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Golden Research Thoughts

Abstract:-

The present study was undertaken to assess the water quality of the selected distributaries of river Cauvery in Tiruchirappalli district. Water samples were collected during 3 seasons (winter, southwest monsoon and northeast monsoon) and analysed for 14 physico-chemical parameters. While water from Cauvery was found fit for all uses (including domestic use) in all the three seasons, water from all the distributaries was found to be unfit for domestic use during winter; and water from Koolayar channel was unfit for domestic use in northeast monsoon too. However, water from all the channels in all the seasons were found suitable for irrigation and recreational uses. The sewage discharge, open defecation and agricultural run-off were the main sources of pollution.

Keywords:

Agricultural Run-off, Downstream, Sewage Discharge, Urbanization And Wqi.

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WATER QUALITY OF SELECTED DISTRIBUTARIES OF RIVER CAUVERY IN TIRUCHIRAPPALLI DISTRICT, INDIA

INTRODUCTION

Surface water is the major fresh water source easily available for the human consumption. A number of natural factors and human activities affect the quality of the surface water. In the last few decades, there has been a tremendous increase in the demand for freshwater due to rapid growth of population and the accelerated pace of industrialization (Ramakrishnaiah et al., 2009; Yisa and Jimoh, 2010). The municipal unsanitary practices, industrial activities and agricultural fields can discharge a variety of contaminants. These may impair the quality of the receiving water bodies, disrupting the ecosystem causing eutrophication (Alcamo et al., 2000 and EIWR, 2008). Human health is also threatened by the deterioration of the water quality (Okeke and Igboanua, 2003; Yisa and Jimoh, 2010). In addition to this, the world will face acute water scarcity in future. India is predicted to encounter this as earlier as 2025 (IWMI, 2003).

The distributaries of river Cauvery namely Ayyan (AY), Peruvalai (PV), Pullambadi (PB), Panguni (PG) and Koolayar (KY) are running through Manachanallur and Lalgudi regions (taluks). They originate at about 45 km distance from Upper-anicut (upper dam), and run through these regions to either confluence with Coleroon river or end up as lakes (Map 1). These channels are very important fresh water systems for drinking, agriculture, recreation and supporting life activities for 447,523 people (Census, 2011) in these regions. Common anthropogenic activities such as bathing, washings of clothes, cleaning of vessels and vehicles, open defecation, leachates from solid wastes and clandestine discharges of wastewater from industries are non-point sources of pollution in this study area. Hence, it is imperative to assess the extent of pollution and to take correcting measures to check the pollution.

Several studies have reported that the discharge of municipal sewage, industrial effluent and agricultural run-off were the major sources of pollution in river Cauvery and its distributaries/ tributaries (Vimala et al., 2006; Jameel and Hussain, 2005 & 2009; Kumarasamy et al., 2009; Umamaheswari and Anbusaravanan, 2009; Varunprasath and Daniel, 2010; Hema et al., 2010; Kathiravan et al., 2010; Kalavathy et al., 2011; Annalakshmi and Amsath, 2012; Jeena et al., 2012; Venkatachalapathy and Karthikeyan, 2013). However, no such study is available for the distributaries, Ayyan, Peruvalai, Pullambadi, Panguni and Koolayar. Hence the present study was undertaken to assess the water quality of these channels.

MATERIALS AND METHODS

Water sampling and Analyses

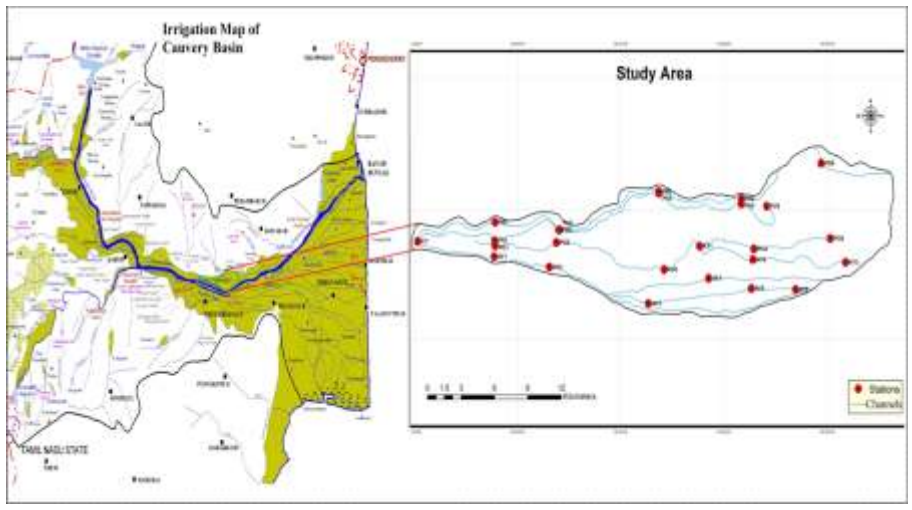
Surface water samples were collected by grab sampling method from river Cauvery and its five distributaries during winter (February), southwest monsoon-SWM (August) and northeast monsoon-NEM (October) in 2013. Upper-anicut was the sampling station for the Cauvery water. For all the 5 distributaries, water samples were collected at a distance of approximately 5 km each. During winter, there was no water available in some downstream stations of all channels at Lalgudi taluk. At these times, water was not collected. pH and DO were determined in the field itself. Each of the water samples was analysed for 14 physico-chemical parameters using standard methods (APHA, 1998).

Water Quality Index (WQI) computation

The WQI is one of the most effective tools to communicate information on water quality to the concerned stake holders and policy makers. WQI reflects the composite influence of different water quality parameters. WQI was calculated by the weighted arithmetic index method (Brown et al., 1972; Atulegwu and Njoku, 2004; Jameel and Hussain, 2005; Swarnalatha et al., 2007; Ramakrishnaiah et al., 2009; Yisa and Jimoh, 2010; Kalavathy et al., 2011; Purohit, 2014). The relative weight of each parameter in the overall water quality was computed with reference to the drinking water standards recommended by Central Pollution Control Board (CPCB, 2008) and Bureau of Indian Standards (BIS, 1993). The quality of water is ascertained as mentioned in table 1.

Table 1: Water quality index classification

Sl.No.	WQI value	Category
1	< 25	Clean
2	26-50	Good
3	51-75	Moderately polluted
4	76-100	Severely polluted
5	> 100	Unfit for human consumption



Map 1: Water sampling stations in distributaries of river Cauvery at Manachanallur and Lalgudi regions

RESULTS AND DISCUSSION

The physico-chemical characteristics of river Cauvery and its distributaries were presented in tables 2 – 7.

Table 2: Physico-chemical characteristics of river Cauvery at Upper-anicut

Season	pH	TDS	Turb.	TA	TH	DO	BOD	Cl^-	F^-	NO_3-	SO_4^{3-}	Ca^{2+}	Mg^{2+}	Fe
Winter	8.2	410	2.6	240	288	7.5	6.0	106.7	0.88	1.5	12.0	70.5	27.2	0.06
SWM	8.5	200	3.7	100	70	11.6	2.0	33.7	0.26	0.8	4.5	18.0	6.1	0.08
NEM	9.2	440	2.3	180	150	5.1	4.0	68.0	0.82	0.9	5.5	36.1	14.6	0.05

Table 3: Physico-chemical characteristics of Ayyan channel

Season	Station	pH	TDS	Turb.	TA	TH	DO	BOD	Cl^-	F^-	NO_3-	SO_4^{3-}	Ca^{2+}	Mg^{2+}	Fe
Winter	AY1	8.0	410	2.9	240	288	6.3	7.0	111.7	1.18	2.3	11.5	70.5	27.2	0.09
	AY2	8.2	420	2.6	250	292	6.8	8.7	124.1	1.22	2.4	12.0	70.5	32.1	0.10
	AY3	8.2	420	2.8	250	300	6.5	9.2	126.6	1.26	2.4	12.5	70.5	42.5	0.11
SWM	AY1	8.3	210	3.8	100	80	10.7	2.2	35.7	0.26	0.8	5.0	22.0	7.3	0.10
	AY2	8.2	215	4.1	100	80	9.4	3.7	33.7	0.24	0.8	5.5	20.0	7.3	0.12
	AY3	8.2	224	4.4	110	80	8.0	4.3	39.7	0.28	0.9	5.5	20.0	7.3	0.12
	AY4	8.1	226	5.2	100	90	6.7	3.3	39.7	0.26	0.8	6.0	18.0	10.9	0.13
	AY5	8.0	250	4.8	120	110	6.5	3.8	45.7	0.32	0.8	7.5	20.0	10.9	0.15
	AY6	8.1	270	4.7	110	120	6.4	4.9	51.6	0.38	1.0	8.0	24.0	12.2	0.17
NEM	AY1	9.0	460	2.5	180	160	5.3	4.2	68.0	0.72	0.8	5.5	32.1	19.4	0.06
	AY2	9.1	450	2.4	190	140	7.0	5.0	70.0	0.78	1.0	6.0	38.1	10.9	0.07
	AY3	9.2	410	2.7	170	145	7.5	6.7	62.0	0.90	1.4	7.5	34.1	14.6	0.08
	AY4	8.8	420	3.7	170	145	6.9	5.8	64.0	0.94	1.4	8.5	34.1	15.8	0.11
	AY5	8.6	430	4.2	180	160	6.4	6.0	76.0	0.90	1.5	8.0	36.1	17.0	0.09
	AY6	8.1	580	4.3	210	195	5.7	6.2	86.0	0.92	1.7	8.5	26.1	31.6	0.08

Table 4: Physico-chemical characteristics of Peruvalai channel

Season	Station	pH	TDS	Turb.	TA	TH	DO	BOD	Cl^-	F^-	NO_3-	SO_4^{3-}	Ca^{2+}	Mg^{2+}	Fe
Winter	PV1	8.2	420	3.3	250	290	7.9	8.0	99.3	1.18	2.0	11.5	70.5	27.2	0.08
	PV2	8.0	420	6.1	220	282	6.0	10.5	99.3	1.32	2.0	12.5	52.9	36.5	0.09
	PV3	8.0	420	6.3	250	290	5.7	12.6	106.7	1.36	2.2	13.5	56.1	42.5	0.10
	PV5	8.1	610	7.4	260	300	6.9	18.0	124.1	1.40	2.0	10.5	44.9	45.7	0.12
SWM	PV1	8.5	220	4.0	100	80	9.5	1.8	39.7	0.28	0.8	5.0	24.0	8.5	0.08
	PV2	8.6	235	4.1	100	85	9.3	2.6	41.7	0.30	0.8	5.0	22.0	7.3	0.10
	PV3	8.4	254	4.3	100	100	7.6	2.5	43.7	0.44	0.8	7.0	22.0	10.9	0.10
	PV4	8.4	252	4.3	100	85	7.6	4.1	41.7	0.42	0.7	5.0	22.0	7.3	0.12
	PV5	8.4	260	4.5	110	95	7.3	4.6	43.7	0.44	0.9	6.0	26.0	8.5	0.14
NEM	PV1	9.1	450	2.5	180	155	5.8	4.4	66.0	0.84	0.9	6.0	40.1	13.4	0.06
	PV2	8.9	450	2.8	190	165	5.6	4.3	64.0	0.84	1.0	6.0	36.1	18.2	0.08
	PV3	9.0	430	3.1	180	135	6.4	4.6	64.0	0.88	1.0	8.0	28.1	15.8	0.10
	PV4	8.6	460	4.0	190	155	6.3	4.7	68.0	0.92	1.3	8.0	32.1	18.2	0.11
	PV5	8.4	430	4.5	180	155	4.5	4.1	64.0	0.98	1.4	9.0	26.1	21.9	0.11

Table 5: Physico-chemical characteristics of Pullambadi channel

Season	Station	pH	TDS	Turb.	TA	TH	DO	BOD	Cl^-	F^-	NO_{3^-}	SO_4^{3-}	Ca^{2+}	Mg^{2+}	Fe
Winter	PB1	8.3	410	4.0	230	292	7.0	9.5	96.8	1.20	1.7	11.5	52.9	38.9	0.07
	PB2	8.4	400	4.6	230	292	10.2	10.0	99.3	1.28	2.0	12.5	64.1	32.1	0.07
	PB3	8.2	420	6.5	230	280	6.2	15.0	96.8	1.44	1.6	20.0	38.5	44.7	0.05
	PB4	8.3	430	5.8	240	290	6.0	12.5	101.7	1.42	1.8	20.0	44.9	45.7	0.08
SWM	PB1	8.5	229	3.8	110	75	9.1	2.3	35.7	0.28	0.8	4.5	24.0	8.5	0.08
	PB2	8.5	246	4.0	100	90	8.9	2.9	43.7	0.30	0.8	5.5	22.0	8.5	0.10
	PB3	8.4	312	4.5	110	100	8.4	3.2	43.7	0.30	0.8	5.8	24.0	8.5	0.13
	PB4	8.3	238	4.2	120	110	8.2	3.5	43.7	0.34	0.8	5.8	22.0	10.9	0.14
	PB5	8.2	252	4.7	100	100	8.0	3.9	41.7	0.36	0.8	12.0	24.0	12.2	0.16
NEM	PB1	9.0	480	2.7	180	165	5.4	4.1	68.0	1.18	1.0	6.0	40.1	15.8	0.06
	PB2	8.9	450	3.0	190	155	5.7	4.2	68.0	1.18	1.0	6.0	34.1	17.0	0.07
	PB3	9.2	420	3.5	170	140	6.5	4.1	64.0	1.12	1.1	7.5	28.1	17.0	0.08
	PB4	9.1	420	3.6	180	145	6.6	4.3	60.0	1.10	1.3	8.0	32.1	15.8	0.09
	PB5	9.2	440	4.1	180	150	7.6	5.0	66.0	0.94	1.4	8.5	26.1	20.7	0.08

Table 6: Physico-chemical characteristics of Panguni channel

Season	Station	pH	TDS	Turb.	TA	TH	DO	BOD	Cl^-	F^-	NO_{3^-}	SO_4^{3-}	Ca^{2+}	Mg^{2+}	Fe
Winter	PG1	7.9	470	4.7	270	348	8.1	8.5	101.7	1.32	2.0	12.5	60.9	47.6	0.10
	PG2	7.8	470	5.2	270	386	4.0	13.0	109.2	1.36	2.8	16.0	59.3	57.8	0.23
	PG3	8.3	550	9.3	280	420	4.6	17.0	126.6	1.46	1.6	15.5	49.7	71.9	0.17
SWM	PG1	8.4	245	5.6	130	110	7.2	3.5	43.7	0.38	0.8	8.0	26.0	12.2	0.14
	PG2	8.5	372	5.9	140	120	6.8	3.4	49.6	0.44	0.9	10.0	28.1	12.2	0.17
	PG3	8.4	300	6.2	150	135	6.4	4.7	53.6	0.44	1.1	11.5	34.0	12.2	0.20
	PG4	8.3	381	6.9	180	145	3.5	3.5	57.6	0.36	1.0	11.5	36.0	15.8	0.22
	PG5	8.2	470	7.1	170	160	2.8	7.2	65.5	0.32	1.3	11.5	38.1	15.8	0.24
NEM	PG1	8.3	550	5.6	230	190	5.1	4.6	92.0	1.06	1.8	8.5	32.1	26.7	0.10
	PG2	8.2	540	4.6	200	180	6.0	2.8	76.0	1.10	2.2	9.0	42.1	18.2	0.10
	PG3	8.5	540	4.5	210	180	7.6	3.9	84.0	1.14	1.7	9.0	36.1	21.9	0.12
	PG4	8.8	410	5.4	200	160	8.0	7.7	68.0	1.20	1.4	10.0	32.1	18.2	0.14
	PG5	9.3	400	5.2	170	130	10.1	8.0	64.0	1.22	1.1	10.5	24.0	17.0	0.11

Table 7: Physico-chemical characteristics of Koolayar channel

Season	Station	pH	TDS	Turb.	TA	TH	DO	BOD	Cl^-	F^-	NO_{3^-}	SO_4^{3-}	Ca^{2+}	Mg^{2+}	Fe
Winter	KY1	8.2	600	7.0	300	426	7.1	26.0	141.4	1.44	1.8	19.5	75.3	46.5	0.08
	KY2	8.4	480	6.7	310	470	5.6	22.5	136.5	1.58	6.2	20.0	80.2	56.1	0.09
	KY3	8.4	640	6.0	280	438	10.7	11.0	148.9	1.16	4.2	23.0	87.0	32.1	0.11
SWM	KY1	8.1	330	6.7	130	120	6.8	7.6	53.6	0.44	0.8	9.5	28.1	12.2	0.22
	KY2	7.9	420	6.3	160	120	6.4	7.1	53.6	0.40	0.9	10.0	30.0	12.2	0.20
	KY3	7.8	440	6.2	170	145	6.1	7.8	57.6	0.46	1.0	11.0	34.0	10.9	0.23
NEM	KY1	8.5	560	5.9	220	185	7.0	11.2	84.0	1.14	1.8	10.5	28.1	27.9	0.18
	KY2	8.4	580	5.2	210	205	6.7	10.8	86.0	1.12	1.9	9.5	40.1	26.7	0.14
	KY3	8.3	610	5.7	210	220	6.4	10.3	90.0	1.08	2.1	10.0	26.1	37.7	0.15

Cauvery: The pH of river Cauvery was alkaline in all 3 seasons and NEM has recorded the highest pH (9.2). The high amount of alkalinity was found in Cauvery water during winter season. The minimum DO (5.1mg/L) was found in NEM only. The BOD values exceeded the standard in winter and NEM. All other parameters were well within the limits of drinking water standards.

Ayyan: The maximum value of pH was observed at AY3 in NEM. The TDS values were found to within the limit except at AY6 (580 mg/L) in NEM. The water samples of Ayyan channel were found to be alkaline in all stations and the alkalinity exceeded the standard during winter season except at AY6. The amount of DO was found to slightly minimum in NEM at AY1 and AY6. The BOD values exceeded the standard in all samples in all seasons and high value was recorded at AY3 in winter. The fluoride slightly exceeded the limit in all water samples during winter. The amount of magnesium slightly exceeded at AY2 & AY3 in winter and AY6 in NEM.

Peruvalai: During NEM, the pH was beyond the prescribed limit except at PV5. The TDS value was away from limit only at PV5 in winter. During winter, turbidity exceeded the limit except PV1and alkalinity of the water samples also exceeded the standard value in all the samples. The BOD in all water samples exceeded the limit in all seasons except at PV1 in SWM.

Pullambadi: All the water samples were found to alkaline and high pH was found in NEM at downstream stations. During winter, the turbidity of the water samples was within the limit except at PB3 and PB4. Total alkalinity of the water samples were beyond the standard value in winter only. In NEM, DO was recorded as minimum at PB1 and PB2. The BOD exceeded in all the samples and high values were found in winter. The value of fluoride was well within the limit in SWM only. The amount of Magnesium exceeded the limit in winter season.

Panguni: In all three seasons, the samples were found to be alkaline and high pH (9.3) was recorded at PG5 in NEM. The TDS value exceeded at PG3 in winter. During NEM, the water samples of PG1, PG2 & PG3 were beyond the TDS standard. Turbidity exceeded the limit in all seasons in down streams. During winter, total alkalinity exceeded the limit and it slightly exceeded at PG1 & PG3 in NEM. Total hardness of the

water samples exceeded during winter season. DO was found to be minimum at PG2 & PG3 in winter and PG4 & PG5 in SWM. The BOD exceeded the limit in all seasons. During SWM, the fluoride was well within the limit in all the samples. Magnesium exceeded the standard in all samples in winter season.

Koolayar: During three seasons, the pH was within the prescribed limit for drinking water. Only in SWM, the TDS of all samples were found to within the limit. The turbidity of all stations was beyond the limit in all seasons. During winter, alkalinity of the water was away from the standard and slightly exceeded in NEM. Only in winter, total hardness of all water samples exceeded the standard value. The DO was recorded as minimum at KY2 in winter. The values of BOD in all water samples exceeded in all seasons. During winter and NEM, the amount of fluoride exceeded in all water samples. The amount of calcium and magnesium of Koolayar channel exceeded the standard in winter season. Magnesium exceeded the prescribed limit at KY3 in NEM. The chloride, nitrate, sulphate and iron in the Cauvery and other five channels were well within the standards in all seasons.

In the observation of physico-chemical characteristics of three seasons, NEM has recorded as high values of pH and winter has recorded low values in all water samples. The mixing of sewage and other pollutants through non-point sources into the distributaries might have caused the decrease in pH during winter. Low water flow in winter could be another possible reason for this.

The TDS values were increasing in all seasons at downstream stations of all channels mainly in the Koolayar channel followed by Panguni channel. It may be attributed to the contamination from non-point sources including agricultural run-off. As these distributaries serve as irrigation channels, they receive contaminants from agricultural run-off.

During the winter season, turbidity of all water samples was high in all channels. The Koolayar channel recorded the highest turbidity of all the channels in all the three seasons. The nutrient from agricultural run-off may be rich in nitrates and phosphates contributing to turbidity. In addition, inorganic clay/ silt from washing of top soil during flooding and inorganic/ organic contaminants from non-point sources and discharge of sewage/ industrial wastewater may also contribute to turbidity (Sawyer et al., 2003).

Total alkalinity was well within the limit during SWM in all channels. In winter, total alkalinity exceeded the standard (200mg/L) in all water samples including Cauvery water. It was due to the amount of carbonates, bicarbonates and hydroxides present in water (Ravichandran et al., 2014).

In Koolayar and Panguni, total hardness of water samples exceeded the standard value (300mg/L) during winter season. It could be due to dissolution of metallic ions from sedimentary rocks, seepage and run-off from soil (Ahluwalia, 2008 and Khatkar & Garg, 2008).

Except CY & PV1 in SWM, the BOD exceeded the standard value (2mg/L) in all the seasons in all the channels. This could be due to sewage confluences mostly in the down streams stations in Lalgudi region.

Variations in physico-chemical characteristics of water quality in all channels were due to the fluctuations in flows and quantities of water and wastes disposals. Moreover, decreased water flow could be the cause for the severe pollution in the winter season. Sewage discharge from domestic area of Samayapuram was the main source of pollution to Peruvalai and Pullambadi channels. Ayyan channel receive the sewage mainly from Lalgudi town. Thus, urbanization seems to be the chief cause for water pollution in the study area.

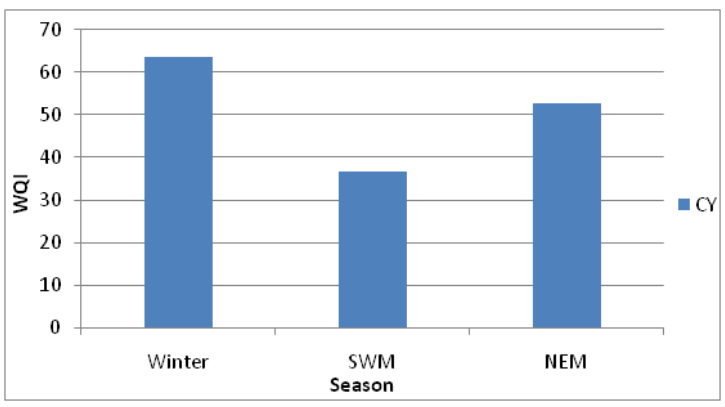


Fig 1: WQI of river Cauvery

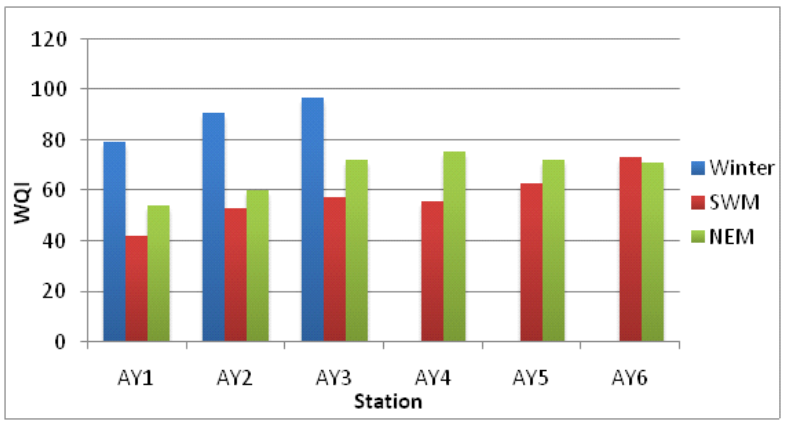


Fig 2: WQI of Ayyan channel

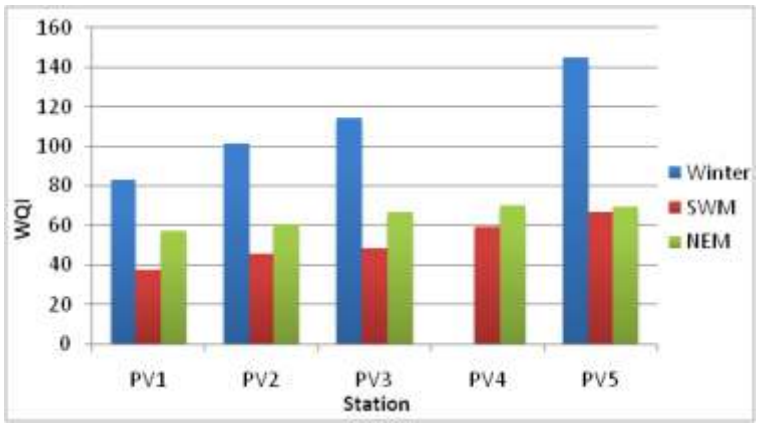


Fig 3: WQI of Peruvalai channel

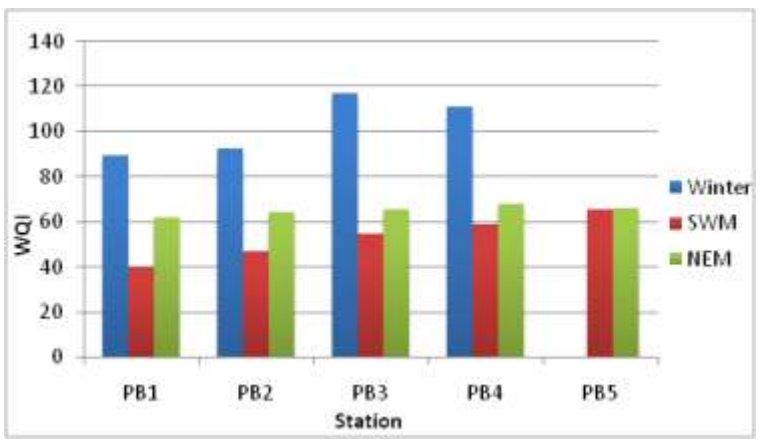


Fig 4: WQI of Pullambadi channel

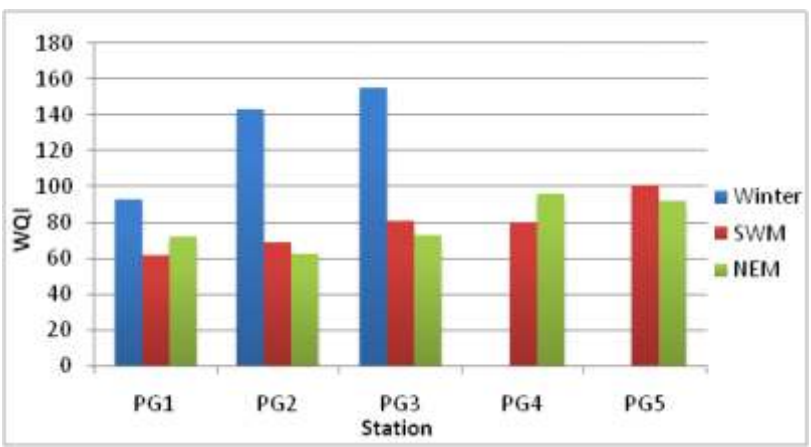


Fig 5: WQI of Panguni channel

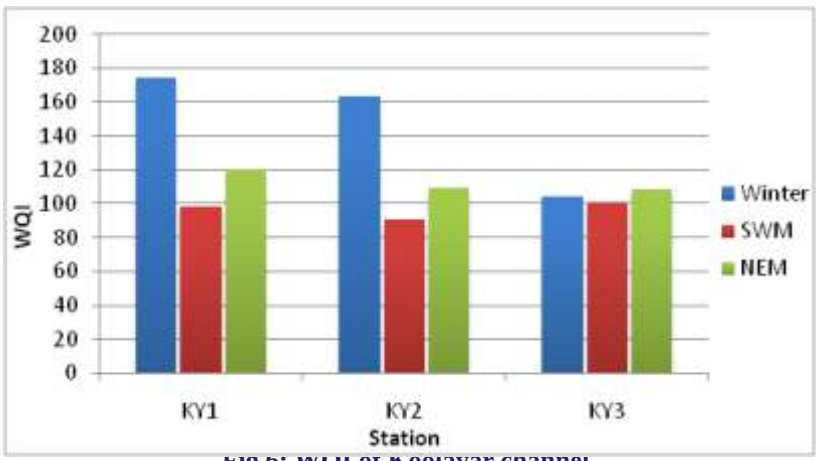


Fig 6: WQI of Koolayar channel

WQI of river Cauvery and their five distributaries are presented in figure 1 – 6. In Cauvery, the water fell under 'good' category during SWM and under moderately polluted in winter and NEM. During winter, the WQI values were increasing at downstream stations of all channels. This indicates the pollution of these channels along their course. Water samples of Koolayar channel at all locations fell under 'unfit for consumption'.

During SWM, the upstream samples of Ayyan, Peruvalai, Pullambadi were found to be 'good' category and remaining downstream samples were found to be 'moderately polluted'. The upstream samples of Panguni were found to be 'moderately polluted'. The downstream samples of Panguni and all samples of Koolayar fell under 'severely polluted' category.

In NEM, all the water samples of Ayyan, Peruvalai, Pullambadi and Panguni were found to be 'moderately polluted'. The samples of Koolayar fell under 'unfit for human consumption'. In nutshell, water quality in winter was found with maximum pollution in all the channels.

Conclusion

In this study, water was found to be highly polluted in winter season followed by NEM. The water from Koolayar channel was found unfit for drinking purposes. High agricultural run-off and human activities in the downstream of Lalgudi region were the causes of pollution. It is concluded that water from Cauvery river and their five channels may be used for recreational and agricultural purposes in all seasons. From the above findings, it is recommended that (i) people may be discouraged the practice of open defecation, (ii) Town/ village administrations may be advised to lay down proper sewage facilities and treatment of sewage before discharges.

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