations among different parameters in canal water in different regions were presented in Table. 3. From the results, it was observed that the pH was moderately positively correlated with major anion-chlorides (r=0. 525) and moderate negative correlation was observed with D.O (r=-0.587). Turbidity showed significant positive correlation with nitrate, BOD, EC, TH, phosphate and TDS (r=0.856, 0.846, 0.812, 0.799, 0.798, 0.783). The results revealed that the canal water was contaminated by anthropogenic activities and percolation of domestic sewage into the canal water of the study area. EC showed significant positive correlation with TDS, phosphate and TH (r=0.986, 0.782 and 0.764) and moderate positive correlation with major anions - chlorides, nitrates and phosphates (r=0. 714, 0.709, 0.782) and major cations - calcium (r=0.654), sodium (r=0. 538) which indicate the contribution of both cations and anions to the electrical conductivity of canal water. TDS shows significantly positive correlation with BOD and phosphate, (r=0.913, 0.764) and moderate positive correlation with chloride and nitrate (r=0.703 and 0.684). Total hardness exhibited a significantly positive correlation with calcium (r=0.723). The result revealed that calcium and bicarbonate were responsible for hardness. Sulphate showed moderate positive correlation with potassium (r=0. 504) and no significant correlation was observed with the other parameters. It suggests that the canal water was contaminated by agricultural back waters. During the study period, chloride shows significantly positive correlation with sodium and phosphate (r=0.794 and 0.787) and moderate positive correlation phosphate (r=0.521), which indicates that the anthropogenic activity was the cause of canal water pollution.

The correlation studies performed, showed a moderate correlation between calcium and fluoride (r=0.608, 0.528). This indicates the dominance of 'temporary hardness' over the 'permanent hardness' of water in the canal water.

CONCLUSION

According to my observations, considering the physico-chemical analysis the downstream water sample of canal i.e downstream (CW3) is found to be polluted when compared to up and mid stream waters. This may be due to leaching of urban waste, presence of dumping yard nearby and practice of open defecation. The quality of surface water in the Gostanadi Velpur canal is not suitable for human consumption but used for domestic purposes.

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